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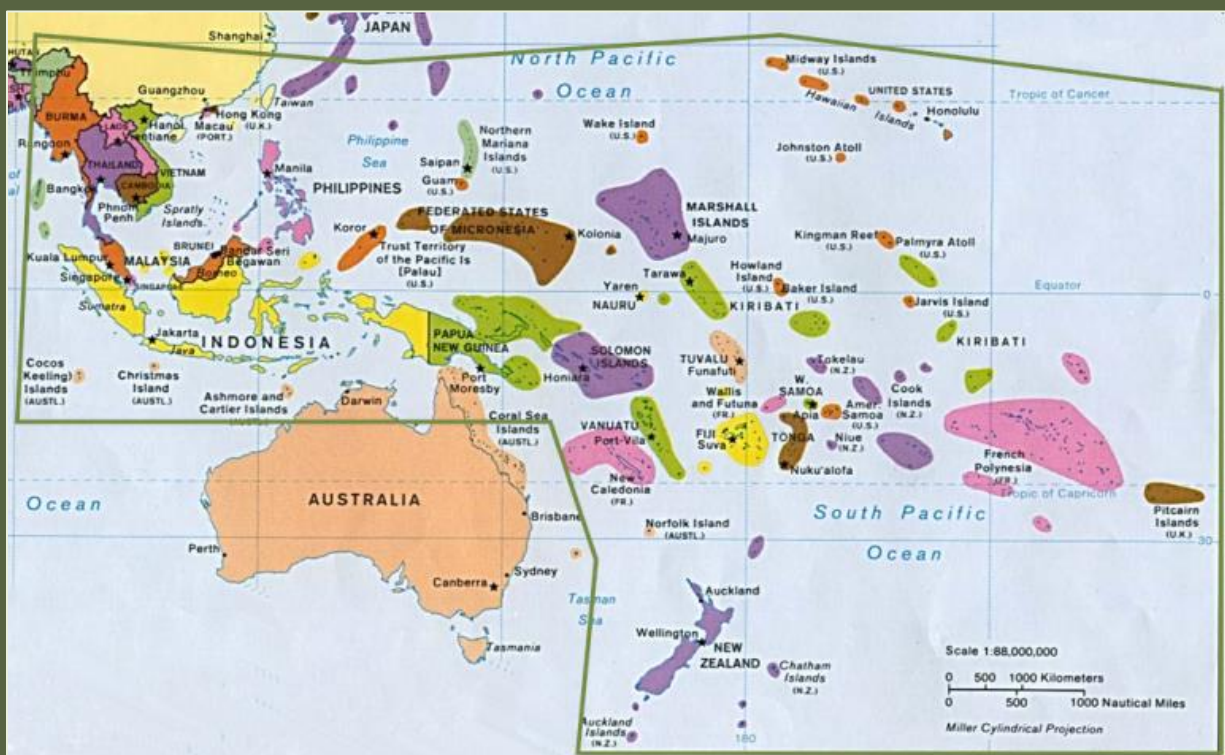
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Distribution and identification of *Rhodothemis* in the eastern part of the Indo-Australian Archipelago (Odonata: Libellulidae)

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Abstract

The small libellulid genus *Rhodothemis* is restricted to Asia and Australia. Two of the four included species were described relatively recently by Lohmann (1984) but much previously documented material was never re-identified and the distribution of the species in the Indo-Australian Archipelago remained poorly known. All material available in the Naturalis Biodiversity Center (RMNH) from the eastern part of the Indo-Australian Archipelago was studied and is here brought on record. Key characters are illustrated and SEM images of the genital ligula are presented.

Key words

Odonata; dragonfly; *Rhodothemis*; taxonomy; New Guinea; Papua New Guinea.

