A SECOND AUSTRALIAN SPECIES IN THE *ORTHETRUM SABINA* COMPLEX (ODONATA: LIBELLULIDAE)

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Abstract

A seventh Australian species of *Orthetrum* Newman, *O. serapia* sp.n., is described. The closely allied species *O. sabina* (Drury) is redescribed and a neotype designated for it. The range of *O. serapia* extends from the southwest Pacific to, apparently, the Philippines where, as in Australia and New Guinea, it overlaps that of *O. sabina*.

Introduction

Orthetrum sabina was described by Drury (1770), who "received it from China" and commented that it "is also found at the island of Johanna near Madagascar" (p. 114) (now Anjouan, in the Comoro Archipelago). Although the Comoro specimens later proved to belong to another species, probably *O. falsum* Longfield (see Ris 1909, Longfield 1955), it became apparent last century that *O. sabina* did indeed have a wide range—North Africa, Cyprus and the Middle East, through the Indian subcontinent and Sri Lanka to southeast Asia, north to China and Japan, south through Indonesia to Australia, and east to Oceania (Ris 1909, 1916; Lieftinck 1962). However, as Ris (1909) pointed out, "the variability of this enormously widely distributed and, throughout its range, common species is quite insignificant" (p. 225). Thus the species acquired remarkably few additional names and Ris (1909) could not justify any of them, even as subspecific names.

It then became clear that eastern Indonesian material of *O. sabina* showed greater heterogeneity. Ris (1916) noted that some specimens from Aru were larger than others and had more extensive, darker markings on the thorax. Similar large, dark individuals were present in collections from Ceram, West Irian and Cape York; the Aru and the Cape York material included both large and small specimens.

Until now, the status of the large, dark variants of *O. sabina* has remained unresolved. However, during 1980-81, I compared Australian material with specimens of *O. sabina* from virtually its entire range, in the holdings of the British Museum (Natural History), the Rijksmuseum van Natuurlijke Historie and Dr Syoziro Asahina, and collected it in China. These comparisons showed that 2 species occur in Australia, differing mainly in abdominal coloration and the structure of the male genitalia; 1 of these species is Drury's *O. sabina*, but the other is undescribed. The new species occurs, or has close relatives which occur, from Fiji through New Guinea and northern Australia to the Moluccas, the Celebes (Sulawesi) and the Philippines, and is broadly sympatric with *O. sabina* in several parts of its range.

The new species is described below as *O. serapia*. The description is based only on Australian material because there is not enough information to determine if the Australian populations are conspecific with the various, allied populations from elsewhere. The terminology is that of Chao (1953).

The material listed is in the Australian National Insect Collection, CSIRO, Canberra (ANIC), unless otherwise indicated: BM, B. P. Moore, Canberra; BMNH, British Museum (Natural History), London; CM, Copenhagen University Zoological Museum; HM, Martin Luther University Museum, Halle; LM, Rijksmuseum van Natuurlijke Historie, Leiden; NMV, National Museum of Victoria, Melbourne; RR, Richard Rowe, Christchurch; SA, Syoziro Asahina, Tokyo.

Note on trivial names

Drury did not indicate why he chose the name *sabina*. Although the name has at times been treated as adjectival (e.g. Ris 1900, Needham 1930), Drury probably regarded it as a classical feminine proper noun to judge from his choice of names for other species of *Libellula* Linnaeus—*arria*, *berenice*, *domitia*, *eponina*, *fulvia*, *lucia*, *lydia*, *servilia*, *tullia*. The Sabina commemorated was possibly St Sabina, who

suffered martyrdom about 126 A.D. during the persecutions under Hadrian, as did the servant who converted her to Christianity, St Serapia. Sabina was a common Christian name in England in Drury's time (M. A. Moffatt pers. comm.).

Orthetrum sabina (Drury) (Figs 1–5, 10–12, 15–21, 27–28, 30–31, 33–34)

Libellula sabina Drury, 1770: 114–115, Pl. 48, Fig. 4.
Orthetrum sabina (Drury); Ris, 1909: 223–225 (*partim*) (synonymy, including *Libellula gibba* Fabricius, *Libellula leptura* Burmeister, *Libellula ampullacea* Schneider, *Lepthemis divisa* Selys).
Orthetrum sabina sabina (Drury); Lieftinck, 1942: 475, Fig. 32 (references).
Orthetrum sabina viduatum Lieftinck, 1942: 475–478, Fig. 33.

Types.—The fate of the type-material of *O. sabina* is unknown. Drury's collection was auctioned in London in May 1805 and 3 annotated copies of the catalogue survive (Chalmers-Hunt 1976). There were 8 lots of Odonata but the catalogue does not specifically mention *L. sabina* in any of them. G. Milne, W. Kirby, E. Donovan and G. Humphrey each bought 1 lot, and A. H. Haworth the remaining 4.

At least some of Milne's collections went to BMNH (Chalmers-Hunt 1976).

It appears that Kirby's collections also went to BMNH (Horn and Kahle 1935–37). However, some of his material may have ended up elsewhere. Kirby bought Lot 60, "Libellula caerulata, and 3 other" (4 specimens altogether). Two old specimens of what is now *Megaloprepus caerulatus* (Drury) survive in the Macleay collections at the University of Sydney; both specimens are now on permanent loan to ANIC. Macleay was at the Drury auction and bought extensively. One of the Macleay specimens of *M. caerulatus* bears the label "Muskito Shore", a locality that Westwood (1837) listed for a specimen of *M. caerulatus* taken by Shakespear in 1779 and mentioned in the Drury manuscripts. The other Macleay specimen is unlabelled but the position of the wings (although not of the legs) agrees with that shown in Drury's illustration. It may well be the holotype (or a syntype); in any case, the suggestion remains that some of Drury's Odonata went via Kirby to Macleay.

Donovan's British insects went to BMNH but Macleay obtained his non-British collections (M. S. Upton (pers. comm.).

Humphrey was a dealer and what became of the lot he bought is unknown. Some may have gone to Macleay, who traded with him (Upton pers. comm.). Humphrey was at the auction of the Dowager Duchess of Portland's collection in 1786 but Macleay was not. However, the Macleay collections contain a specimen of what is now *Neurobasis chinensis* (Linnaeus) labelled "*Habitat in China ab Museo Portlandia*", possibly a specimen that Humphrey purchased.

Haworth's collections were sold by J. C. Stevens in London in 1834 but, unfortunately, no annotated catalogues survive (Chalmers-Hunt 1976). However, it is known that some of Haworth's material went to BMNH; the Hope collections, Oxford; and the Yorkshire Museum, York (Chalmers-Hunt 1976).

I have ascertained that there are no specimens in BMNH, the Macleay collections, the Hope entomological collections or the Yorkshire Museum that can be identified as Drury's material of *O. sabina*, and can only conclude that the type-material is lost. Because it is clear that the dragonflies that have been called *O. sabina* are heterogeneous, it is necessary to designate a neotype to ensure stability of nomenclature.

Neotype ♂ of *Libellula sabina* Drury, 1770, by present designation, CHINA: Guangzhou, Zhong Shan University, *in cop.*, 2.x.1981, J. A. L. Watson (BMNH, neotype and associated female).

