

The Odonata of Sulawesi and adjacent islands. Part 7. *Libellago* and *Sclerocypha* (Chlorocyphidae)

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ABSTRACT

The Sulawesi species of the genera *Libellago* and *Sclerocypha* are revised. *L. asclepiades*, *L. rufescens*, *L. xanthocyana* and *S. bisignata* are redescribed, and three species of *Libellago* – one with four subspecies – are described as new to science, viz. the closely allied *L. daviesi* sp. nov. from the northern arm of Sulawesi and *L. manganiu* sp. nov. from Sangihe Island, north of Sulawesi, and a complex of four mainly parapatric subspecies allied to *L. rufescens*, viz., *L. celebensis* sp. nov. from W part of Central Sulawesi, and nominotypical subspecies, *L. celebensis anoa* ssp. nov. from NE part of South Sulawesi, *L. celebensis dorsonigra* ssp. nov. from NE part of South Sulawesi, and *L. celebensis orientalis* ssp. nov. from extreme E part of South Sulawesi, E part of Central Sulawesi and Southeast Sulawesi. The status of the genus *Sclerocypha* is discussed. A key to the species of Chlorocyphidae (except *Rhinocypha*) known from Sulawesi, is provided.

INTRODUCTION

The species richness of many Sulawesi (Celebes) odonate groups is low compared with that of Borneo or Java (e.g. van Tol 1987). The absence of many poorly dispersing groups, such as Platycnemididae, is presumably related to the isolated position of Sulawesi for more than 50 million years. The existence of a land connection with Sundaland via the Makassar Strait between Borneo and Sulawesi is considered unlikely for any period during the last 50 million years. If a land connection has ever existed, it should be sought to the south (Java) (R. Hall in Groves 2001: 338).

Although parts of the southwestern arm of Sulawesi have existed as an island for ca 50 million years, the other parts of Sulawesi are geologically much younger, and merged with SW Sulawesi later in geological time. According to Hall (1997, 2002) Sulawesi in its present conformation is only ca five million years old. The island is an amalgamation of a series of micro-continental fragments, of which geologists at least have identified the northern arm, the Banggai peninsula, and the southeastern arm. These palaeo-islands are presently connected in the mountainous central part of Sulawesi. North-south directed mountain ridges east and west of Lake Poso, and the Matano and Towuti lakes were formed during and after collision events. The micro-continental fragments were mainly parts of the northwestern margin of the Australian Plate, although the northern arm (Gorontalo, Minahasa) was presumably

formed due to rotation of the Pacific Plate along the Australian Plate and was part of a northern archipelago with parts of the current Philippines and Moluccas. Van Tol (2007b) provides a further summary of the tectonic history of Sulawesi, while van Tol & Gassmann (2007) discuss the biogeography of the region, with particular attention to odonates.

The turbulent tectonic history and isolated position of Sulawesi is considered to be the reason for its generally unbalanced faunal composition. Faunal elements must have reached the continental fragments by chance dispersal, followed by a process of local extinction or radiation. Radiation into mainly parapatric taxa is found in such distantly related groups as macaques (Evans et al. 1999; Groves 1980, 2001), waterstriders (Polhemus & Polhemus 1990) and cicadas (Duffels 1990). Sulawesi is also well known for taxa of which no close relatives survive, e.g. the mammal genus *Bubalus* (anoa), with two closely related species *B. depressicornis* and *B. quarlesi*. The isolated position and diverse topography of Sulawesi were key factors for the survival of such aberrant taxa. Many groups of predators, such as felids, never became established on Sulawesi, thus reducing competition and the chances of extinction of the island's inhabitants. The physical diversity of the landscape further created a perfect environment for survival of local species during periods of rapid environmental change.

The family Chlorocyphidae demonstrates various aspects of these traits. Three genera endemic to Sulawesi are presently recognized, viz. *Disparocypha*, *Sclerocypha* and *Watuwila*. This is a high number for a group with less than 20 genera worldwide (van Tol 2007a). The phylogenetic position of especially *Disparocypha* is still uncertain. It has so many autapomorphies that it was placed in a separate subfamily by Munz (1919). Two genera more widespread in Southeast Asia, *Libellago* and *Rhinocypha*, are also known from Sulawesi. The status of the Sulawesi species of the latter genus was previously discussed by Lieftinck (1938), who presumed a close relationship of the Sulawesi species *R. frontalis* and *R. monochroa* to the *tincta*-group of the Moluccas and New Guinea, presumably including *R. colorata* (Selys) of the Philippine Islands. Two more species are presently known from Sulawesi, *R. phantasma* (see Lieftinck 1935), and *R. semitincta* (J. van Tol unpubl.).