Introduction

Rhodothemis Ris, 1909 is a small genus of four libellulid species found in Asia and Australia. The species occur at standing or slowly flowing, largely unshaded waters with abundant vegetation. The four species occur from mainland Asia throughout the Philippines and the Indonesian Archipelago to Australia and the Solomon Islands. Based on material available in the Naturhistorisches Museum Basel, Switzerland (NHMB) and the Naturalis Biodiversity Center (RMNH) Lohmann (1984) described two new species, *R. mauritsi* Lohmann, 1984 from northern New Guinea and *R. nigripes* Lohmann, 1984 from the Lesser Sunda Islands (Flores, Sumba) and the Moluccas (Batjan, Ceram, Burum, Sula). Prior to this the genus was considered to consist of just two species with *R. lieftincki* Fraser, 1954 found in Australia and *R. rufa* (Rambur, 1842) found throughout the Indonesian archipelago, the Philippines and large parts of mainland Asia. The situation in New Guinea was unclear as Fraser (1954) mentioned a series of *R. lieftincki*



from New Guinea but most of the previously documented material was never re-examined. Lohmann (1984) studied only part of the material available in the RMNH and listed the islands from where material was seen in a postscript at the end of the paper but did not provide detailed locality information. In this postscript it was also stated that material from the Vogelkop Peninsula, southern New Guinea, the Solomon Islands and Sulawesi possibly belonged to undescribed species. Due to this the distribution of the different species of *Rhodothemis* in eastern Indonesia, Papua New Guinea, the Solomon Islands and Australia remained unclear (Michalski 2013). Here we present information on the distribution of the four species based on material in the RMNH and provide information on the identification including SEM-pictures of the vesica sperminalis.

Material and methods

All male specimens of *Rhodothemis* from the eastern part of the Indo-Australian Archipelago present in RMNH were studied for this revision. Females cannot be identified to species level and are only listed when collected together with male specimens. Geographic coordinates are given only when present on original labels. The names of the provinces have been added by the authors. Present day names for localities inserted by the authors are given in square brackets.

Results

Data records

All male specimens of *R. lieftincki* (except those from Australia), *R. mauritsi* and *R. nigripes* present in the RMNH are listed with the exception of those which are already mentioned in detail in Lohmann (1984). A selection of specimens from Sumatra, Borneo, Peninsular Malaysia and the Philippines was studied and found to belong to *R. rufa* (records not listed). Likewise specimens from half a dozen localities from Australia (Northern Territory and Queensland) were studied and found to belong to *R. lieftincki* (records listed). Material previously published as *R. rufa* from Biak Island (Sasamoto & Shibata 2003) was re-identified by Akihiko Sasamoto and found to belong to *R. nigripes*.

Rhodothemis lieftincki

Australia, Queensland 1 ♂: Cairns, Redlynch, 15 October 1938, R.G. Wind; 1 ♀: Cairns, Redlynch, 8 November 1938, R.G. Wind; 2 ♀: Cairns, Redlynch, 18 November 1938, R.G. Wind; 1 ♂, 1 ♀: Cairns, Redlynch, 1 December, 1938, R.G. Wind; 2 ♂: Cairns, Redlynch, 4 October 1952, R. Dobson; 1 ♀: Innisfail, 15 September 1953, R. Dobson; 1 ♂: Tambourine, Russell's Gully, 3 January 1955, R. Dobson.



Australia, Northern Territory 1 ♂: Adelaide River (Kediri), 21 April 1931, E. Hand-schin.

New Guinea, PNG 1 ♂: National Capital District, Port Moresby, in scrub brush area near small river, 20 June 1975, leg. H.R. Wimmer; 1 ♂: Central Province, Sogeri, 7 November 1969, leg. R. Straatman.

New Guinea, Indonesia 2 ♂♂: Indonesia, Papua Province, Digul River Terrane, Mappi Post, December 1938, leg. J.M. van Ravenswaay-Claasen; 2 ♂♂ Papua Province, Merauke, 1 May 1957, G.F. Mees; 1 ♂, Papua Province, Tanah Merah, 80m, 26 August 1959 [on light]; Papua Province, Kabupaten Merauke Salor, 08°16.962S 140°21.912E, 15-19 July 2007, leg. KEP & Mhs UNCEN (record previously published as *R. rufa* in Kaize & Kalkman 2009).

