

DIVERSITY AND DISTRIBUTION OF THE VERONICELLIDAE (GASTROPODA: SOLEOLIFERA) IN THE ORIENTAL AND AUSTRALIAN BIOGEOGRAPHICAL REGIONS

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We present the known diversity and distribution of Veronicellidae in the Oriental and Australian biogeographical regions. Material from several museums was used (Gomes & Thomé, 2001). The 13 species identified are: *Filicaulis bleekeri* (Keferstein, 1865), *Laevicaulis alte* (Férussac, 1821), *Sarasinula plebeia* (Fischer, 1868), *Semperula birmanica* (Theobald, 1864), *Se. carusi* (Simroth, 1893), *Se. insularis* Thomé (1983), *Se. maculata* (Templeton, 1858), *Se. parva* (Heynemann, 1885), *Se. thailandensis* Thomé et al., 1994, *Se. wallacei* (Issel, 1874), *Valiguna flava* (Heynemann, 1885), *Vl. siamensis* (Martens, 1867) and *Veronicella cubensis* (Pfeiffer, 1840). *Semperula* is mainly concentrated in the Australian region. *Se. maculata*, *Se. parva* and *Se. wallacei* are found in the Australian region, close to the Wallace line, with the exception of the latter which can also be found on the island of Upolu, much further to the east. *Se. insularis* is only recorded in the Christmas islands (Australia). *L. alte* and *Sa. plebeia* have the widest distribution, being found in both the Oriental and Australian regions. *F. bleekeri* and *V. flava* are restricted to a few Indonesian islands, near the Wallace line, while there are records of *Vl. siamensis* in Thailand and Sri Lanka. *Ve. cubensis* is recorded only in Hawaii and Guam, in the Australian region. □ *Mollusca, Soleolifera, Veronicellidae, distribution, Australian region, Oriental region.*

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The Veronicellidae Gray, 1840, has a tropical and subtropical distribution. It comprises land slugs totally devoid of shells, with a thick mantle (tegument), arched body and separate male and female genital pores, the former located anteriorly, under the right tentacle, and the other located medially, in the middle of the right hyponotum. They are well known throughout the world due to medical and economic importance of some species (Gomes & Thomé, 2001).

In the Oriental and Australian biogeographical regions (Fig. 1) the group has been the subject of considerable study, especially from 1821 to 1925. In this period more than 70 species were proposed, the descriptions based mainly upon colouration and morphology. Only occasionally did the descriptions contain general aspects of anatomy, where the greater part of the diagnostic characteristics of Veronicellidae is found.

Despite criticism from some authors (Baker, 1925; Thomé, 1975b), Grimpe & Hoffmann (1925a,b) and Hoffmann (1925) contributed considerably to knowledge of the Veronicellidae in these regions. They reassembled practically the entire synonymy of the Veronicellidae, furnishing important data about the systematic, distribution and morphology of 7 species, each of

which featured a long synonymic list. Species from these regions have also been studied by Forcart (1969, 1973), Bishop (1977), Thomé (1983, 1992), Thomé et al. (1994) and Gomes & Thomé (2001).

We aim to ascertain the current diversity and distribution of the Veronicellidae in the Oriental and Australian biogeographical regions for comparisons with the patterns of diversity found in the Neotropical and Ethiopian regions (Thomé, 1975a,b, 1988c, 1989, 1993b; Thomé et al., 1997; Forcart, 1953, 1963, 1967, 1969, 1973).

MATERIALS AND METHOD

Original descriptions, together with later characterisations and notes referring to the proposed species of Veronicellidae from the Oriental and Australian biogeographical regions were analysed. Type material in the Senckenberg Museum (SMF) (Frankfurt, Germany) (6 lots, 13 specimens), the Natural History Museum (BMNH) (London) (2 lots, 10 specimens) and Museu de Ciências e Tecnologia da PUCRS (MCP) (Porto Alegre, Brazil) (3 lots, 38 specimens) were examined. Data referring to 102 lots of Veronicellidae from diverse locations in the Oriental and Australian regions, previously



FIG. 1. Biogeographical regions according to Wallace (Cox, 2000).

examined and identified by Gomes & Thomé (2001), was considered. This material came from the Australian Museum (AM) (Sydney) (58 lots, 202 specimens), Field Museum of Natural History (FMNH) (Chicago) (25 lots, 119 specimens), Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (FZB) (Porto Alegre) (4 lots, 42 specimens) and the Muséum National d'Histoire Naturelle (MNHN) (Paris) (15 lots, 37 specimens). Specimens were dissected as described by Thomé & Lopes (1973).

The species described as synonyms were those whose types were examined and (or) whose descriptions and re-descriptions furnished sufficient anatomical detail. In those cases where this was not possible, objective synonyms proposed by Hoffmann (1925) and Grimpe & Hoffmann (1925a,b), were accepted and considered in the survey of registered occurrences. Synonyms from beyond the study area were not taken into synonymy of the species.

Localities mentioned conform to their present designations, according to The Times Atlas of the World (1994) and Debenham (1978).

RESULTS AND DISCUSSION

Filicaulis bleekeri (Keferstein, 1865)

Veronicella (*Vaginulus*) *bleekeri* Keferstein, 1865: 118-126.
Meisenheimeria (*Vanigula*) *bleekeri* Grimpe & Hoffmann, 1925a: 387.

Vanigula bleekeri Hoffmann, 1925: 135-137, 231-232; Grimpe & Hoffmann, 1925b: 8, 13-14, 23.

Filicaulis bleekeri Baker, 1925: 14; Hoffmann, 1927: 18-19.

Filicaulis bleekeri was proposed from Java (Indonesia), under the designation *Veronicella* (*Vaginulus*) *bleekeri* by Keferstein (1865). The original description is a relatively detailed anatomical study that includes descriptions of the radula and jaw. Grimpe & Hoffmann (1925a)

proposed *Vanigula* as a subgenus of *Meisenheimeria* Grimpe & Hoffmann, 1924 and included within it *Ve. bleekeri*. Hoffmann (1925) raised *Vanigula* to generic status at same year it was synonymised by Baker (1925) with *Filicaulis* Simroth, 1913. Hoffmann (1927) confirmed this synonymisation.