Holotype ♀ of *Libellula gibba* Fabricius, 1798 (= *O. sabina*) (CM). The specimen was collected by Daldorff "*in India orientali*" (Fabricius, p. 284), probably Madras (Zimsen 1964), but bears only the label "gibba" in Fabricius' hand.

Lectotype ♀ of *Libellula leptura* Burmeister, 1839, by present designation (= *O. sabina*) (HM). Two of Burmeister's specimens survive; the lectotype female is intact, but the paralectotype male lacks abdominal segments 4–10. The lectotype bears an old label "14", and the handwritten label "Considered by me as Burmeister's ♀ type of his *Libellula leptura* (= sabina Dru.) P. P. Calvert, May, 1896."; both specimens are still placed under the drawer-label "*leptura* MB. Java. Hoffmgg." in Burmeister's hand (cf. Calvert 1898).

Paratype ♂, ♀, of *Orthetrum sabina viduatum* Lieftinck, 1942, "CENTRAL N. NEW GUINEA" (WEST IRIAN): Baliem, 1600 m, *in cop.*, 14.xii.1938, L. J. Toxopeus (ANIC).

Chinese material examined.—GUANGDONG: Neotype ♂ and associated ♀; 1 ♀, Chin Yuan county, Yin Zhuan, 7.ix.1981, J. A. L. Watson; 1 ♀, Chin Yuan county, Fei Lai Tsia, 8.ix.1981, J. A. L. Watson; 1 ♀, Shiao Ching, 26.ix.1981, J. A. L. Watson; 1 ♂, Guangzhou, 21.vii.1976, R. Rowe (RR); 7 ♂♂, Guangzhou, Zhong Shan University, 21.ix.1981, 2.x.1981, J. A. L. Watson. FUJIAN: 2 ♂♂, Shaowu, 17–18.vii.1942, H. F. Chao (LM). TAIWAN: 1 ♂, 3 ♀♀, Taipei county, Lin Kou, 12 km W of Taipei, May 1978, W. Rubink; 1 ♀, Taipei county, Yeh Liu, May 1978, W. Rubink & A. Juan.

Australian material examined.—WESTERN AUSTRALIA: 4 ♂♂, Kalumburu Mission, Mar. 1954, E. P. Hodgkin; 1 ♂, Wyndham, Kimberley Research Station, Mar. 1954, E. P. Hodgkin; 2 ♂♂, 3 ♀♀, 2 pairs being *in cop.*, Myall Bore, Derby, 4.iii.1954, E. P. Hodgkin; 2 ♂♂, 1 ♀, same locality, 6.iii.1968, J. A. L. Watson. NORTHERN TERRITORY: 1 ♂, 12°06′S 133°04′E, Cooper Creek, 19 km E by S of Mt Borrodaile, 31.v.1973, J. A. L. Watson; 4 ♂♂, 1 ♀, *in cop.*, Yirrkala Mission, 31.i–3.ii.1968, J. A. L. Watson; 1 ♂, 12°18′S 133°17′E, 15 km SW by S of Nimbuwah Rock, 10–11.xi.1972, J. A. L. Watson; 1 ♂, 12°20′S 133°19′E, Nabarlek Dam, 15 km S by W of Nimbuwah Rock, 2.vi.1973, J. A. L. Watson; 1 ♂, 12°25′S 132°59′E, 12 km SW by S of Oenpelli, 31.v.1973, J. A. L. Watson; 1 ♂, 12°26′S 132°58′E, 1 km S of Cahill's Crossing, East Alligator

River, 9.xi.1972, J. A. L. Watson; 1 ♀, Howard Springs, 22.iii.1968, B. P. Moore (BM); 1 ♂, 12°28′S 132°52′E, 14 km N of Mudginbarry homestead, 13–14.xi.1972, J. A. L. Watson; 1 ♂, 12°34′S 131°18′E, Fogg Dam, 9 km N by W of Beatrice Hill, 19.v.1973, J. A. L. Watson; 1 ♂, 12°35′S 132°52′E, Magela Creek, 2 km N of Mudginbarry homestead, 25–26.v.1973, J. A. L. Watson; 1 ♂, 12°48′S 132°42′E, Nourlangie Creek, Woolwonga, 8 km N of Mt Cahill, 21–22.v.1973, J. A. L. Watson; 1 ♂, 12°50′S 132°52′E, Baroalba Gorge, 19 km E by N of Mt Cahill, 6.iii.1973, J. A. L. Watson; 1 ♂, 12°51′S 132°54′E, 22 km E of Mt Cahill, 9.iii.1973, J. A. L. Watson; 3 ♀♀, Litchfield Station, Morgan Hole Lagoon, 30.vi.1974, J. F. Hutchinson; 1 ♂, 13°45′S 130°41′E, Daly River Mission, 9.viii.1974, J. F. Hutchinson; 1 ♀, same locality and collector, 17.viii.1974; 1 ♂, Daly River Mission, Devil Devil Creek, near Chickenhawk, 2.x.1974, J. F. Hutchinson; 1 ♂, 2 ♀♀, 14°06′S 130°18′E, 37 miles (59 km) SW of Daly River Mission, 26.viii.1968, M. Mendum; 1 ♀, 14°09′S 130°04′E, near Tom Turner's cross, Peppimenarti, 27.viii.1974, J. F. Hutchinson. QUEENSLAND: 1 ♂, 2 ♀♀, Thursday Island, Torres Strait, 17–18.i.1957, R. Dobson; 2 ♂♂, same locality, 5.xii.1976, May 1977, R. Paton; 1 ♂, McIvor River, 25 miles (40 km) N of Cooktown, 6.v.1970, S. R. Curtis; 1 ♀, Daintree, 28.x.1966, J. A. L. Watson; 1 ♀, North Mossman River, Mossman, 12.viii.1968, J. A. L. Watson; 1 ♂, Kuranda, 9.xi.1951, R. Dobson; 1 ♀, Barron River, Kuranda, 9.xi.1951, R. Dobson; 1 ♂, Barron Falls, 26.v.1956, E. Harris; 1 ♂, Cairns, Jan. 1905, R. J. Tillyard; 1♂, upper Mulgrave River, via Gordonvale, 29–30.iv.1970, S. R. Curtis; 1 ♀, streams draining W of Seymour Range, N of Innisfail, 2–4.xi.1966, J. A. L. Watson; 1 ♂, Eubenangee Swamp, N of Innisfail, 3.vi.1950, A. N. Burns; 1 ♂, same locality, 3–4.xi.1966, J. A. L. Watson; 2 ♂♂, East Innisfail, 4.xi.1966, J. A. L. Watson; 1 ♀, Millstream Falls, near Ravenshoe, 27.xii.1967, R. Dobson; 2 ♂♂, Mission Beach, near Tully, 4.x.1967, R. Dobson; 1 ♂, 1 ♀, Dunk Island, 10 and 18.viii.1950, R. Dobson; 1 ♀, Ingham, 9.v.1950, K. L. S. Harley; 1 ♂, Rollingstone, 34 miles (54 km) NW of Townsville, 29.iii.1969, J. A. L. Watson; 1 ♂, Hayman Island, 18.x.1950, R. Dobson; 1 ♂, Andergrove, 27.iv.1958, J. M. Adams; 1 ♂, Mackay, no date, A. Marriage; 1 ♂, 1 ♀, Yeppoon, 15.iii.1963, E. Adams; 1 ♀, same locality, Mar. 1963, C. Vallis; 1 ♂, Black Gin Creek, near Rockhampton, Jan. 1957, C. Vallis; 1 ♀, Serpentine, Rockhampton, Nov. 1955, C. Vallis; 1 ♀, Bundaberg, 5.xi.1971, H. Frauca; 2 ♂♂, Baldwin Swamp Fauna Reserve, Bundaberg, 16.xi.1971, H. Frauca; 1 ♀, Palmwoods, 17–19.i.1968, R. Dobson; 1 ♂, Brisbane, Dec. 1904, R. J. Tillyard; 1 ♀, same locality and collector, 22.i.1913; 1 ♂, same locality, 16.x.1938, C. F. Ashby; 1 ♀, Tamborine, 30.xii.1912, R. J. Tillyard. NEW SOUTH WALES: 1 ♀, Hibbard, 3 miles (5 km) WNW of Port Macquarie, 9.xi.1967, K. H. L. Key; 1 ♀, Bandon Grove, near Dungog, 26.xi.1967, J. A. L. Watson; 1 ♀, Pokolbin, 25.iii.1967, J. A. L. Watson; 1 ♂, Kahibah, 28.xi.1967, J. A. L. Watson; 5 ♂♂, 3 ♀♀, Narrabeen, 5.i.1950, R. Dobson; 1 ♂, Eastwood, Sydney, 6.iii.1948, R. Dobson; 1 ♀, Lake Conjola, 26.iii.1950, R. Dobson; 1 ♂, "Deep Creek" (exact locality unknown), 7.xii.1948, K.G.B.