The relationships of the *Libellago* species of Sulawesi to other taxa of this genus are still unclear. A first attempt to clarify these was made by Laidlaw (1950), and again by van Tol (1998) and van Tol & Gassmann (2007). In particular, the red-coloured species described in the present paper show a remarkable degree of overall similarity to each other, and to other red-coloured *Libellago* species, such as *L. aurantiaca* Selys, which is widespread in the mainland of Southeast Asia, Sumatra and Borneo. In addition, there is also a close resemblance between these species and those assigned to the genus *Watuwila*, or to the red-coloured *Rhinocypha*, e.g. *R. pagenstecheri* Förster from Flores and *R. ogasawarensis* Matsumura and *R. uenoi* Asahina from the Ryukyu islands. Further studies are needed for a reconstruction of the phylogenetic relationships of the Chlorocyphidae. The extremely low diversification of most morphological characters, including the secondary genitalia (Cowley 1937), has severely hampered phylogenetic studies of Chlorocyphidae up to now. Genera are mostly defined by characters of wing venation. The value of wing venation in phylogenetic studies may, however, be rather limited, since parallel evolution is both likely and difficult to recognize. Molecular studies, such as Dumont et al. (2005) on the Calopterygidae, may provide new insight in the chlorocyphid relationships in the near future.

The present paper is the 7th part of a series on the Odonata fauna of Sulawesi (part 6, see van Tol 2007b), and focuses on the descriptions of the Sulawesi taxa of *Libellago* and *Sclerocypha*, completing the revision of the Chlorocyphidae of this island, except *Rhinocypha* and *Disparocypha* (see also van Tol 1998). The relationships of the species described in the present paper, and the biogeographical implications, are further discussed in another paper (van Tol & Gassmann 2007).

MATERIAL AND METHODS

This study is mainly based on specimens preserved in the National Museum of Natural History Naturalis, Leiden (RMNH). Further specimens were received on loan from the Zoologisches Museum der Humboldt Universität, Berlin (ZMHB), Senckenberg Museum, Frankfurt (SFMD); National Museums of Scotland, Edinburgh (RSME), and the Royal Belgian Institute of Natural Sciences, Brussels (IRSN). André Günther (Freiberg) kindly offered his reference collection of Sulawesi Chlorocyphidae for this study.

Specimens were studied with various microscopes (Leica, Zeiss), the illustrations prepared with a camera lucida. The colour photographs were made with Nikon cameras with 60 mm or 200 mm Micro-Nikkor lenses, using Kodachrome or Fuji film.

Terminology, including that of wing venation, follows Watson & O'Farrell (1991). Terms as 'anterior' and 'posterior' for markings on the synthorax are used according to the orientation in preserved specimens. Due to secondary rotation of the thorax, the 'posterior' side of markings technically is the 'dorsal' side.

The term 'Sg.' on many labels is an abbreviation for 'Sungai', meaning 'stream' or 'river'.

CHARACTERS IN CHLOROCYPHIDAE

As with most Calopterygoidea, representatives of the family Chlorocyphidae show extensive territorial and courtship behaviour in the imaginal stage. Orr (1996) authoritatively describes the morphological, especially the ornamental, features of the Bornean species of the Chlorocyphidae in relation to these behavioural aspects. Presumably owing to the complex precopulatory behavioural mechanisms of species recognition, the diversity of morphological characters in the genitalia is remarkably low (e.g. Cowley 1937; Laidlaw 1950). Apparently, premating isolation by behavioural mechanisms (e.g. Paulson 1981; Robertson 1982a, b; Tennessen 1982) is such, that there is no evolutionary pressure for morphological radiation in this group. Also the larval stages provide little information on the higher phylogenetic relationships.

The absence of structural diversity causes serious difficulties in establishing the taxonomy of this group. The focus on coloration for species recognition is usually unsatisfactory, especially when it is considered that, in the Chlorocyphidae, remarkable superficial similarity occurs even between species with distinct structural characters at the generic level (cf. van Tol 1998). The present paper is restricted to an analysis of the morphological and ornamental features. For most taxa colour photographs were available. These colour pictures are included in this paper, since they show most clearly the significant differences in living colours of the various taxa described. The differences in preserved specimens are much more subtle, as is reflected in the descriptions.