DISTRIBUTION OF *F. BLEEKERI*. Ambon, Anambas, Banda, Bornéo, Java, Sumatra (Indonesia) and Bangkok (Thailand) (Hoffmann, 1925; Grimpe & Hoffmann, 1925a,b).

The genus *Filicaulis* is also found in islands that form part of the Ethiopian biogeographical region (Comores, Madagascar e Seychelles) where, according to Forcart (1953), two other species are found.

Laevicaulis alte (Férussac, 1821)

Vaginulus alte Férussac, 1821: 14.

Vaginula alte Fischer, 1871: 157.

Vaginula maculosa Hasselt, 1830: 968; Semper, 1885: 325-326.

Vaginula frauenfeldi Semper, 1885: 324.

Vaginula leydigii Simroth, 1889: 552; Simroth, 1891: 861-906.

Veronicella willeyi Collinge, 1900: 431-434.

Vaginula leydigii celebensis Simroth, 1918: 282.

Vaginula leydigii keyana Simroth, 1918: 282.

Meisenheimeria alte Grimpe & Hoffmann, 1925a: 362-406; Hoffmann, 1925: 120-129; Grimpe & Hoffmann, 1925b: 8-13.

Laevicaulis alte; Baker, 1925: 18; Hoffmann, 1927: 3,18; Cowie, 1997: 38; Cowie, 1998: 38.

Laevicaulis alte was the first species of Veronicellidae proposed for the Oriental region. It was described by Férussac (1821) based upon material from Pondichery (India) as *Vaginulus alte*. *Vaginulus* Férussac, 1821 was improperly altered to *Vaginula* Berthold, 1827 (Thomé et al., 1997). From which point, *L. alte*, together with other species of Veronicellidae, were referred to as belonging to *Vaginula*. Grimpe & Hoffmann (1925a,b) included *L. alte* in *Meisenheimeria* Grimpe & Hoffmann, 1924 that was synonymised by Baker (1925) with *Laevicaulis* Simroth, 1913, which was accepted by Hoffmann (1927). Today, *L. alte* is well characterised and much is known of its anatomy, systematic, distribution and biology (Fischer, 1871; Grimpe & Hoffmann, 1925a,b; Forcart, 1953; Raut & Mandal, 1984; Raut & Panigrahi, 1988, 1989; Panigrahi & Raut, 1992; Thomé et al., 1997; Thomé et al., 2001). Gomes & Thomé (2001) examined lots of *L. alte* from Oriental and Australian regions, adding new morphological and anatomical characteristics.

Although, in the original study *Vaginula maculosa* Hasselt, 1830, was described from Java (Indonesia), there is only a brief characterisation of the morphology and colouration, the samples were later re-examined by Semper (1885). He outlined the structures used to identify the species of Veronicellidae at that time (external colouration, position of the female genital pore, penis and penial gland). Semper (1885) proposed *Va. frauenfeldi* based on material from Madras (India), the anatomical description was the same as that for *Va. maculosa*. His descriptions and illustrations of these two species coincide perfectly with those for *L. alte*. Moreover, *L. alte* is found in Indonesia as well as India.

Simroth (1889), based upon morphological and anatomical characteristics proposed *Va. leydigi*, for Brisbane. Simroth (1891) added detailed descriptions of the reproductive, nervous and digestive systems, and included comparative histological studies of two other species found in the Oriental and Australian regions. Simroth (1918) upon finding *Va. leydigi* in Sulawesi and the Kay Islands, proposed *Va. leydigi celebensis* and *Va. leydigi keyana*. The specimens, according to the author, presented variations in size of the penis, number of gland tubules and intensity of colouration when compared to the original species. According to the system of Veronicellidae currently in use, Simroth's (1889) subspecies are not valid, given that variations of this type are often found in Veronicellidae, between different populations and even within the same population (Martins, 1998; Soares & Thomé, 2002; Gomes & Thomé, 2001, 2002). *Va. leydigi* is a synonym of *L. alte* according to Simroth (1889). Only two species of Veronicellidae are found in Australia, *L. alte* and *Sa. plebeia*, both well known (Burch, 1976; Bishop, 1977; Smith, 1984).

Paratypes of *Veronicella willeyi* from Lifou (New Caledonia), proposed by Collinge (1900) and deposited in the Natural History Museum (BMNH-1905.4.12.9-10), were examined and the anatomy corresponds to that of *L. alte*.

DISTRIBUTION. Moa, Murray, Thursday Islands (Torres Strait), Cardwell, Cooktown, Lismore, Mission Beach, Rockhampton, Yeppoon, NorthWest island (Queensland), Hong Kong, (China), Viti Levu (Fiji), Midway, Molokai, Oahu, Honolulu, Hawai (Hilo, Kailua) (Hawaii), Andaman, Madras, Pondichery (India), Ambon, Bali, Banda, Java, Kai, Halmahera (Ternate), New Guinea (Sarmi),

Sulawesi (Raha), Sunda, Timor Timur (Tenimber), (Indonesia), Pinang (Malaysia), Bourail, Koné, Lifou, Nouméa, Maré, Oubatche, Ouvéa (New Caledonia), Manila, Mindanao (Philippines), Takao, Auping (Taiwan), Éfaté, Espiritu Santo (Vanuatu) and Upolu (Western Samoa) (Grimpe & Hoffmann, 1925a,b; Hoffmann, 1925, 1927, 1930; Forcart, 1969, 1973; Bishop, 1977; Thomé, 1989; Cowie, 1997, 1998; Thomé et al., 1997; Gomes & Thomé, 2001). Gomes & Thomé (2001) first registered the species in Fiji, Malaysia and New Guinea.