Additional extralimital specimens of *O. sabina* were examined from: SOMALIA: (BMNH). ETHIOPIA: (BMNH), SUDAN: (LM), EGYPT: (BMNH, LM), CYPRUS: (BMNH, LM). TURKEY: (LM) (including *O. sabina ampullaceum*). ISRAEL: (BMNH). IRAQ: Mesopotamia (BMNH). SAUDI ARABIA: (BMNH). SOUTH YEMEN: (BMNH); Socotra (BMNH). IRAN: (LM). INDIA: (BMNH, LM); "eastern India" (CM) (holotype of *Libellula gibba*). NEPAL: (BMNH, LM). MALDIVE ISLANDS: (BMNH). SRI LANKA: (BMNH, LM). BURMA: (BMNH). THAILAND: (BMNH, LM). VIETNAM: (BMNH, LM). CHINA: (BMNH); Taiwan (BMNH, LM). JAPAN: (SA); Ryukyu Islands (BMNH, LM); Kyushu (LM). MALAYSIA: Malaya (ANIC, BM, BMNH, LM); Sarawak (BMNH). SINGAPORE: (ANIC, BMNH). PHILIPPINES: (BMNH, LM). INDONESIA: Sumatra (BMNH, LM); Enggano (LM); Borneo (Kalimantan) (BMNH, LM); Java (ANIC, BMNH, HM, LM) (including types of *Libellula leptura*); Karimundjawa (LM); Sumbawa (LM); Sumba (ANIC); West Irian (BMNH, LM). PAPUA NEW GUINEA: (ANIC).

Chinese material of O. sabina (Figs 1, 10, 15, 27, 30, 33)

Dark brown to black, marked with yellow or greenish yellow.

Male

Dimensions.—Hind wing averaging 37.25 mm (range 35.9–39.1 mm); abdomen (including appendages) averaging 39.00 mm (range 36.5–41.7 mm) (N = 10).

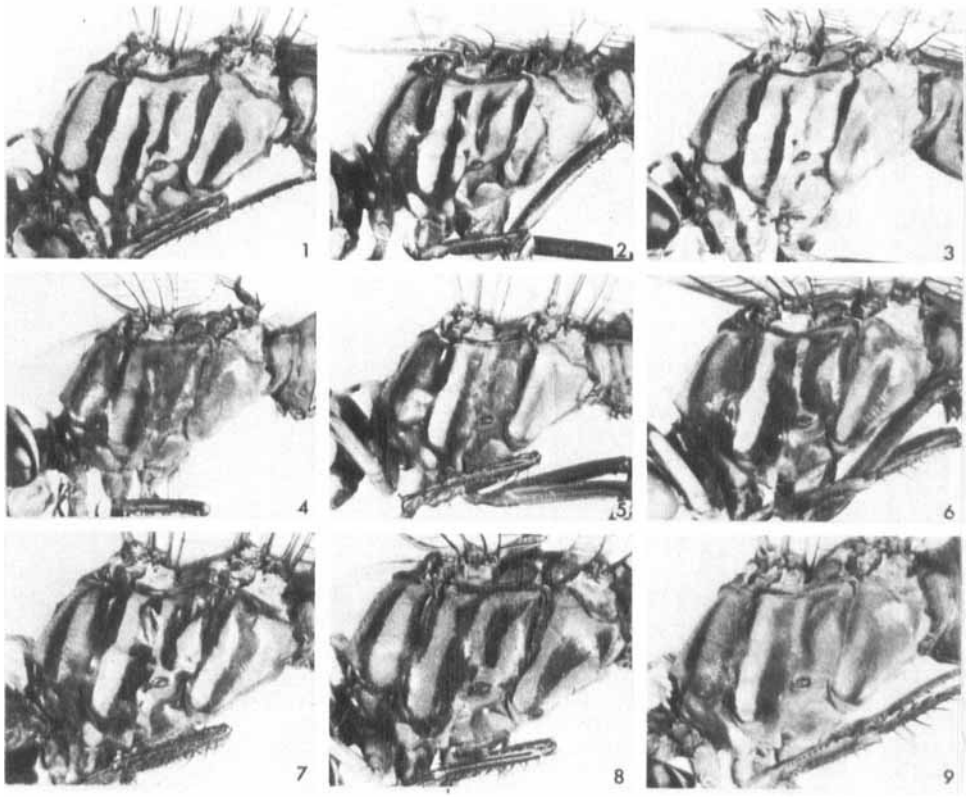
Head substantially yellow, variably marked with dark brown to brownish black; median lobe and inner margins of lateral lobes of labium brown; margin and central spot or line on labrum brown; margin and upper part of anterior frons brown to dark brown; narrow brownish black band on sides and top of frons, along junction with eye and in front of vertex; vertex black, except for brownish yellow rounded spot on part to almost all of hind surface; outer corners of occiput dark brown; much of postgena brownish black, except for constricted band along lower three-quarters of outer margin; antennae black.

Prothorax dark brown; central margin of anterior lobe of pronotum, crest of median lobe and anterior part of margin of its sagittal groove, and much of posterior lobe yellow; leg usually substantially dark brown, lower face of trochanter and femur yellow, outer ridges of tibia and basal 2 tarsal segments yellow, coxa and trochanter sometimes substantially yellow.

Synthorax (Fig. 1) greenish yellow, marked with extensive, complex and, in places, ill-defined dark brown pattern of variable intensity; yellow stripe immediately behind mesopleural suture brighter than others; legs substantially brownish black, coxae and trochanters partially yellowish brown, yellow line on inner ridge of metafemur and, variably, of mesofemur, on outer ridges of mesotibia and, sometimes, metatibia, and on basal 2 mesotarsal segments.