STATUS OF TAXA

The absence of structural differences in a group of 'geographically recognizable forms' of red-coloured *Libellago* on Sulawesi, made a decision on the status of these forms problematic. Several groups of Sulawesi odonates, such as some Platystictidae and Calopterygidae, include taxa with significant geographical variation. This variation, e.g. in *Neurobasis kaupi* Brauer, appeared to be clinal when more specimens from different parts of Sulawesi became available. During fieldwork on the red-coloured *Libellago* I found that *L. rufescens* occurred syntopically with another taxon. The other taxon is one form of a widespread group found in the geographical centre, and the eastern and southeastern parts of the island. These forms are nearly fully parapatric, do not occur syntopically, and no intermediates were found during my fieldwork. Later, an intermediate form was found near Lake Poso by A. Günther.

Using the Biological Species Concept, and mainly based on the observation of the intermediate form, I have decided to consider the closely related red-coloured *Libellago* not belonging to *L. rufescens*, or to a structurally different taxon, as one single species. The geographically recognizable forms of *L. celebensis* are distinguished as subspecies. The study of molecular and behavioural characters, and of specimens from more localities, may provide further insight in the relationships of these taxa, which may also result in a re-evaluation of their taxonomic status.

CHECKLIST OF THE CHLOROCYPHIDAE OF SULAWESI

***Disparocypha* Ris, 1916**

D. biedermani Ris, 1916

***Libellago* Selys, 1840**

L. asclepiades (Ris, 1916)

L. celebensis sp. nov.

L. c. anoa ssp. nov.

L. c. celebensis ssp. nov.

L. c. dorsonigra ssp. nov.

L. c. orientalis ssp. nov.

L. rufescens (Selys, 1873)

L. daviesi sp. nov.

L. manganitu sp. nov.

L. xanthocyana (Selys, 1869)

***Rhinocypha* Rambur, 1842**

R. frontalis (Selys, 1873)

R. monochroa (Selys, 1873)

R. phantasma Lieftinck, 1935

R. semitincta (Selys, 1869)

***Sclerocypha* Fraser, 1949**

S. bisignata (McLachlan, 1870)

***Watuwila* van Tol, 1998**

W. vervoorti van Tol, 1998

Libellago Selys, 1840

Libellago Selys, 1840: 200, original diagnosis, type species *Agrion lineata*; — Fraser (1934: 59, *Calopteryx lineata* Burmeister mentioned as genotype); — Bridges (1994: III.26, catalogued, type species).

Micromerus Rambur, 1842: 238, original diagnosis, included species *Micromerus lineatus* and *M. uxor*.

Libellago as characterized by Fraser (1949), terminology of wing venation adapted: males with Fw without pterostigma, usually tip of Fw black, Hw without opaque markings, but pterostigma present; not more than 6 Ax, sectors of Arculus arising from common point, Arculus bent at right angles or almost so; R2 running straight as a continuation of superior sector of Arculus, not arched towards R1 basally; Anal vein leaving hind margin of wing proximal to basal Ax. The first mentioned character (no pterostigma in Fw) is variable in the genus as presently defined.

Two species described in the present paper, *L. daviesi* sp. nov. from the northern arm of Sulawesi, and *L. manganitu* sp. nov., a closely related species from Sangihe Island, have the Costa thickened to a certain extent, as previously described in the genus *Sclerocypha* (see below). They share, however, most characters with *Libellago*, such as the origin of the Anal vein proximal to Ax1, 5 Ax (instead of ca 9), no additional Ax between the primaries, and no opaque band at the level of the nodus. Reconstruction of the phylogeny may reveal that the genus *Sclerocypha* can be characterized by its thickened Costa. This character is, however, not unique to *S. bisignata* and the two new species. It is also present in at least one other, not closely allied, Sulawesi chlorocyphid, viz., *L. asclepiades*. Pending a phylogenetic reconstruction of the genera of the Chlorocyphidae, I have retained the genus *Sclerocypha* in the original sense, with only *S. bisignata* included.

Libellago asclepiades (Ris, 1916)

(Fig. 1, Plate IIIa)

Micromerus asclepiades Ris, 1916: 305, 309-310, figs. 5, 6, key to *Micromerus* (= *Libellago*) of Celebes, original description of male and female, type locality Maros, abdomen and thorax of male illustrated.

Libellago asclepiades (Ris) — Bridges (1994: VII.20, catalogued); — Tsuda (2000: 75, catalogued).