Laevicaulis occurs in Africa where, 8 species occur, among them *L. alte*, the only species of the genus found outside the African continent (Forcart, 1953). The species has recently been registered in the Bermudas and Texas (U.S.A) (Thomé, 1989; Thomé et al., 1997).

***Sarasinula plebeia* (Fischer, 1868)**

Vaginulus plebeius Fischer, 1868: 146; Thomé, 1971: 34-36.
Vaginula andreana Semper, 1885: 321.

Veronicella hedleyi Simroth, 1889: 552; Simroth, 1918: 861-906.

Vaginula levucana Simroth, 1918: 262-290.

Vaginula samoana Simroth, 1918: 290-291.

Vaginula tahitiana Simroth, 1918: 290-292.

Sarasinula plebeia Grimpe & Hoffmann, 1924: 177; Grimpe & Hoffmann, 1925a: 19-26; Hoffmann, 1925: 190, 251-252; Grimpe & Hoffmann, 1925b: 344-406; Thomé, 1975b: 25-27.

Imerinia plebeia Baker, 1925; Hoffmann, 1934: 259-260.

Vaginula plebeia Cowie, 1997: 38.

Vaginulus (Sarasinula) plebeius Forcart, 1969: 149-150; Aguayo, 1964; Forcart, 1973; Cowie, 1998.

Sarasinula plebeia Thomé, 1975b: 25-27; Gomes & Thomé, 2001: 141-143; Gomes & Thomé, 2002.

Sarasinula plebeia was originally assigned to *Vaginulus* Férussac, 1821 based upon a drawing received by the senior author from correspondents in Nouméa (New Caledonia). The species served as a base for *Sarasinula* Grimpe & Hoffmann, 1924, synonymised with *Imerinia* Cockerell, 1891 by Baker (1925) and Hoffmann (1934). Thomé (1971), after having examined 3 specimens from New Caledonia, in the Muséum National d'Histoire Naturelle (Paris), chose one to be a plesiotype. Thomé (1975b), in his revision of the Veronicellidae in the Neotropical region, considered *Sarasinula* valid. Gomes & Thomé (2001, 2002) examined specimens of *Sa. plebeia* from various localities of the regions under study, including New Caledonia. Based on this material they re-described, in detail, the anatomy of the species and assessed the intraspecific variability between species originating from 7 countries of the Australian region.

Following examination of the types of *Vaginula andreana* Semper, 1885 from Mauritius, Thomé (1988b) revalidated the species in *Sarasinula*. Prior to this, Hoffmann (1925) had considered the species a synonym of *Sa. plebeia*. Assessing the anatomical descriptions of *Va. andreana* performed by these authors and considering the morphological variability of *Sa. plebeia* in the Australian region (Gomes & Thomé, 2002) it is verified that the synonymy suggested by Hoffmann (1925) be maintained.

Simroth (1889) proposed *Va. hedleyi*, taking into consideration morphological and anatomical characteristics of material from Brisbane (Australia). After comparing the two species from the region, Simroth (1891) re-described the species, furnishing data, including histological sections, on the reproductive, nervous and digestive systems of *Va. hedleyi*. From these descriptions and illustrations we confidently include this species in the synonymy of *Sa. plebeia*.

Simroth (1918) upon analysing veronicellids from various Pacific Ocean islands, proposed various species, in general, differentiated by inconsistent and invalid details, such as colouring and minimal differences in the position of the female genital pore and number of gland tubules. Among these, *Va. levucana* (type locality: Viti Levu, Fiji), *Va. samoana* (type locality: Apia, Western Samoa) and *Va. tahitiana* (type locality: Papeete, Tahiti), are all synonyms of *Sa. plebeia*. As well as the original descriptions, paratypes of *Va. samoana* (SMF-45245/3), *Va. levucana* (SMF: 45239/4) and the holotype of *Va. tahitiana* (SMF-45246/1) were examined.

DISTRIBUTION. Atherton, Brisbane, Cairns, Cardwell, Cooktown, Gladstone, Innisfail, Lismore, Proserpine, Rockhampton, Saint George, Sarina, Townsville, Repulse Bay (Queensland), Grafton, Muswellbrook, Clarence (New South Wales), Darwin (North Territory), Bau, Levuka, Viti Levu (Fiji), Hawaii, Oahu (Hawaii), Ambon, Halmahera, Sumatra (Toba) (Indonesia), Guam, Saipan (Marianas), Bourail, Canala, Ilha dos Pins, Koné, Lifou, Maré, Nouméa, Oubatche, Ouvéa, Yaté (New Caledonia), Leyte, Manila (Philippines), Bougainville (Solomon Islands), Papeete, Tipaerui Valley (Tahiti), Tonga island, Mangareva (Tuamotu), Aoba, Malakula, Malo, Efate, Espiritu Santo (Vanuatu) and Apia, Savai'i, Upolu (Western Samoa) (Grimpe & Hoffmann, 1925a,b; Hoffmann, 1925, 1927, 1934; Forcart, 1969,

1973; Bishop, 1977; Cowie, 1997, 1998; Gomes & Thomé, 2001). Gomes & Thomé (2001) first registered the species in New South Wales and the Northern Territory (Australia), the Solomon Islands, Tonga and Tuamotu.

Sarasinula Grimpe & Hoffmann (1924) occurs in the Neotropical, Australian and Ethiopian regions (Madagascar and the Comoros). This appears to form a natural group of species, relatively close in evolutionary terms and consequently similar morphologically. Due to this, there is still no consensus as to how many are valid species (Gomes & Thomé, 2002).

***Semperula birmanica* (Theobald, 1864)**

Vaginulus birmanicus Theobald, 1864: 243-244.

Vaginula birmanica Tapperoni-Canefri, 1889: 337-338.

Semperula birmanica Grimpe & Hoffmann, 1925a: 338, 394; Hoffmann, 1925: 182-186, 254-255; Grimpe & Hoffmann, 1925b: 8, 17, 36-38; Thomé et al., 1994: 597.