Wings hyaline, except for small brown area at bases of CuP and A in fore wing, sometimes lacking, and larger basal spot in hind wing, extending over first 2–3 rows of anal cells adjacent to membranule; most veins blackish brown, costa, subcostal and, variably, costal antenodal crossveins yellow, subcostal part of nodus, subnodus, arculus, cu-a, veins bounding triangular spaces, and crossveins in radial and anal fields partly or

totally yellow; antenodal crossveins (excluding Ax_2) 12–14/9–11, postnodals 9–12/10–13; arculus very close to level of Ax_2; hypertriangle of fore wing crossed, of hind wing free; fore wing triangle 2-celled, hind wing triangle free; fore wing subtriangle 3-celled, discoidal field of fore wing 3–4 cells wide at triangle, of hind wing 2–3 cells wide; pterostigma straw-coloured to yellowish brown, 3.6–4.0 mm long in fore wing, 3.7–4.1 mm in hind wing; membranules dark brownish grey.



FIGS 1–9—Thoracic patterns of *Orthetrum*, lateral: **(1–4)** *O. sabina sabina*: **(1)** ♂, Guangzhou, China; **(2)** ♂, Thursday Island; **(3)** ♀, Derby; **(4)** ♂, Daly River Mission. **(5)** *O. sabina viduatum*, ♂, Baliem, New Guinea. **(6–9)** *O. serapia*: **(6)** holotype ♂, Cooktown; **(7)** ♂, Keppel Sands; **(8)** ♂, Daly River; **(9)** ♀, Litchfield Station.

Abdomen (Figs 10, 15) strongly swollen at base, deepest at junction of segments 2–3, narrowing abruptly to segment 4, expanding dorsoventrally from segment 6 to end of segment 8, tapering slightly to segment 10; tergite 1 black with broad, middorsal distal yellow triangle, its apex directed forward; tergite 2 dark brown in front of supplementary transverse carina (SUTC), with yellow middorsal and lateral patches substantially yellow behind it, dark brown or yellow ringed with dark brown below its end; anterior part of tergite 3 bearing almost semicircular yellow spot on each side of midline in front of pronounced ridge of SUTC, based on antecostal ridge and extending to SUTC, flanked by lateral band, and followed by pair of subtriangular dorsolateral yellow spots extending two-thirds or more of distance to posterior transverse carina (PTC), flanked by triangular to rounded yellow spot bounded by SUTC in front, and lateral carina (LC) below, sometimes reaching PTC behind, lower part of tergite brownish black and yellow to substantially yellow; tergite 4 black above, yellow at sides, the black middorsal stripe pointed in front, then broadening almost to LC one-quarter to one-third length of segment from base, narrowing progressively to middle of segment, broadening abruptly to LC at two-thirds to four-fifths of segment length, lower part of tergite yellow to dull brown, distal band black; tergite 5 black above, with marginal yellow patch over central one-third to one-half, continuous with central yellow portion of lower tergite and, in some specimens, a pair of small yellow basal spots astride the middorsal line; tergite 6 with similar pattern, the marginal yellow patch about one-half to three-fifths length of segment, commencing about one-third segment length from base, contiguous with yellow region of lower tergite; tergites 7–9 black; segment 10 variable, black at base, yellow distally, to black above and basally at sides, yellow elsewhere; sternites mostly brownish black.

Secondary genitalia (Figs 27, 30).—Anterior lamina dark brown, upright, its apex bilobed, anterior face bearing dense tuft of reddish brown setae on either side of midline; hamule subtriangular in profile, the apex truncate, almost parallel to line joining tips of anterior and genital lobes, the boss at end of anterior ridge of hamule scarcely projecting beyond alignment of posterior part of margin, which ends in black, outwardly directed, sharp hook, anterior and basal one-third dark brown, central and posterior subtriangular area, above and in front of hook, pale yellow; genital lobe densely haired, dark brown, rounded.

Anal appendages yellow, tips slightly darkened; superior appendages almost straight, with pointed, slightly upturned tip, ventral surface set with 13–20 black denticles (mean 16.8) in irregular row extending slightly beyond level of tip of inferior appendage, average length 2.22 mm (range 2.1–2.3 mm); inferior appendage more than one-half to almost two-thirds length of superiors, apex broadly emarginate or excised, upturned denticle on each lobe black.

Female

Dimensions.—Of heavier build than ♂ (cf. Fig. 13); hind wing averaging 37.41 mm (range 35.8–39.6 mm); abdomen (including appendages) averaging 39.13 mm (range 38.6–40.0 mm) (N = 8).

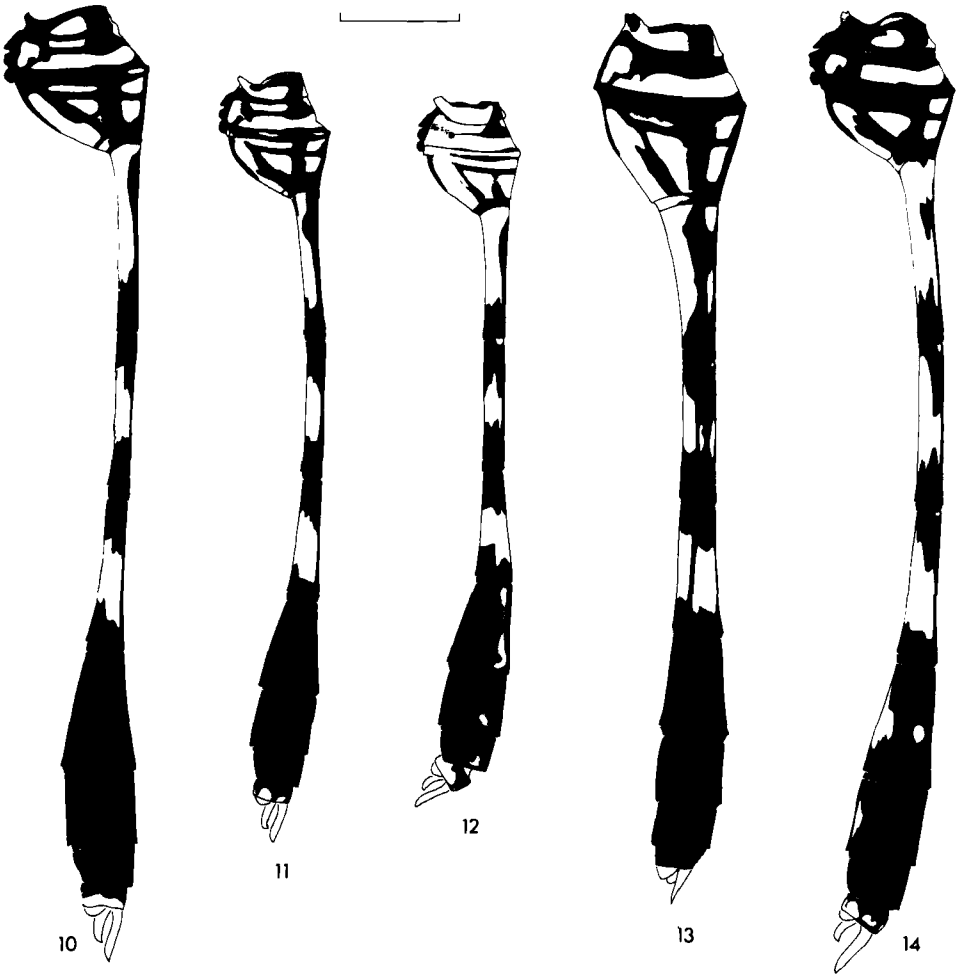
Colour pattern similar to that of ♂; yellow areas of tergites 3 and 6 more extensive; lower tergite 7 sometimes bearing yellow patch; lower, distal tergite 9 commonly yellow; segment 10 yellow or substantially yellow.