Specimens examined

Localities in concise form, arranged from north to south (72 specimens, all in RMNH, unless stated otherwise). — 1 ♂, 1 ♀, Sangala, 05 ix 1993, M.T. Wasscher; 1 ♂, 1 ♀, Madjene, 30 xi 1939, J.J. van der Starre; 3 ♂, 6 ♀ (1 in coll. Donnelly), Madjene, 20 iii 1940, J.J. vander Starre; 1 ♂, 1 ♀, Madjene, 23 iv 1940, J.J. van der Starre; 1 ♀, Madjene, 30 xi 1940; 1 ♂, 3 ♀, Polewali, 24 ix 1940, J.J. van der Starre; 1 ♂, 1 ♀, Polewali, 11 xii 1940; 1 ♂, 1 ♀ (syntypes) (in SMFD), Maros, 28 iv 1914, L. Martin; 1 ♂, 1 ♀, Maros, 13 xi 1939, J.J. van der Starre; 7 ♂, 1 ♀, Bantimurung, 14-18 viii 1949, A. Diakonoff; 4 ♂, Bantimurung, 28 May 1982, M.A. Lieftinck;

3 ♂, 3 ♀, Bantimurung, Pattunuang Asue, 21-30 ix 1983, S.S. Pariwono; 4 ♂, 2 ♀, E. of Maros, 16 vi 1985, J. van Tol; 1 ♀, East of Maros, 91JvT07, 19 iv 1991, J. van Tol; 19 ♂, 1 ♀, E of Maros, 91JvT09, 19-23 iv 1991, J. van Tol; 1 ♂, Road to Malino, pl 47, 24 vii 1936, L.J. Toxopeus.

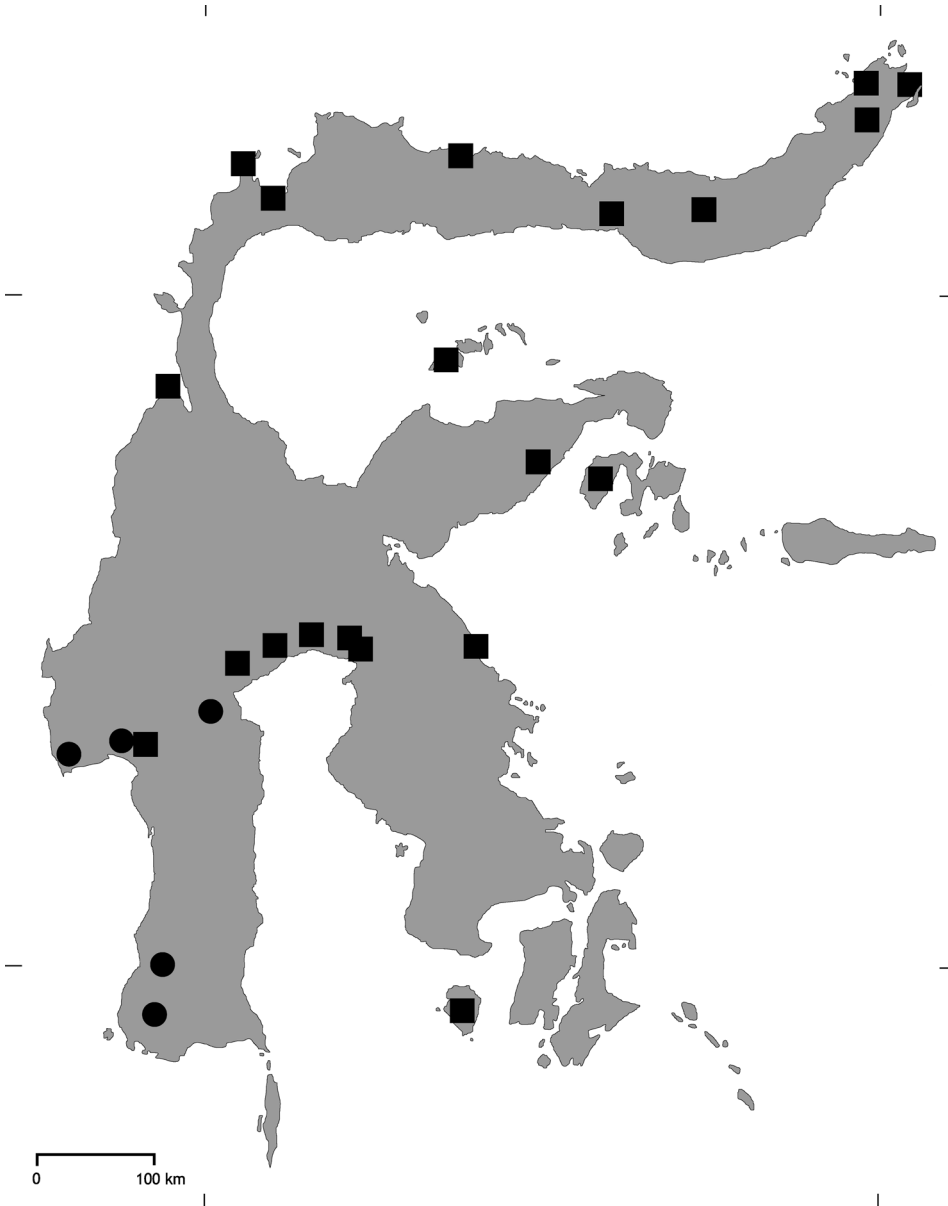


Figure 1: Distribution map of *Libellago asclepiades* (●) and *L. xanthocyana* (■) in Sulawesi.