Solomon Islands 2 ♂♂, 1 ♀: Solomon Islands, Guadalcanal, 24-25 November 1920, leg. J.A. Kusch (published as *R. rufa* by Lieftinck 1949); 1 ♂: Solomon Islands, Guadalcanal, December/January 1921, leg. J.A. Kusch (published as *R. rufa* by Lieftinck 1949); 1 ♂ Solomon Islands, Guadalcanal, Tetera area, deadfish Lagoon, 12 January 1944, V.R. Knapp.

Rhodothemis mauritsi

The following record is listed in Lohmann without date and collector:

Indonesia, New Guinea 1 ♂ Papua Province, Kabupaten Jayapura, Sentani lake, Joka, 26 October 1954, leg. L.B. Holthuis.

Rhodothemis nigripes

Indonesia, New Guinea 3 ♂♂: Indonesia, Papua Barat Province, Vogelkop Peninsula, Sorong, 5, 8 and 21 August 1948, leg. M.A. Lieftinck; 1 ♂: Indonesia, Papua Barat Province, Vogelkop peninsula, Steenkool [=Bintuni], 17 May 1957, D. Bergman; 1 ♂, 1 ♀: Papua Province Kabupaten Biak-Numfor, Wapor river, Gebar, Sambawo Fuwar, Biak Utara, 15 August 2002, leg. H. Shibata & Y. Nishimura (record previously published as *R. rufa* in Sasamoto & Shibata 2003); 1 ♂: Indonesia, Papua Province, Kabupaten Japen, Randawaya (Waroroni), 01°51.456S 136°32.909E, 0-50m, 29 July 2006, leg. F. Manobi.

Indonesia, Sulawesi 1 ♂: Indonesia, Sulawesi, Gorontalo Province, Gorontalo, leg. Rosenberg; 1 ♂: Indonesia, Sulawesi, Panubre (difficult to read), Rosenberg; 1 ♂: Indonesia, North Sulawesi Province, Minahasa, Mapanget, 3 August 1940, L. Coomans de Ruiter; 1 ♂: Indonesia, North Sulawesi Province, Tolinggula, 30 December 1940, leg. J.J. van der Starre; 1 ♂: Indonesia, Sulawesi, Sewilie, 3 January 1941, leg. J.J. van der Starre.

Indonesia, Flores 1 ♀ (cf): Indonesia, East Nusa Tenggara Province, Flores, Mbura, June 1937, J.K. de Jong.



Indonesia, Seram 1 ♂: Indonesia, Moluccas, Seram, Awaia, 24 November 1941, J.J. van der Starre.

Indonesia, Buru 1 ♂: Indonesia, Maluku Province, Buru, Wamlana, 11 June 1959, leg. A.M.R. Wegner.

Indonesia, Sula 1 ♂: Indonesia, North Maluku Province, Sula Island, S. Mangole, September 1939, S. Bloembergen.

Indonesia, Bacan 7 ♂♂: Indonesia, North Maluku Province, Bacan, Wajaua Birabir Aketjil, 23 June 1953; 4 ♂♂, 1 ♀: Indonesia, North Maluku Province, Bacan, Wajaua Birabir Aketjil, 27 June 1953; 1 ♂: Indonesia, North Maluku Province, Bacan, Songa, 27 June 1953; 3 ♂♂: Indonesia, North Maluku Province, Bacan, Wayaua Pool edge of logged forest, 0°45'S 127°38'E, 7 July 1985, F.G. Rozendaal.

Indonesia, Obi 5 ♂♂: Indonesia, North Maluku Province, Obi, Wajaloar, 28 August 1953; 7 ♂♂ 1 ♀: Indonesia, North Maluku Province, Obi, Laiwui, September-October 1953.