Wings much as in ♂; membranes sometimes extensively suffused yellow; antenodals 13–15/10–12, postnodals 9–12/9–12; pterostigma 4.0–4.8 mm long in fore wing, 4.1–5.2 mm in hind wing.

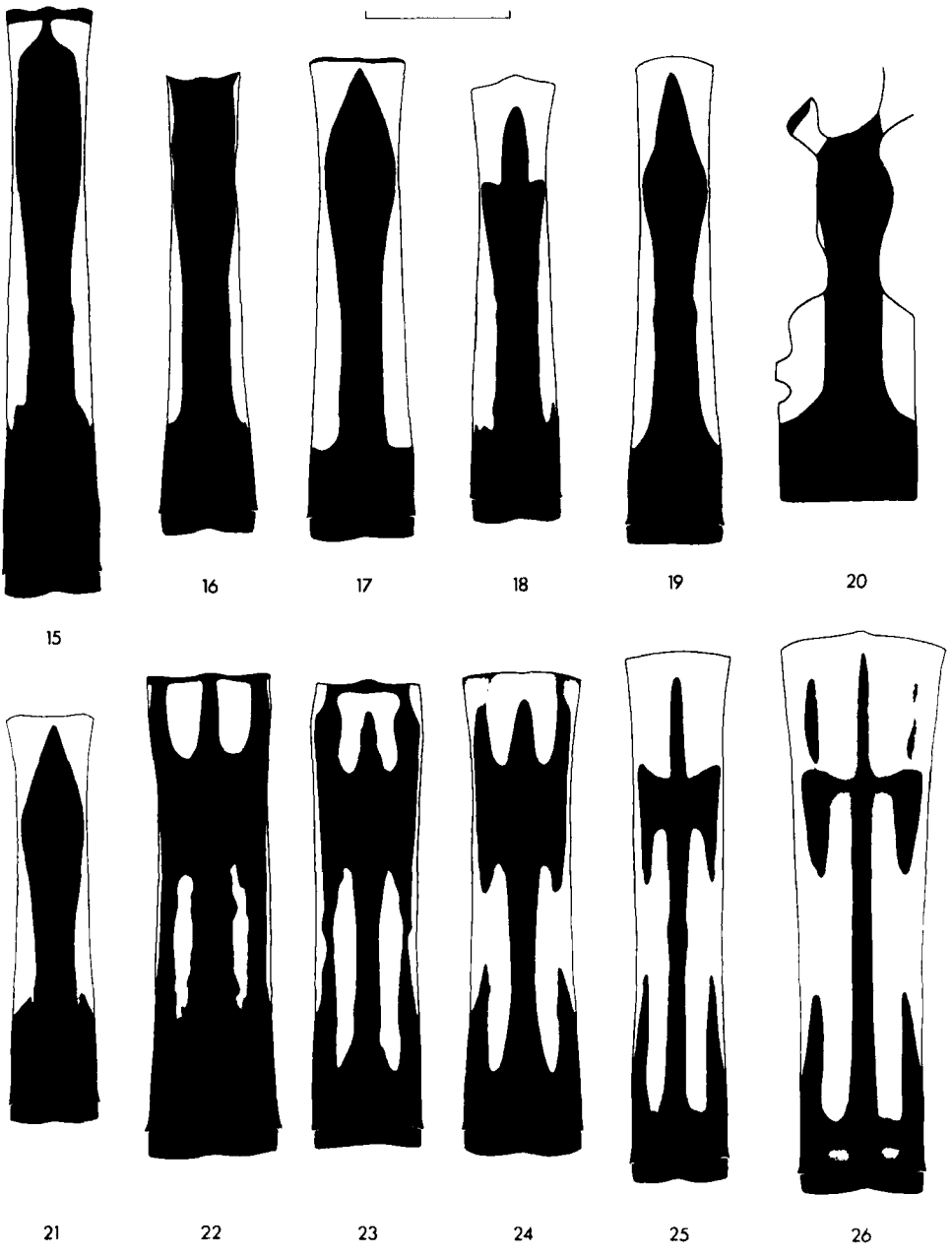
Vulvar scale (Fig. 33) set in recess, the wall of recess formed by broadened lower tergite 8, reflexed at lateral carina, the resulting dilatation not extending beyond ventral contour of abdomen; upright, curved, cowl-like, lateral margin sharply reflexed towards midline.

Australian material of O. sabina (Figs 2–4, 11, 16–18, 28, 31, 34)

Similar to Chinese *O. sabina*, but smaller and paler.



FIGS **10–14**—Abdominal patterns of *Orthetrum*, lateral: **(10–11)** *O. sabina sabina*: **(10)** ♂, Guangzhou, China; **(11)** ♂, Derby. **(12)** *O. sabina viduatum*, ♂, Baliem, New Guinea. **(13–14)** *O. serapia*: **(13)** ♀, Warraber Island; **(14)** ♂, Daly River. Scale = 5 mm.



FIGS **15–26**—Dorsal views of abdominal tergite 4 of *Orthetrum:* **(15–20)** *O. sabina sabina*: **(15)** ♂, Guangzhou, China; **(16)** ♂, Derby; **(17)** ♂, Nourlangie Creek; **(18)** ♂, East Innisfail; **(19)** lectotype ♀ of *Libellula leptura*, Java; **(20)** holotype ♀ of *Libellula gibba*, India (redrawn from sketch supplied by P. Nielsen, not to scale). **(21)** *O. sabina viduatum*, ♂, Baliem, New Guinea. **(22–26)** *O. serapia*: **(22)** ♀, Warraber Island; **(23)** ♂, Thursday Island (base of tergite distorted); **(24)** holotype ♂, Cooktown; **(25)** ♂, Litchfield Station; **(26)** ♀, Litchfield Station. Scale = 2 mm.

Male

Dimensions.—Hind wing averaging 32.14 mm (range 29.1–34.8 mm); abdomen (including appendages) averaging 33.23 mm (range 29.4–35.0 mm) (N = 60).

Colour pattern (Figs 2, 4, 11, 16–18).—All but upper end of postgena yellow adjacent to eye; procoxa, trochanter, much of femur, outer ridge of tibia and outer face of basal tarsal segments yellow; dark brown

bands on synthorax variable, often much reduced, yellow stripes behind meso- and metapleural sutures brighter than others; outer faces of much of meso- and metacoxae and trochanters, inner and basal part of outer ridges of mesofemur and of tibia, inner ridge of metafemur and of basal part of tibia, and outer face of basal tarsal segments yellow; yellow marks on tergites 2–3 commonly more extensive than in Chinese *O. sabina*; tergites 4–6 with marginal yellow stripes, as in Chinese *O. sabina*, paired anterior spots on 5 or 6 present or absent; tergites 7–9 occasionally bearing ill-defined, yellowish brown band on each side of middorsal line, most evident on tergite 7 and at apex of tergite 9; segment 10 commonly black above.