Diagnosis

A delicate and colourful species; male with markings on thorax pale blue, abdominal markings pale bluish on S1-3, and orange S4-10, markings of S9 and S10 very small, orange markings of S3-8 continue onto ventral parts of tergites; wings in basal half with amber bluish, tip of Fw with a small brownish black oblique marking.

Redescription of male

Head: Labium black, heavily punctate, base of middle and lateral lobes pale, middle lobe brown, labrum and mandibles shiny black, labrum with some metallic sheen, genae mainly pale blue; convex anterior parts of clypeus (anteclypeus) black with metallic sheen and ca twelve transverse grooves, posterior surface matt-black – the flattened dorsal part of the clypeus, as in *L. xanthocyana*, absent –, a small blue spot against mandible; pattern of pale parts on head complex, as follows: on frons anterior to antennae are subquadrangular paired blue spots, separated from one another ca $\frac{3}{4}$ the width of a spot, and from the pale-coloured base of the antenna by ca $\frac{1}{4}$ the width of a spot; a second, much smaller pair of spots lies between the antennae just before median ocellus, the distance between spots ca the width of one spot; behind is a pair of small suboval spots flanking the lateral ocelli; hind margin of occiput curved, coloured bluish yellow, medio-anteriorly with a spot of the same colour; postocular lobes with a small bluish or bluish yellow spot against hind margin; pale stripe along the eyes from genae dorsally extending to lateral ocelli. Antenna: pedicellus and flagellum black.

Thorax: Pronotum matt-black, anterior lobe with a pale transversal stripe; median lobe laterally with a rather large suboval pale blue spot, hind lobe medially with a lozenge-shaped pale marking. — Synthorax semi-matt black with extensive pale blue markings; mesothoracic triangle short with rounded sides; dorsal carina blue, anteriorly V-shaped, posteriorly narrowing and ending in a sharp point; antehumeral stripe well before mesopleural (humeral) suture, widest anteriorly and gradually tapering towards posterior end, broken just before pre-alar ridge; mesepimeron with an oblong spot along mesopleural suture just before pre-alar ridge, mesokatepisternum with a small blue spot along junction with mesepimeron; metepisternum with a rectangular marking posterior to metathoracic spiracle, dorso-anteriorly with a rectangular extension of ca $\frac{1}{3}$ the length and width of the larger marking; posteriorly another large pale marking, widest anteriorly, dorsally running in one line towards hind margin of synthorax, ventrally emarginate, leaving a very narrow blue line at narrowest part; metepimeron central in posterior part a large, subtriangular marking. Ventral side of synthorax matt-black. — Legs dark brown, with bases of femora paler. — Wings with tips of Fw with oblique dark spots, anteriorly covering ca 10 costal cells; Fw without pterostigma, Costa of Fw thickened between Ax4 and nodus, especially notable near nodus; veins anterior to nodus orange-brown, and wing membrane, especially of Hw, with amber tinge, most distinct anterior to nodus, but less intensely extending well beyond nodus, also less distinct near wing base; Fw and Hw with two primary Ax, and 4 Ax between Ax2 and nodus; Arculus arising from one point; R2 not arched towards R1; Anal vein arising from hind margin of wing proximal to Ax1.

Abdomen: Matt, dorsally black with blue markings on S1-3, and orange markings on S4-8; markings as follows: paired rectangular spots on S1, separated by ca the width of one spot, S2 with paired round spots with extensions half the diameter of a spot in posterior part, pointing mediad, the tips just failing to meet, plus small paired round spots in lateroposterior corner of S2, S3 with paired rectangular spots, anteriorly starting at segment base, posteriorly ending ca the width of the marking from hind margin, medially somewhat diverging, similar spots on S4-8, but gradually increasing in size posteriorly, where the median black line disappears and only one large spot remains on S7 and S8; S9 and S10 fully matt-black; ventral side of tergites 3-8 also with orange markings, increasing in size from a small marking on S3 to a large spot on S8, covering anterior $\frac{3}{4}$ of segment, posterior margin of markings oblique; sternites brownish black. Appendages matt-black, inferiors ca half as long as superiors; superiors virtually straight, the tips nearly touching.

Measurements [mm]: Abdomen 14-15; Hw 17-18.

Redescription of female

Head: Markings very similar to male, but less colourful, pale coloration brownish yellow, additional to male markings the female with large rectangular lateral spot on either side of the rhinarium.