Identification

The species of *Rhodothemis* are libellulids of medium large size (hindwing 28-37 mm, abdomen 22-29 mm) and can be separated from other libellulids occurring through-

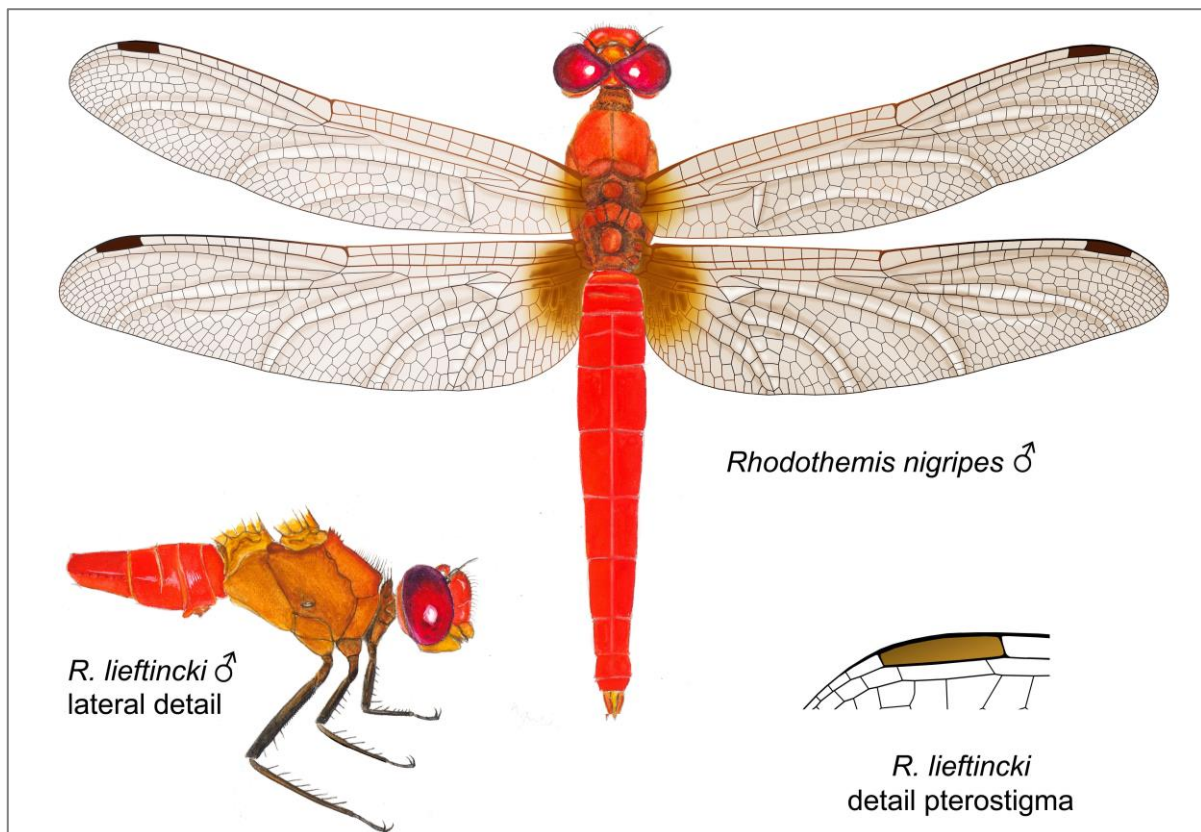
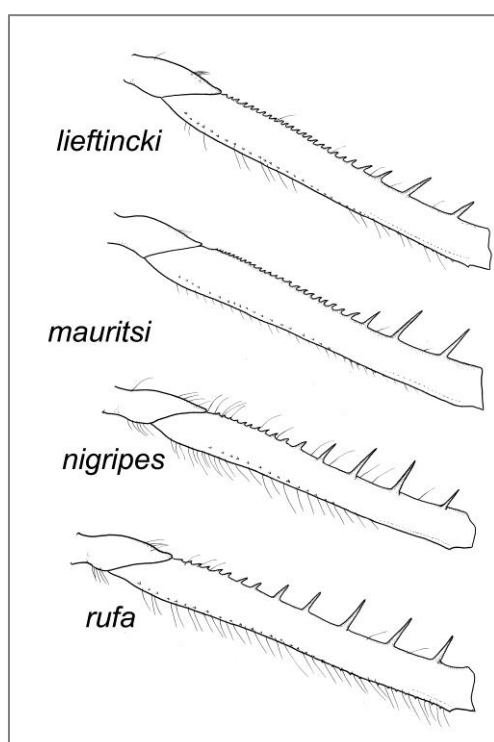