Semperula birmanica was proposed by Theobald (1864), based upon specimens from Rangoon (Burma). It was originally included in *Vaginulus*. Hoffmann (1925) did not examine the holotype, but found material from museums in Vienna and Berlin that Tapperoni-Canefri (1889) identified and described as this species. Even though he did not have anatomical descriptions, based upon morphological descriptions Hoffmann (1925) concluded that the authors were dealing with the same species. Based upon this material, Hoffmann (1925) described, in general the anatomy of *Va. birmanica*, and included it in *Semperula*.

The species is similar to *Se. maculata*, although, when examined closely and described by Grimpe & Hoffmann (1925a) and Hoffmann (1925), the penis, considered the principal specific diagnostic feature of Veronicellidae, exhibits a 'honeycomb' aspect with a turned up 'fingerlike' projection, which is relatively characteristic. Thomé et al. (1994), upon proposing a new species of *Semperula*, considered *Se. birmanica* a valid species from the original literature and subsequent citations.

DISTRIBUTION. Bhamo, Pegu, Rangoon, Tenasserim, Thayet-Myo (Burma), Hong Kong, Macau, Tonquim (China), Arrakan, Calcutta, Bengal, Sikkim (India), Bali, Java, Lombok, Sumatra (Padang) (Indonesia), Melaka, Pinang (Malaysia), Manila, Mindanao (Zamboanga), Samar, (Philippines) and Ho Chi Minh (Viet Nam) (Hoffmann, 1925, 1928, 1930; Grimpe & Hoffmann, 1925a,b).

Semperula Grimpe & Hoffmann, 1924, is restricted to the Oriental and part of the Australian biogeographical regions, where 7 valid species occur.

***Semperula carusi* (Simroth, 1893)**

Vaginula carusi Simroth, 1893: 65-69.

Semperula carusi Thomé, 1992: 100-101.

Se. carusi was originally described from Singapore by Simroth (1893) who supplied important data on its morphology and anatomy. Hoffmann (1925) and Grimpe & Hoffmann (1925a,b), after analysing the type material, considered it a synonym of *Se. maculata*. However, Thomé (1992), after re-examining the lectotype and paralectotypes, in the Zoologisches Museum (Berlin, Germany), re-described and revalidated *Se. carusi* for having singularities that differentiate it from all the other anatomically known species of the genus.

DISTRIBUTION. Singapore (Simroth, 1893; Thomé, 1992).

***Semperula insularis* Thomé, 1983**

Semperula insularis Thomé, 1983: 15-18.

Se. insularis Thomé, 1983 from Christmas Island (Australia) represents a valid species, with peculiar morphological characteristics.

DISTRIBUTION. Christmas Island (Thomé, 1983).

***Semperula maculata* (Templeton, 1858)**

Vaginula maculata Templeton, 1858: 49-50; Semper, 1885: 322.

Vaginula hennigi Simroth, 1889: 552; Simroth, 1891: 861-906.

Semperula maculata Grimpe & Hoffmann, 1925a: 389-90, 392; Hoffmann, 1925: 175-9, 210-1, 258-60; Grimpe & Hoffmann, 1925b: 38-9; Hoffmann, 1927: 37; Hoffmann, 1930: 98-9; Hoffmann, 1934: 255-6; Thomé, 1992: 98-100.

Vaginula creophila Simroth, 1918: 261, 288-9; Hoffmann, 1941: 239-41.

Vaginula rufiglandula Simroth, 1918: 261, 283-4; Hoffmann, 1941: 237.

Vaginula rufiglandula rufescens Simroth, 1918: 261, 283; Hoffmann, 1941: 237.

Vaginula newtoni Simroth, 1893: 68-9.

Vaginula borneensis Simroth, 1897: 142-4.

Vaginula variegatula Simroth, 1918: 284.

Vaginula signata Simroth, 1918: 248.

Vaginula signata signator Simroth, 1918: 284.

Vaginula svelana Simroth, 1918: 284.

Se. maculata, proposed by Templeton (1858) based upon material from Colombo (Sri Lanka), is not identifiable from the original description. Despite this, Semper (1885), attributed specimens to this species, describing the aspect of the penis,

the penial gland and pedal nerves. The same structures were re-described by Grimpe & Hoffmann (1925a,b) and Hoffmann (1925), following the re-examination of Semper's (1885) specimens. Thomé (1992) re-described *Se. maculata*, agreeing with the attributions proposed by Semper & Hoffmann (1925). Gomes & Thomé (2001) examined a lot originating from Kuala Lumpur (Malaysia), whose anatomy corresponded to that already known for *Se. maculata*. This material was used to augment the anatomy of *Se. maculata*.

Vaginula hennigi was proposed by Simroth (1889) from Cambodja (Thailand) and re-described in detail (Simroth, 1891). As with the other two species mentioned by Simroth (1889, 1891), *Va. hennigi* exhibits sufficient morphological, anatomical and histological descriptions for synonymisation.

Hoffmann (1930, 1941) validated *Va. variegatula* Simroth (1918) and *Va. signata* Simroth (1918) from Lombok, after analysing the type material of both; he included them in *Semperula*. The two species had been considered synonyms of *Se. maculata* by Hoffmann (1925). The fact of the penial opening is located 'a little' further forward and the small differences in the size and location of the female genital pore used by Hoffmann (1930, 1941) to propose revalidation, are not sufficient justification. Moreover, the samples used were juvenile, which naturally display differences in the shape of the reproductive structures. Therefore, these two species should remain as synonyms of *Se. maculata*. The same can be argued in relation to *Va. signata signator* and *Va. svelana*, proposed by Simroth (1918) due to the variations of external colour. Holotypes of *Va. signata* (SMF-45226/1), *Va. svelana* (SMF-45220/1) and paratypes of *Va. signata signator* (SMF-45231/3) were examined.