Thorax: As male; wings fully hyaline, with pterostigma in both Fw and Hw.

Abdomen: Somewhat shorter and distinctly stouter than in male; coloration of abdomen shiny black with extensive pale markings as follows: a median line on all segments consisting of a narrow exclamation mark on S2, a wide exclamation mark on S3, S4-7 with a line somewhat constricted in posterior part, S8-9 with oval spot, S10 without median markings; tergites laterally with longitudinal markings, constricted in the middle; S1 with only a roundish spot, lateral marking of S2 not quite reaching anterior margin of segment, S9 with oval spot near posterior margin, S10 with paired central spots; a further ventral row of pale markings abutting the sternites, each marking wide in anterior half, and tapering posteriorly; intersegmental annulae fully black; sternites black.

Measurements [mm]: Abdomen 14-15, Hw 19-20.

Affinities

According to Ris (1916: 310), based on its nervature, close to *L. lineata*. However, the markings on the abdomen are closer to *L. xanthocyana*.

Distribution

Southwestern arm of Sulawesi (Fig. 1). The species was still rather common around Bantimuring near Maros, the type locality, in the 1990s.

Libellago celebensis sp. nov.

The area roughly delimited by Palopo and Polewali in the southwest, Palu in the northwest, and further extending to the east into the Banggai and southeastern arm of Sulawesi, is inhabited by a complex of generally scarlet-red *Libellago* taxa, here united as *Libellago celebensis* sp. nov. This taxon is subdivided into four subspecies, which are parapatric, and generally recognizable by the colour pattern of the head, pronotum, synthorax, and abdomen. I have several observations of an abrupt change of subspecies in adjoining river systems, but specimens collected around Lake Poso are distinctly intermediate between *L. c. celebensis* and *L. c. orientalis*. Further studies are needed to judge the status of these populations; see also discussion above.

All subspecies of this complex can be distinguished from *L. rufescens* by the absence of white tibiae, the absence of a pale stripe on the occiput, and the absence of pale markings on the lateral lobes of the pronotum. At least in the Palopo area this species complex is syntopic with *L. rufescens*.

For a further characterization, see the nominotypical subspecies.

Libellago celebensis anoa ssp. nov.

(Figs 2a, 3a, 4a, 5a, 6)

Etymology

Anoa, after Sungai Anoa (Anoa river) between Wotu and Lake Poso, the type locality. A noun in apposition.

Specimens examined

Holotype ♂ (JvT 1528, in RMNH): "Indonesia. C. Sulawesi / 30 km N of Wotu: Sg. Anoa, river / thr prim forest; waterfall nr / bridge Wotu-Tentena; upstream / ponded sites, small tributaries / Boulders, sand. w = 4-8 m, d = 20-80 cm / 650 m. 2°20'30"S 120°47'45"E / 23 Oct 1993; leg. J. van Tol" [all written on card with specimen]. — Paratypes (21 specimens, all in RMNH): 1 ♂ (JvT 1833), CS Celebes, Todjamboe, klein zijbeekje [small tributary], 21 vii 1936, L.J. Toxopeus; 1 ♂ (JvT 1816), C Celebes, Palopo, 11 v 1941, H. & E. Vonk; 4 ♂, 1 ♀ (JvT 5092, 5094, 5096, 5102, 5865), NW Palopo, Salo Tandung, 300-600 m, 27 iv 1991, J. van Tol; 1 ♀ (JvT 5104), 12 km NW Palopo, Sg. Bambalu, 500 m, 27 iv 1991, J. van Tol; 3 ♂ (JvT 17068-17070), Tojambu, [800-1000 m], 1991, Yohan R.; 1 ♀ (JvT 1644), same data als holotype; 5 ♂, 4 ♀ (JvT 1663-1665, 1667-8, 1670-1671, 1673-4), 10 km NW Palopo, Salo Tandung, 300-600 m, 30 x 1993, J. van Tol. — Other specimens, damaged, or without precise locality (2 specimens): 1 ♂, 10 km WNW Palopo near Tojambu, 800 m, 29 iv 1991, Yohan R.; 1 ♂ (JvT 16386), Puncak Palopo, 1993, Yohan R.