Wings.—Antenodal crossveins (excluding Ax_0) 11–14/9–12, distal antenodals of either wing occasionally incomplete, postnodals 8–11/9–13; hypertriangle of fore wing usually crossed; fore wing triangle 2-celled, occasionally 3-celled or free; fore wing subtriangle 3-celled, occasionally 4-celled; pterostigma straw-coloured to brown, 3.3–4.4 mm long in fore wing, 3.3–4.7 mm in hind wing.

Secondary genitalia (Figs 28, 31) as in Chinese *O. sabina*, but boss at end of anterior ridge of hamule rather less pronounced.

Anal appendages.—Eight to 17 (average 12.3) denticles on lower margin of superiors.

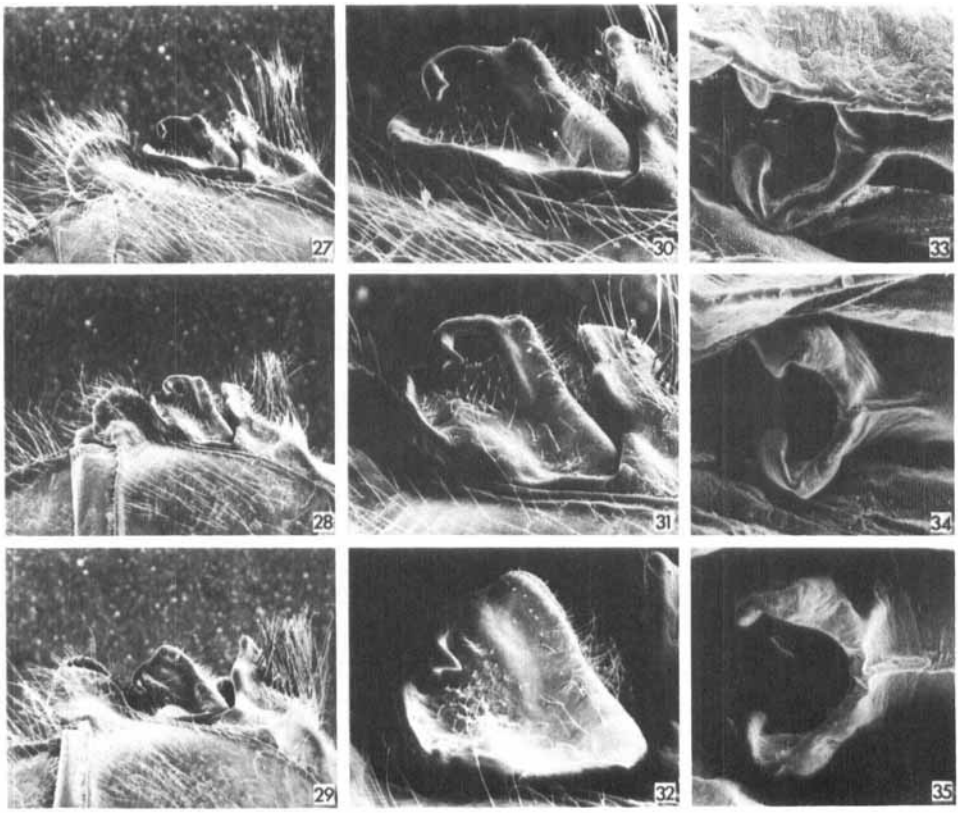
Female

Dimensions.—Hind wing averaging 32.51 mm (range 28.7–35.8 mm); abdomen (including appendages) averaging 33.53 mm (range 30.0–37.7 mm) (N = 35).

Colour pattern (Fig. 3) as in ♂, yellow areas tending to be more extensive.

Wings.—Antenodal crossveins 11–15/9–11, postnodals 7–11/8–12; triangular spaces as in ♂; pterostigma of fore wing 3.4–4.6 mm long, of hind wing 3.5–4.7 mm.

Vulvar scale (Fig. 34) as in Chinese *O. sabina*.



FIGS **27–35**—*Orthetrum:* **(27–29)** secondary genitalia of ♂, left lateral view: **(27–28)** *O. sabina:* **(27)** Taiwan; **(28)** Nourlangie Creek. **(29)** *O. serapia*, Mission Beach. **(30–32)** left hamule of ♂: **(30–31)** *O. sabina sabina*: **(30)** Taiwan; **(31)** Nourlangie Creek. **(32)** *O. serapia*, Iron Range. **(33–35)** vulvar scale of ♀, right lateroventral view: **(33–34)** *O. sabina sabina*: **(33)** Taiwan; **(34)** Daly River Mission. **(35)** *O. serapia*, Iron Range.

Material of O. sabina *from elsewhere* (Figs 5, 12, 19–21)

All the additional material here identified as *O. sabina* has a pattern of abdominal coloration similar to that of Chinese and Australian specimens, and genitalia of similar form. The holotype ♀ of *Libellula gibba* and the lectotype ♀ and paralectotype ♂ of *Libellula leptura* are of this kind (Figs 19–20). The extent of the black markings is variable; in some (but not all) specimens from Iran, the abdomen is very dark, and the marginal yellow areas are greatly reduced, sometimes to a yellow line along the lateral carina.

O. sabina viduatum, from the Baliem Valley in the New Guinea (West Irian) highlands, is more distinctive, at least in its pale coloration (Figs 5, 12, 21); the genitalia of both sexes are similar to those of the typical subspecies from New Guinea and Australia. Lieftinck (1942) described the colour pattern but did not document the extent of the pale areas on tergites 4–6. These are shown in Figs 12 and 21. *O. sabina viduatum* is smaller than Chinese *O. sabina*, but not Australian; the male hind wing is 32.7–34.0 mm long, and the female 32.8–34.7 mm (Lieftinck 1942).

The form of *O. sabina* that Schneider (1845) described as *Libellula ampullacea*, from "Kellemisch" (? = Kellmis, on the Turkish Mediterranean coast), shows some resemblance to *O. sabina viduatum*. A specimen in LM, from Manavgat, near Kellmis, identified by A. R. Waterston as *O. sabina ampullaceum*, has a hamule like that of other *O. sabina* and the typical *sabina* pattern on tergite 4; however, tergites 5–6 bear longitudinal pale stripes over the central part of the segment close to the middorsal line, those on tergite 6 being well developed and fused to the marginal mark.

I have not tried to decide whether or not *O. sabina*, as recognised here, includes more than 1 species; the distinctness of *O. sabina viduatum*, and the apparent coexistence of dark and pale forms in Iran, suggest strongly that it does. The important point is that all the names that Ris (1909) regarded as synonyms of *O. sabina* are inapplicable to the species here described as *O. serapia*.

Orthetrum serapia sp.n. (Figs 6–9, 13–14, 22–26, 29, 32, 35)

Orthetrum sabina (Drury); Ris, 1909: 223–225 (*partim*), Fig. 149; 1916: 1090–1091 (*partim*).
Orthetrum sp. near *O. sabina*; Watson and Abbey, 1980: 4, 16, 36, 40.