Thomé (1992) proposed *Va. creophila* and *Va. rufiglandula*, originally described by Simroth (1918) from Lombok and Sulawesi (Indonesia) respectively, as synonyms of *Se. maculata* and *Va. rufiglandula rufescens*, from the same location as the nominal species. Together with these, the synonymy also includes *Va. newtoni* Simroth, 1893, from Java and *Va. borneensis* Simroth, 1897 from Borneo (Indonesia). All these species are synonyms of *Se. maculata*, in accordance with criteria presented by Thomé (1992).

DISTRIBUTION. Luwu, Tonquim (China), Madras (India), Ambon, Bali (Gitgit), Banda, Borneu (Baram), Bogor, Flores, Halmahera (Ternate), Jakarta, Java, Lombok (Swela, Sadjang, Sapit), Manila, Nias, Salayar, Sumatra, Sulawesi, Sumbawa, (Pandang and Singkarak) (Indonesia), Singapore, Kuala Lumpur (Malaysia), Mindanao, Manila (Philippines), Colombo, Galle, Kandy, Ratnapura (Sri Lanka) and Bangkok, Cambodia (Thailand) (Hoffmann, 1925, 1927, 1930; Thomé, 1992; Gomes & Thomé, 2001).

***Semperula parva* (Heynemann, 1885)**

Vaginula parva Heynemann, 1885: 89-90, 122-3.

Vaginula chavesi Simroth, 1893: 66.

Vaginula djiloloensis Simroth, 1897: 140-142, 144.

Semperula parva Thomé, 1992: 92-94, 100-101.

Se. parva was recorded in Indonesia and the Philippines due to a synonymy specified by Thomé (1992). After examining type material of species from this region, he proposed the revalidation of *Se. parva*, considering *Va. djiloloensis* Simroth (1897), from Halmahera (Indonesia) and *Va. chavesi* Simroth (1893), from Mindanao (Philippines), as synonyms of the former. Based upon the original descriptions of the species and the argument presented by Thomé (1992), these synonymies are accepted. *Se. parva* was described from the Seychelles Islands (Indian Ocean) by Heynemann (1885), being considered a synonym of *Se. maculata* by Hoffmann (1925).

DISTRIBUTION. Halmahera (Indonesia) and Mindanao (Philippines) (Thomé, 1992).

***Semperula tailandensis* Thomé et al, 1994**

Semperula tailandensis Thomé et al., 1994: 597-604.

Se. tailandensis was described by Thomé et al. (1994) from Salaya Nakhon (Thailand). The type material was re-examined by Gomes & Thomé (2001) who re-characterised the species. The species has sufficient anatomical characteristics to differentiate it within the Veronicellidae.

DISTRIBUTION. Salaya Nakhon (Thailand) (Thomé et al., 2001; Gomes & Thomé, 2001).

***Semperula wallacei* (Issel, 1874)**

Vaginula wallacei Issel, 1874: 385.

Vaginula idae Semper, 1885: 321-322.

Vaginulus reinhardti Semper, 1885: 323.

Semperula wallacei Hoffmann, 1941: 329-324.

Semperula wallacei reinhardti Hoffmann, 1941: 231-233.

Semperula wallacei celebensis Hoffmann, 1941: 233.

Semperula wallacei boviceps Hoffmann, 1941: 233.

Semperula celebensis Forcart, 1973: 26.

Semperula reinhardti Thomé, 1988b: 65-67.

Semperula christmasis Thomé, 1983: 18-20.

Semperula solei Forcart, 1969: 151-156.

Se. wallacei was proposed by Issel (1874) on an example from Sarawak (Borneo). Hoffmann (1925) and Grimpe & Hoffmann (1925a,b) considered *Se. wallacei* a synonym of *Se. idae* Semper (1885), ignoring the fact that the latter was proposed subsequently. Only later, did Hoffmann (1941), upon rediscovering Issel's holotype of the species that had been considered lost, correct his error, placing *Se. idae* in the synonymy of *Se. wallacei*, and describing the morphology and anatomy of some structures. Gomes & Thomé (2001) re-described the species, commenting on previously unknown anatomical features.

Vaginulus reinhardti was proposed by Semper (1885) based on material from Macao (China). Hoffmann (1925) and Grimpe & Hoffmann (1925a,b) considered it a synonym of *Se. idae* (= *Se. wallacei*). Grimpe & Hoffmann (1924) designated the latter as a type of *Semperula*. Hoffmann (1941), upon examining the juvenile paratype of *Vs. reinhardti*, decided to consider it a subspecies of *Se. wallacei*, based on different positions of the genital pore. Thomé (1988b) upon re-examining the holotype of the species, the penis of which was not with the specimen, considered it valid. Nevertheless, analysis of the descriptions furnished by the various authors, indicates that there are insufficient anatomical differences for such a validation. Therefore, we consider *Vs. reinhardti* as a synonym of *Se. wallacei*. In this later study from Hoffmann (1941), he erected *Se. wallacei celebensis* and *Se. wallacei boviceps*. These would be considered different from *Se. wallacei* due to the position of the 'papilla' of the right deferent vessel and the degree of demarcation of the circular nervure found in the penis of this species in the case of *Se. w. celebensis* and due to the colouring and position of female genital pore, in the case of *Se. w. boviceps*. However, these differences are not sufficient for them to be considered subspecies, given that such variations were verified by us within the different populations of *Se. wallacei* examined here. Thus, Hoffmann's (1941) two subspecies may be considered synonyms of *Se. wallacei*.

The types of *Se. solei* (Forcart, 1969) from Espiritu Santo and Efate (Vanuatu) and lots from Indonesia (Ambon) and Western Samoa (Upolu), examined by Forcart (1973) and identified as *Se. wallacei celebensis*, were re-examined by Gomes

& Thomé (2001). They verified that the material was *Se. wallacei*.

Se. christmasis described by Thomé (1983) from Christmas Island, is also a synonym of *Se. wallacei*. This can be verified by analysis of the original descriptions and illustrations.