Diagnosis

A robust taxon of the *L. rufescens* group. Males with large blue marking on frons, occiput black, lateral lobes of the pronotum black, two lateral pale spots on the posterior lobe of pronotum, a narrow orange antehumeral stripe, abdomen with

scarlet-red dorsum, ventral side of tergites black; in direct comparison with other subspecies abdominal colour deeper red. *L. c. orientalis* ssp. nov. and *L. rufescens* also have a largely blue coloured frons. *L. c. anoa* differs from *L. c. orientalis* by the colour and width of the antehumeral stripe, the colour of the abdomen, and also by the shape and extent of the blue marking on the frons. *L. rufescens* has white inner tibiae, a transverse stripe on the occiput, and a pale orange spot on the lateral lobe of the pronotum; the large orange marking on the metepisternum is fully or partially interrupted in the middle. *L. c. celebensis* and *L. c. dorsonigra* have a black frons. *L. c. anoa* differs from red coloured species assigned to *Sclerocypha* or *Watuwila* by generic characters (see key).

Description of holotype male

Left middle leg and flagella of both antennae missing.

Head: Labium with middle lobe with extensive creamish white markings in basal part, terminally shining black; lateral lobes dark, bases somewhat paler; labrum shiny, but distinctly punctate; mandibles shining dark brown; clypeus anteriorly shining dark brown, laterally somewhat paler; remainder of head matt-black, except for large pale blue marking on frons, anteriorly running beside the antennae towards their base, reaching median ocellus, and level of lateral ocelli with outer narrow acute extensions of blue area; postocular spots triangular (Fig. 2a); occiput black. Antenna with pedicellus and flagellum black.

Thorax: Pronotum (Figs 3a, 4a) with transversal band over anterior lobe complete, not quite reaching the (black) outer corners; median lobe with small, paired, triangular orange-yellow spots, anteriorly acute; lateral lobes black without any pale marking; posterior lobe with only a small triangular, yellow marking in each corner.

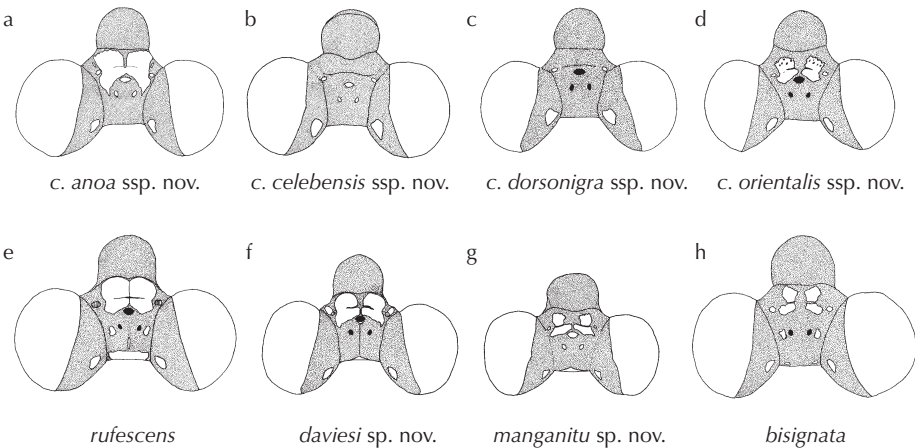


Figure 2: Head of *Libellago* and *Sclerocypha* males, dorsal view — (a) *L. celebensis anoa* ssp. nov.; (b) *L. c. celebensis* ssp. nov.; (c) *L. celebensis dorsonigra* ssp. nov.; (d) *L. celebensis orientalis* ssp. nov.; (e) *L. rufescens*; (f) *L. daviesi* sp. nov.; (g) *L. manganitu* sp. nov.; (h) *S. bisignata*.

— Synthorax (Fig. 5a) with orange or orange-yellow markings (not bluish); mesepisternum with a rather narrow antehumeral stripe, tapering posteriorly, and a short transversal marking abutting ante-alar triangle; mesokatepisternum black; mesepimeron black, except for an extremely small pale marking in posterior corner next to humeral suture (marking somewhat larger in other specimens); metepisternum with large orange markings as in Fig. 5a, marking constricted but not interrupted in middle; metepimeron with large triangular orange-yellow marking posteriorly. — Legs entirely black or brownish black. — Wing with Costa not distinctly widened; three to five Ax distal to Ax2; Anal vein leaving hind margin of wing ca level of Ax1; Arculus sharply angled, sectors arising from same point; R2 straight in line with Rs, not arched towards R1.

Abdomen: S1 dark yellow, with a central black dorsal marking; S2-10 dorsally bright red; ventral part of tergites with extensive black markings; sternites black. Anal appendages black.

Measurements [mm]: Abdomen 22; Hw 25.

Description of female

Robust, with pale markings yellowish white, with some bluish tinge, especially on frons.

Head: Pale markings as follows: head with basal half of median and lateral lobes of labium yellowish white; mandibles and gena pale, postclypeus with paired, small, indistinct crescent-shaped marking, anterior side of scapus pale, frons pale, except for a black median stripe, anteriorly somewhat wider than posteriorly, paired trapezoid markings between antennae, small oval postocular spot.