Types.—*Holotype* ♂, QUEENSLAND: Cooktown, 12.x.1980, J. A. L. Watson (ANIC Type No. 9885). *Paratypes*: NORTHERN TERRITORY: 1 ♂, 2 ♀♀, 13°29 'S 130°41 'E, Litchfield Station, Morgan Hole Lagoon, 30.vi.1974, J. F. Hutchinson; 1 ♂, 13°41 'S 130°35 'E, junction of Daly River and Charlie Creek, 11.v.1974, J. F. Hutchinson, QUEENSLAND: 1 ♀, Queensland, no date, F. P. Dodd (BMNH); 1 ♀, 10°12 'S 142°50 'E, Warraber (Sue) Island, 9.xi.1977, R. A. Farrow; 2 ♂♂, Thursday Island, Torres Strait, 5.vi.1969, A. Neboiss (NMV); 1 ♂, same locality, May 1977, R. Paton; 1 ♂, Prince of Wales Island, Torres Strait, 28.v.1969, A. Neboiss (NMV); 1 ♂, 1 ♀, *in cop.*, Claudie River, near Iron Range, 21.xi.1968, S. & K. Breeden; 1 ♂, Orchid Point, S of Lloyd Bay, 29.xi.1913, J. A. Kershaw (NMV); 2 ♂♂, 1 ♀, Coen, 10.xi.1947, 21.xi.1947, H. L. Pottinger (ML); 1 ♂, 15°03 'S 145°09 'E, 3 km NE of Mt Webb, 29.iv.1981, J. E. Feehan; 1 ♀, Cooktown, May 1909, R. J. Tillyard (BMNH); 1 ♂, 1 ♀, *in cop.*, Intake, near Redlynch, 7.xii.1967, R. Dobson; 1 ♀, Crystal Cascade, 30.viii.1971, S. Asahina (SA); 3 ♂♂, 1 ♀, Cairns, 15.vi.1962, 10.x.1962, 15.x.1963, 24.iii.1964, E. C. Corbet (SA); 1 ♂, same locality, 20.x.1962, G. Corbet (BMNH); 1 ♂, same locality, 11.x.1967, R. Geijskes (LM); 4 ♂♂, Mission Beach, 26–29.x.1980, L. Muller & G. Theischinger; 1 ♀, Hayman Island, 22.x.1950, R. Dobson; 2 ♂♂, Yeppoon, Mar. 1963, C. Vallis; 2 ♂♂, Keppel Sands, Mar. 1954, E. E. Adams (LM).

Extralimital specimens, apparently of *O. serapia*, were examined from: PHILIPPINES: (LM); Luzon (BMNH); Palawan (LM). INDONESIA: SULAWESI: (BMNH, LM); MOLUCCAS: "Morty" (= Morotai) (BMNH); "Gilo" (? = Jailolo, Halmahera) (BMNH); Sula Islands (LM); Ambon (BMNH, LM); Buru (LM); Ceram (BMNH); Aru (LM); Tanimbar (LM); WEST IRIAN (LM). PAPUA NEW GUINEA: Papua (BMNH, LM); Morobe District (BMNH); Bismarck Archipelago (LM). SOLOMON ISLANDS: Shortland Island (BMNH); Santa Isabel (BMNH); Malaita (LM); Guadalcanal (LM); Olu Malau (BMNH); Rennell (BMNH). SAMOA: (BMNH). FIJI: Viti Levu (BM).

Data from these specimens were not incorporated into the description of *O. serapia*, and the material is not to be regarded as paratypic.

Very similar in appearance to Chinese *O. sabina*, brownish black and yellow, thorax and abdomen slightly pruinose in mature individuals.

Male (Figs 6–8, 14, 23–25, 29, 32)

Dimensions.—Hind wing averaging 35.23 mm (range 33.6–36.6 mm); abdomen (including appendages) averaging 35.80 mm (range 33.4–39.9 mm) (N = 17).

Colour pattern of head and thorax (Figs 6–8) much as in Chinese *O. sabina*, tending to be darker than in Australian *O. sabina*; margin and basal central spot on labrum brown; dark marks on margin and upper part of anterior frons sometimes pale brown, ill-defined; yellow spot on hind surface of vertex rounded, bilobed or double, sometimes extending between horns of vertex above median ocellus; occiput usually dark brown; outer yellow band extending over lower one-half to two-thirds of postgena; margin of sagittal groove of median lobe and much of posterior lobe of pronotum sometimes brownish black; all basal tarsal segments commonly lined yellow.

Abdominal tergite 2 dark brown in front of, and substantially yellow behind SUTC (Fig. 14), yellow shading into dark brown below its end; anterior part of tergite 3 variably, and sometimes extensively yellow,

commonly bearing almost semicircular yellow spot on each side of midline as in Chinese *O. sabina*, pair of subtriangular dorsolateral yellow spots extending between three-quarters and entire distance to PTC, larger triangular flanking yellow spot bounded by PTC behind; tergite 4 (Figs 23–25) with pair of yellow basal spots, narrowly joined in front, ranging from variably finger-like stripes rather less than one-fifth length of segment to broad patches extending to LC and SUTC, and a pair of elongate yellow stripes on same alignment, rather more than twice as long, commencing near or a little beyond basal one-third of segment, usually and often substantially joined near centre to narrow yellow line along LC, lower part of tergite pale yellow except over distal one-quarter to one-third; tergites 5–6 (Fig. 14) with pattern of similar kind, basal spots transverse, narrow, separated on 6, distal stripe broadly confluent with shorter or longer lateral stripe, often narrowly isolated from LC, anterior and posterior parts of lower tergite variably dark; tergite 7 substantially black, with variable, often ill-defined yellow spot or spots corresponding to fused distal stripes of preceding tergites, and pale stripe of roughly similar or greater length on lower tergite; tergites 8–9 black, sometimes irregularly shaded with yellow, or with yellow patch on lower tergite; segment 10 variable, black, with or without ill-defined middorsal and ventrolateral yellowish brown spots, or substantially yellowish brown, darker at base; sternites mostly dull brown.

Wings much as in *O. sabina*; most veins blackish brown, subcostal antenodal crossveins yellow; antenodal crossveins (excluding Ax_0) 13–15/9–12, distal antenodals occasionally incomplete, postnodals 9–11/10–13; triangular spaces as in Australian *O. sabina*; pterostigma 3.4–4.1 mm long in fore wing, 3.5–4.1 mm in hind wing.

Secondary genitalia (Figs 29, 32).—Hamule differing from that of *O. sabina*, almost triangular in profile, the apex of triangle formed by boss at end of anterior ridge of hamule, projecting well beyond rest of hind margin.

Anal appendages as in Chinese *O. sabina*, ventral surface set with 14–18 black denticles (mean 15.4), average length 2.28 mm (range 2.2–2.5 mm).

Female (Figs 9, 13, 22, 26, 35)

Dimensions.—Hind wing averaging 36.21 mm (range 35.2–37.4 mm); abdomen (including appendages) averaging 37.13 mm (range 34.0–40.6 mm) (N = 6).