DISTRIBUTION. Christmas Island (Australia), Hong Kong, Macao (China), Viti Levu (Fiji), Ambon (Wasi), Borneo (Sarawak), Sulawesi (Parepare, Gimpu, Macasar), Sumatra (Tebingtinggi) (Indonesia), Upolu (Western Samoa) and Espiritu Santo, Efate (Vanuatu) (Grimpe & Hoffmann, 1925a,b; Forcart, 1969; Forcart, 1973; Gomes & Thomé, 2001). Gomes & Thomé (2001) first registered the species in Fiji and Western Samoa.

***Valiguna flava* (Heynemann, 1885)**

Vaginula flava Heynemann, 1885: 10-11.

Vaginula schneideri Simroth, 1895: 7-8.

Semperula (Valiguna) schneideri Grimpe & Hoffmann, 1925a: 391-392.

Semperula siamensis schneideri Hoffmann, 1925: 181-182; Grimpe & Hoffmann, 1925b: 18-19, 31-33.

Valiguna schneideri Hoffmann, 1941: 236.

Valiguna isseli Hoffmann, 1941: 234.

Valiguna flava was proposed by Heynemann (1885) due to the morphological characteristics and colouring of a specimen from Borneo (Indonesia). That author also mentioned its occurrence at Nias and the western coast of Sumatra (Indonesia). Hoffmann (1925) and Grimpe & Hoffmann (1925a,b) considered *Vl. flava* a synonym of *Se. maculata*, without having examined the type material. We re-examined the holotype of *Vl. flava*, in the Natural History Museum (BMNH-1880.10.6.4). The species is relatively peculiar, especially with the regards anatomical characteristics. The penis has relatively specific dentate and lobular formations. Based upon this material the species is totally differentiated from *Se. maculata*.

Va. schneideri Simroth, 1895 is based upon material from the east of Sumatra (Indrapura, Tandjong Kuba). Grimpe & Hoffmann (1925a) proposed *Valiguna* as a subgenus of *Semperula*, considering *Va. schneideri* a type species. Hoffmann (1925) and Grimpe & Hoffmann (1925b) arrived at the conclusion it was a subspecies of *Se. siamensis*, disregarding *Valiguna*. Hoffmann (1941), though, upon finding *Vl. isseli*, that he judged to be new, with morphological characteristics similar to those of *Va. schneideri* reconsidered the taxon *Valiguna*, and elevated it to genus level. To judge from the

original description of *Va. schneideri* as well as the descriptions of Hoffmann (1925) and Grimpe & Hoffmann (1925a,b) the species is a synonym of *Vl. flava*. *Valiguna isseli* Hoffmann, 1941, based upon material from Borneo, appeared to be similar to *Va. schneideri*, but differed from the former mainly in its colouring and the position of the female genital pore. Therefore, there are insufficient characteristics to maintain it as a valid species and should be considered a synonym of *Vl. flava*.

DISTRIBUTION. Borneo, Nias and Sumatra (Indrapura) (Indonesia) (Heynemann, 1885; Simroth, 1895).

***Valiguna siamensis* (Martens, 1867)**

Vaginulus siamensis Martens, 1867: 68.

Vaginulus reticulatus Westerlund, 1883: 49; Thomé, 1984: 29-32.

Semperula siamensis Grimpe & Hoffmann, 1925a: 388, 390-391; Hoffmann, 1925: 179-181, 256-257; Grimpe & Hoffmann, 1925b: 8, 17-19, 44-47.

The description of *Vaginulus siamensis* made by Martens (1867), based upon material from Petshaburi (Thailand) is quite short, referring to the morphological characteristics and external colouring. Later, the holotype in the Berlin museum, was re-examined by Hoffmann (1925) who, described general aspects of the anatomy of the species. Grimpe & Hoffmann (1925a,b) and Hoffmann (1925) included *Vs. siamensis* in *Semperula*. They describe the relatively unusual aspect of the penis that has, on its convex side structures in the form of crests. Here, it is proposed that *Vl. siamensis* be included in *Valiguna*, together with *Vl. flava*, given that this type of formation, spines or crest-like accessories to the penis, only occurs in this species.

Grimpe & Hoffmann (1925a) proposed *Valiguna*, as a subgenus of *Semperula*, having *Vl. siamensis schneideri* as type species. *Valiguna* covers those forms in which the deferent vessel opens neither terminally (*acrocaulis*, as is the case of *Sarasinula*) nor basally (*pleurocaulis*, as is the case of *Semperula*), being intermediate to the two types (*acropleurocaulis* ou *pseudopleurocaulis*).

In the original description of *Vaginulus reticulatus* Westerlund, 1883 proposal based upon material from Galle (Sri Lanka) contains only a brief characterisation of the morphology and colouring. However, Thomé (1984) found, deposited in the Naturhistoriska Riksmuseet in Stockholm (Sweden), syntypes of the species, which he used to describe in detail the anatomy of the species. The morphology and anatomy of *Vs.*

reticulatus coincide with that described by Grimpe & Hoffmann (1925a,b) and by Hoffmann (1925) for *Ve. siamensis*.

DISTRIBUTION. Galle (Sri Lanka) and Petshaburi (Thailand) (Martens, 1867; Thomé, 1984).

***Veronicella cubensis* (Pfeiffer, 1840)**

Onchidium cubense Pfeiffer, 1840: 250.

Veronicella cubensis Thomé, 1993a: 113-120; Thomé et al., 1997: 531-532; Cowie, 1997: 39.