Figure 1. Male *Rhodothemis*, showing dorsal *Rhodothemis nigripes* and lateral detail of *Rhodothemis lieftincki* (All species, including *R. rufa* and *R. mauritsi* are very much alike in general facies). Drawings A.G. Orr.

out the range of the genus based on the following combination of characters: (1) Antenodals in forewing $10\frac{1}{2}$ - $12\frac{1}{2}$, so last antenodal incomplete; (2) one cell row between IR3 and Rspl; (3) abdomen yellow-brown or red, never with extensive black pattern; (4) occiput enlarged, eyes only meet over a short distance, (5) hind lobe of prothorax large, broad and fringed with long black hairs.

The frons and abdomen of *Rhodothemis* males becomes uniform red with age while the sides of the thorax become reddish brown (Fig 1a, b). The species most likely to be confused with species of *Rhodothemis* is *Crocothemis servilia* (Drury, 1770) with which it often shares the uniform red abdomen and frons, the brown thorax, the yellow pterostigma and the reddish legs. Many distinctions were noted by Orr (2003, 2005). *C. servilia* has less strongly developed spines on the legs, has a relatively shorter hind femur not reaching the base of the abdomen when folded back, lacks the large and erect hindlobe of the prothorax and has the eyes broadly touching (i.e. the occiput is not as enlarged as in *Rhodothemis*). In *Rhodothemis* at least some part of the forewing discoidal field has two cell rows only, whereas *Crocothemis* have a minimum of three cell rows. In addition *Crocothemis* never has extensive black on the legs while this is often the case in *Rhodothemis*. *Rhodothemis nigripes* is named for its deep black legs. However the other species can have largely black legs as well although in general the tibiae are largely reddish to brownish while the femora in most cases at least have a brown line. It is not possible to identify species of *Rhodothemis* to species-level without first catching them. The key, which is largely based on that presented by Lohmann (1984) provides identification to species level. The key by Lohmann (1984) uses also the hamulus as character but we did not test this character as the other characters allow for ready identification.



Females can easily be separated in the field from other genera occurring east of Wallace's Line by having a pale line which runs over the front and dorsum of the synthorax extending as far as the first few segments of the abdomen often strongly contrasting with the dark thorax (also visible in young males). Something similar can be seen in females *Orthetrum villosovittatum* (Brauer, 1868) but in this species the abdomen has a different shape with the basal third slenderer than at the midpoint.

Figure 2. Leg armature of hind femora of males *Rhodothemis*. *R. lieftincki* (Bramston Beach, North Queensland), *R. mauritsi* (Jayapura, Papua, Indonesia), *R. nigripes* (Japan), *R. rufa* (Sarawak, Borneo). Drawings A.G. Orr.