Colour pattern similar to that of ♂, yellow areas sometimes more extensive (Figs 9, 25) but, in ♀ from Warraber Island, far more restricted (Figs 13, 22).

Wings.—Venation sometimes extensively yellowish brown, with costa yellow to pterostigma; antenodals 13–16/10–11, postnodals 9–10/10–12; triangular spaces as in ♂; discoidal field of fore wing 3–4 cells wide at triangle, then 3 cells wide, of hind wing 2–3 cells wide at triangle, then 2 cells wide; pterostigma 4.0–4.6 mm long in fore wing, 4.1–4.6 mm long in hind wing.

Vulvar scale (Fig. 35) much as in *O. sabina*, but outer corners thickened, terminating in low boss.

Comparison with extralimital material

Specimens from Fiji, the Solomon Islands, New Guinea, Aru and Tanimbar closely resemble Australian material in the shape of the hamule and the coloration of the abdomen, and there is little doubt they are *O. serapia*. Some are darker than Australian specimens with, apparently, more substantial and clearly demarcated black lines on the synthorax, and a tendency for the dorsolateral yellow stripes to be isolated from the yellow bands along the lateral carinae on abdominal segments 4–5. Some Moluccan specimens, particularly from Ambon and Buru, are darker again, although the hamule is of the form seen in *O. serapia*; the dorsolateral stripes on abdominal segments 4–5 may be reduced to short lines, much as in Fig. 22, but are sometimes almost obscured. In specimens from farther afield, in the Celebes and the Philippines, the anterior ridge on the hamule sometimes projects less markedly beyond the margin of the hamule, resembling more closely that of *O. sabina*, and the abdominal coloration is extensively yellow, notwithstanding which the large, dorsolateral stripes on segments 4–5 may be isolated from the lateral bands.

Diagnosis of O. serapia

Watson and Arthington (1978) keyed the adults and larvae of the Australian species of *Orthetrum* Newman. Both male and female adults of *O. serapia* key out to *O. sabina*. In both sexes, the colour pattern of abdominal tergite 4 separates the 2 species; the yellow marks are lateral and marginal in *O. sabina* (Figs 16–18), but are more complex in *O. serapia*, with an additional dorsolateral yellow stripe on each side, fused or not with the lateral yellow band (Figs 22–26). The anterior ridge of the hamule protrudes more in *O. serapia* (Fig. 32) than in *O. sabina* (Fig. 31), and the lateral corners of the vulvar scale are more strongly reinforced (Figs 34–35).

The larva of *O. serapia* is unknown but is likely to resemble that of *O. sabina* very closely.

Relationship between O. serapia *and* O. sabina

O. sabina and *O. serapia* are very closely allied. At least in Australia and New Guinea, they are broadly sympatric: within Australia, *O. sabina* is known from the western Kimberleys across the northern part of the Northern Territory to northern Queensland, thence south along the coast to south of Sydney, whereas *O. serapia* has been found in coastal regions from the Daly River to Rockhampton. At some individual localities, they have been found together. However, the extensive material now available provides no evidence that they interbreed; they are distinct species.

The overall distribution of *O. serapia sens. lat.* (the eastern parts of Indonesia, New Guinea, northern Australia and inner Oceania) suggests that the species might originally have been an eastern outlier of the Afro-Asian species that is now *O. sabina*. In Indonesia, *O. sabina* has a southwestern range, reaching Australia via Sumatra, Java, the Lesser Sunda Islands and New Guinea; whether it extends to Oceania is not yet clear. It is possible that both species have extended their ranges in recent times, for both frequent shallow, open freshwaters, and the development of rice agriculture has enormously enlarged their potential habitat. Lieftinck (1954) commented that *O. sabina* is "a common and widespread species" in the Malaysian region, being "most abundant in cultivated areas. Breeds in any stagnant and slow flowing water . . . but its breeding places are usually of artificial origin".

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References

BURMEISTER, H. (1839).—*Handbuch der Entomologie* **2**(2). Enslin: Berlin.
CALVERT, P. P. (1898).—Burmeister's types of Odonata. *Trans. Am. ent. Soc.* **25**: 27–104.
CHALMERS-HUNT, J. M. (1976).—*Natural history auctions 1700–1972*. Sotheby Parke Bernet: London.
CHAO, H. F. (1953).—The external morphology of the dragonfly *Onychogomphus ardens* Needham. *Smithson. misc. Collns* **122**(6): 1–56.
DRURY, D. (1770).—*Illustrations of natural history* **1**. White: London.
FABRICIUS, J. C. (1798).—*Supplementum entomologiae systematicae*. Proft and Storch: Copenhagen.
HORN, W. and KAHLE, I. (1935–37).—*Über entomologische Sammlungen, Entomologen und Entomo-Museologie* **1–3**. (Reprinted from *Ent. Beih. Berl.-Dahlem* **2–4**.)
LIEFTINCK, M. A. (1942).—The dragonflies (Odonata) of New Guinea and neighbouring islands Part VI. Results of the third Archbold Expedition 1938–'39 and of the Le Roux Expedition 1939 to Netherlands New Guinea (I. Anisoptera). *Treubia* **18**: 441–608.
LIEFTINCK, M. A. (1954).—Handlist of Malaysian Odonata. *Treubia* **22** (Suppl.): xii + 202.
LIEFTINCK, M. A. (1962).—Insects of Micronesia Odonata. *Insects Micronesia* **5**: 1–95.
LONGFIELD, C. (1955).—The Odonata of N. Angola Part I. *Publcões cult. Co. Diam. Angola* **27**: 13–63.
NEEDHAM, J. G. (1930).—A manual of the dragonflies of China. *Zoologia sinica* (A) **1**(1): 1–345 + 11.
RIS, F. (1900).—Libellen vom Bismarck-Archipel gesammelt durch Prof. Friedr. Dahl. *Arch. Naturgesch.* **66**: 175–204.
RIS, F. (1909).—Libellulinen 2. In *Collections zoologiques du Baron Edm. de Selys Longchamps* **9**: 121–244. Institut royal des Sciences naturelles de Belgique: Brussels.
RIS, F. (1916).—Libellulinen 9. In *Collections zoologiques du Baron Edm. de Selys Longchamps* **16**: 1043–1278. Institut royal des Sciences naturelles de Belgique: Brussels.
SCHNEIDER, W. G. (1845).—Verzeichniss der von Hrn. Prof. Dr. Loew im Sommer 1842 in der Türkei und Kleinasien gesammelten Neuroptera, nebst kurzer Beschreibung der neuen Arten. *Stettin. ent. Ztg* **6**: 110–116.
WATSON, J. A. L. and ABBEY, H. M. (1980).—Dragonflies (Odonata) from the Northern Territory. *Rep. Commonw. scient. ind. Res. Org. Div. Ent.* **21**: 1–44.
WATSON, J. A. L. and ARTHINGTON, A. H. (1978).—A new species of *Orthetrum* Newman from dune lakes in eastern Australia (Odonata: Libellulidae). *J. Aust. ent. Soc.* **17**: 151–157.
WESTWOOD, J. O. (1837).—*Illustrations of exotic entomology* **1–3**. Bohn: London.
ZIMSEN, E. (1964).—*The type material of I. C. Fabricius*. Munksgaard: Copenhagen.

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