Veronicella cubensis was proposed by Pfeiffer (1840) from Cuba (Neotropical region). The original work consists of a brief commentary about the colouring. Hoffmann (1925) considered the species a synonym of *Belocaulus sloanei* (Cuvier, 1817). However, these two species were later re-described by Thomé (1988a, 1993a) based upon type materials, both being considered valid, the latter passed to *Veronicella*. Thomé (1993a), working on neotypes and paraneotypes, described in detail the morphology and anatomy of *Ve. cubensis*. He furnished a list of synonymic citations and registered the species for Hawaii (Oahu, Kalihi). Thomé et al. (1997) and Cowie (1997) mentioned the species for Hawaii. The morphology and anatomy of specimens from Guam (Mariana Islands) (MCP-6505, MCP-6506, MCP-6507) were found to coincide with that of *Ve. cubensis*.

DISTRIBUTION. Oahu (Hawaii) and Guam (Marianas Islands) (Cowie, 1977; Thomé, 1993a; Thomé et al., 1997).

Veronicella Blainville, 1817 is found in the Neotropical biogeographical region, where there are registers of 8 species, according to Thomé (1975, 1988a, 1993a).

CONCLUSIONS

Initial systematic studies of the Veronicellidae resulted in a large number of species being proposed in an arbitrary manner, based, in the majority of cases on variations in colour and small anatomical variations. Consequently, a large number of species are synonyms. It was possible to recognise 13 valid species of Veronicellidae, in 6 distinct genera (*Filicaulis*, *Laevicaulis*, *Sarasinula*, *Semperula*, *Valiguna* and *Veronicella*), in the Oriental and Australian regions. The majority of species have a distribution restricted to these regions, although they may also have constituents in the Ethiopian and Neotropical faunas.

Semperula stands out, as it includes the only species of the Veronicellidae family in which the penis has a deferent vessel opening in the basal or median position. The genus is represented by 7 species whose distribution is restricted to the Oriental and Australian regions (Fig. 2). *Se. birmanica*, *Se. carusi*, *Se. insularis*, *Se. thailandensis* and *Se. siamensis* are widely distributed in the Oriental region, but there are no registers in the Australian region. *Se. maculata*, *Se. parva* and *Se. wallacei* are also found in the Australian region, near Wallace's line. Only the latter, is found to the east, on the island of Upolu (Western Samoa).

F. bleekeri and *Ve. flava* have a restricted distribution, being found only on a few Indonesian islands close to Wallace's line, while *Ve. siamensis* is occurs in Thailand and Sri Lanka (Fig. 3).

L. alte and *Sa. plebeia* are the species with the widest distributions, being found in the Oriental as well as the Australian region (Fig. 3). Both are thought to have been introduced into these regions. The first appears to be of African origin (Ethiopian region) (Bruggen, 1981). The origin of *Sa. plebeia* remains unclear, although there is a consensus that it is a species that has been introduced into Australia and widely spread by commerce in the Indian and Pacific Oceans (Forcart, 1973; Burch, 1976; Bishop, 1977; Smith, 1984). It probably originated from American tropical regions, where it occurs from the Antilles to Chile (Thomé, 1987, 1997) given that there is no record of the genus in the Ethiopian and Oriental regions.

There are only two records of *Ve. cubensis* in the Australian region. It was introduced from Central America (Thomé, 1993a, 1997; Cowie, 1997).

In the Oriental and Australian regions the Veronicellidae occur naturally from South Asia to east of Wallace's Line (Hoffmann, 1925). These regions have a low diversity, when compared with South America where 18 genera of Veronicellidae are found (Thomé, 1975b). Bruggen (1986) suggested, in his comparison of the diversity of species found in the Neotropical and Ethiopian regions, that this may be the result of the competition for niches with other families of slugs and snails, such as Aperidae, Rathouisiidae and Urocyclidae, that are not found in the Neotropical region.

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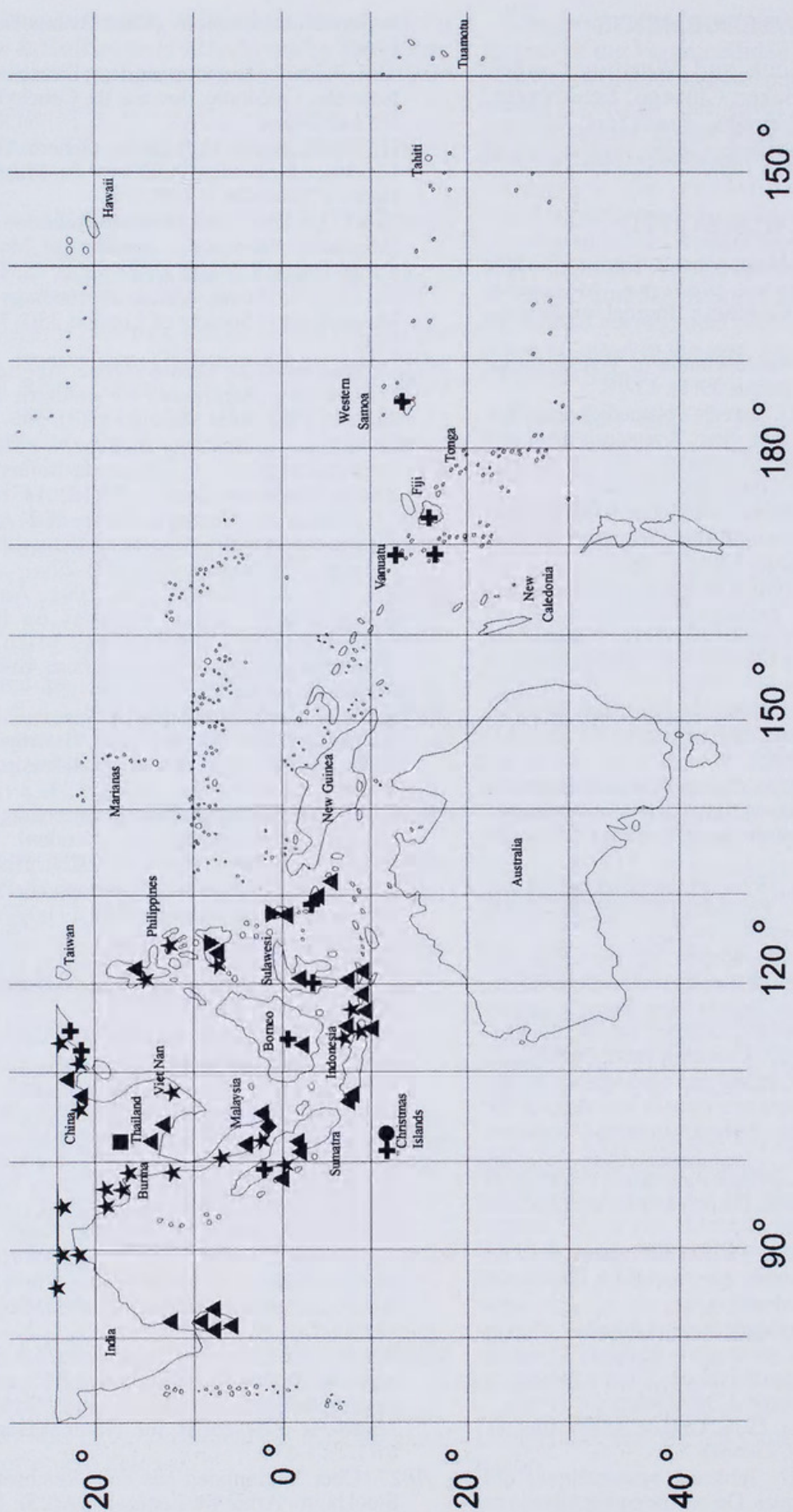