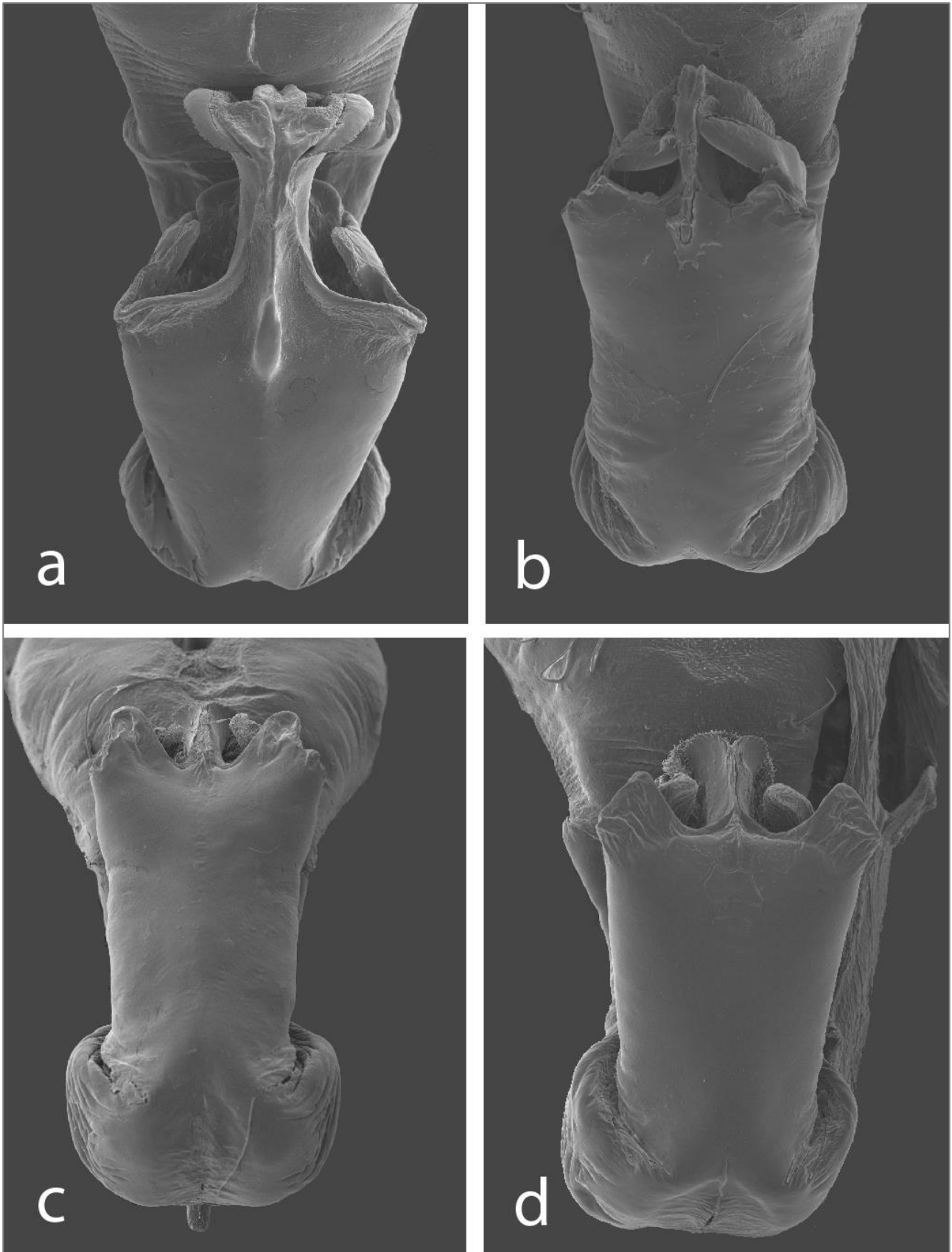


Figure 3. SEM-images of vesica sperminalis of males *Rhodothemis*. (a) *R. lieftincki* (Mt. Tamborine, S. Queensland), (b) *R. mauritsi* (Jayapura, Papua, Indonesia), (c) *R. nigripes* (Wajaua Birabir Aketjil, Bacan), (d) *R. rufa* (Chon Buri Bang Phra, Thailand). Photo D. Gassmann.

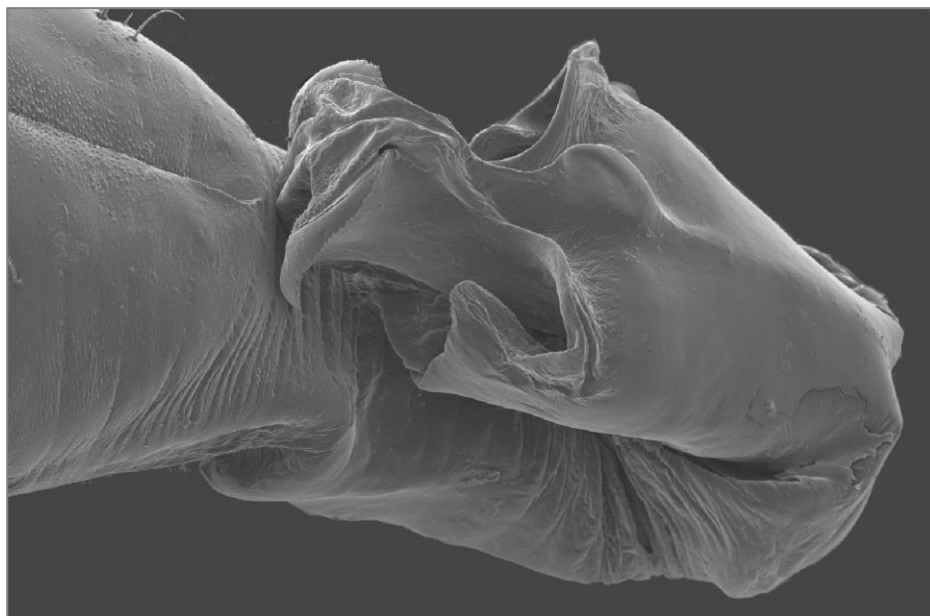


Figure 4. SEM-images of vesica sperminalis of males *Rhodothemis lieftincki* from lateral showing the prominent ridge on central lobe. Photo D. Gassmann.

Key to the males of *Rhodothemis*

- 1b. Femora of hind leg with 20-27 small spines and 2-3 large spines (Fig. 2a, b) 2
 1a. Femora of hind leg with 8 to 12 small spines and 4-5 large spines (Fig. 2c, d) 3
- 2a. Vesica sperminalis with median lobe large and broadening distally, median lobe with prominent central ridge associated with a long apical process (Fig. 3a, 4)
 *R. lieftincki*
- 2b. Vesica sperminalis with median lobe smaller and not broadening distally, median lobe without prominent central ridge (Fig. 3b) *R. mauritsi*
- 3a. Last two pairs of legs in mature specimens completely black; Pt dark brown, less than 3 mm long; area of postgenae bordering occiput completely black; vesica sperminalis with small central lobe which is only slightly longer than lateral lobes (Fig. 3c); spot at base of hind wing larger and darker (brown) *R. nigripes*
- 3b. Last two pairs of legs in mature specimens partly reddish-brown; Pt yellow-brown, 3 mm or more; area of postgenae bordering occiput brown; vesica sperminalis with central lobe which is clearly longer than lateral lobes (Fig. 3d); spot at base of hind wing smaller and paler (yellow brown) *R. rufa*

Discussion

The studied material fitted the description provided by Lohmann (1984) and we see no reason to believe that material from the Vogelkop Peninsula or from the Solomon Islands represents new species. Figure 5 shows the presently known distribution of the four species the eastern part of the Indo-Australian Archipelago. The four species of *Rhodothemis* seem to have non-overlapping ranges. There are at present no confirmed records of *R. rufa* east of Wallace's Line and on Sulawesi, the Moluccas (Batjan,

Ceram, Burum, Obi, Sula), the Lesser Sunda Islands (Flores, Sumba), the Vogelkop Peninsula and on the islands of Biak and Japen it is replaced by *R. nigripes*. Monk et al. (1997) list the occurrence of *R. rufa* for several other islands of the Moluccas (Kai, Aru, Banda, Ternate, Halmahera, Morotai). It is unclear what material these records are