FIG. 2. Distribution of *Se. birmanica* (★), *Se. carusi* (◆), *Se. insularis* (●), *Se. maculata* (▲), *Se. parva* (▼), *Se. tailandensis* (■) and *Se. wallacei* (+) in the Oriental and Australian biogeographical regions.

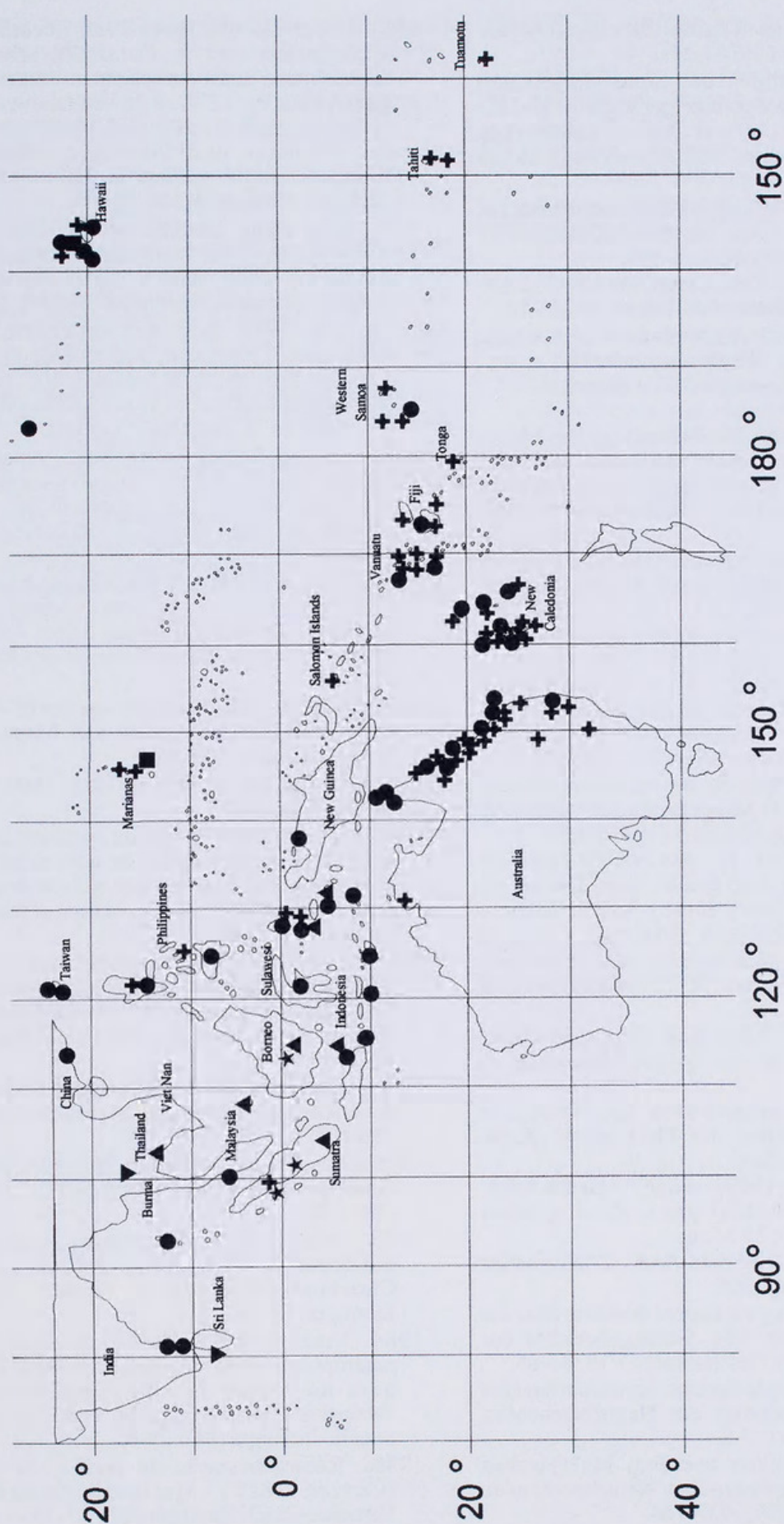


FIG. 3. Distribution of *F. bleckeri* (▲), *L. alte* (●), *Sa. plebeia* (+), *Vl. flava* (★), *Vl. siamensis* (▼) and *Ve. cubensis* (■) in the Oriental and Australian biogeographical regions.

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