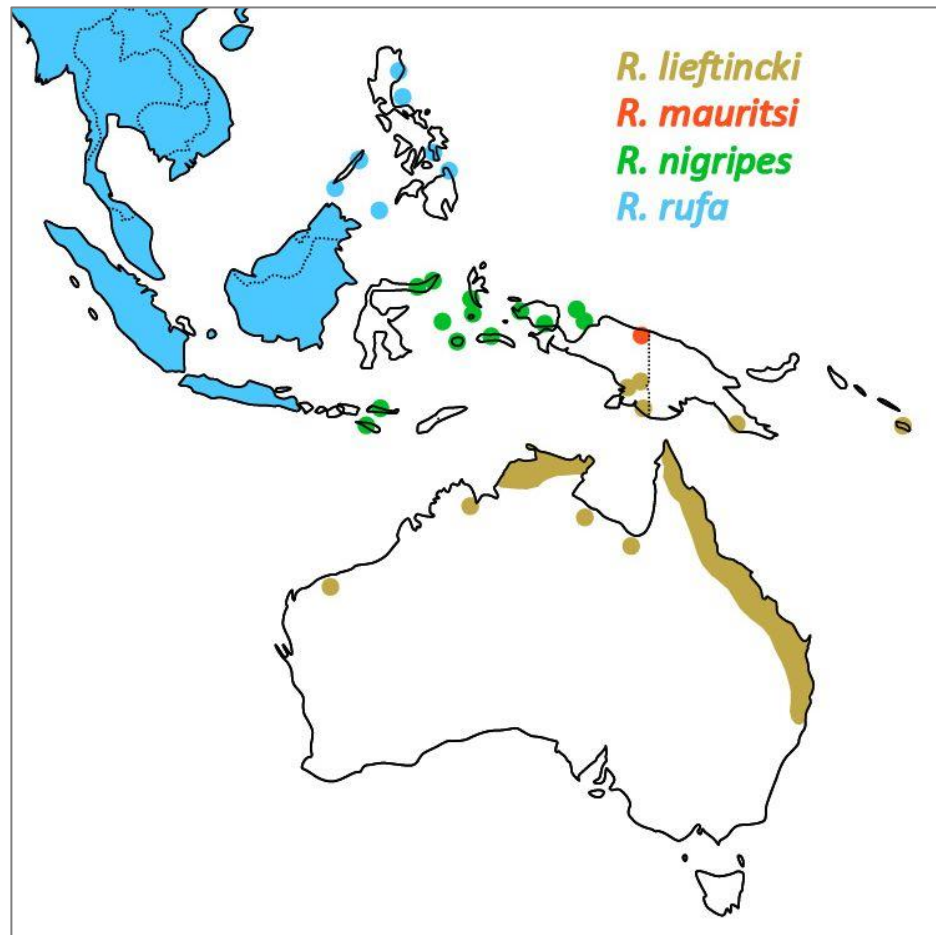


Figure 5. Distribution of species of *Rhodothemis* in the Indo-Australian Archipelago. The distribution west of the Wallace Line (*R. rufa*) is based on literature. East of Wallace's Line only records confirmed by us are shown with the exception of those from Australia for which we only checked material of a handful of localities.

based on and they need reconfirmation. If these records indeed pertain to *Rhodothemis* than it is likely that they refer to *R. nigripes*. The neck of the Vogelkop Peninsula might form the border between *R. nigripes* and the two easternmost species. *R. mauritsi* is only known from the surroundings of Jayapura and might be confined to lowland New Guinea north of the Central Mountain Range. *R. lieftincki* is more widespread and is found on the southern lowlands of New Guinea, the surrounds of Port Moresby, north and east Australia and Guadalcanal. All confirmed records of *Rhodothemis* from Australia refer to *R. lieftincki* suggesting that it is the only species of this genus present in Australia.

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