Thorax: Pronotum as in male, hence no pale marking on lateral lobe of pronotum, nor medially on posterior lobe; markings on synthorax very similar to male. Some pruinescence on ventral side of thorax and abdomen.

Abdomen: Narrow median stripe along distal third of S1, and S2-7, interrupted by intersegmental annulae; wider lateral pale stripes on S1-8, and over marking on posterior half of S9, S10 black; tergites pale against sternites (partly hidden by pruinescence); sternites black.

Measurements [mm]: Abdomen 18, Hw 26. Variation in measurements of female insignificant.

Variation

Markings of specimens collected in Salo Tandung (10 km NW of Palopo) do not differ from the holotype; abdomen [mm] 20-21; Hw 25-26.

Biology

Found in various middle-sized streams in the (geographically) southern part of central Sulawesi. It has been found syntopic with *L. rufescens*, and occurs also in the same area, but not on the same sites, as *L. celebensis dorsonigra*. Unfortunately, this taxon was only recognized after the completion of the field work. Specimens of *L. rufescens* and *L. c. anoa* are labelled from the same date and river; it is unknown whether they were ecologically separated in the field.

Distribution

Rivers around the northern and northwestern corner of Teluk Bone (Bone Bay) (Fig. 6). Superficially the same range as *L. celebensis dorsonigra*, but not recorded from the same sites. *L. celebensis anoa* was found together in the same streams with *L. rufescens* NW of Palopo. The type locality is at higher altitude than the records of *L. c. dorsonigra* in the area north of Wotu (Manganitu). *L. c. anoa* presumably inhabits streams around 400-600 m a.s.l.

Libellago celebensis celebensis ssp. nov.
(Figs 2b, 3b, 4b, 5b, 6, Plate IIa)

Micromerus rufescens [nec Selys; pro parte]. — Ris (1916: 305, 308, fig. 3, male from Palu: Pekawa only; male described and thoracic markings illustrated).

Etymology

Celebensis, originating from the Celebes (= Sulawesi). An adjective.

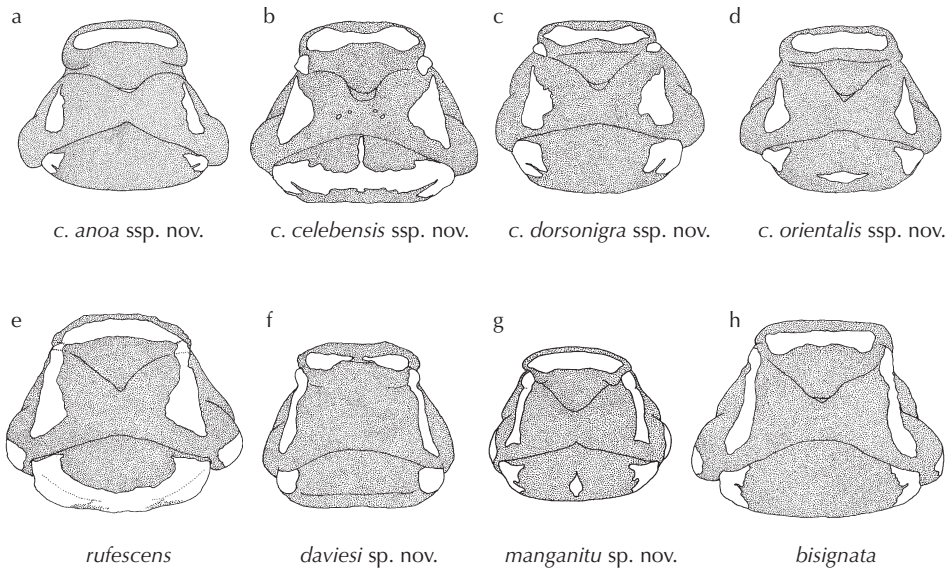


Figure 3: Pronotum of *Libellago* and *Sclerocypha* males, dorsal view — (a) *L. celebensis anoa* ssp. nov.; (b) *L. c. celebensis* ssp. nov.; (c) *L. celebensis dorsonigra* ssp. nov.; (d) *L. celebensis orientalis* ssp. nov.; (e) *L. rufescens*; (f) *L. daviesi* sp. nov.; (g) *L. manganitu* sp. nov.; (h) *S. bisignata*.

Specimens examined

Holotype ♂ (JvT 5321): “C. Celebes, Toro (Koelawi-Palu), bergbeekje [mountain stream], CdR XXVII, 07 xi 1940, Felix”. — Paratypes (25 specimens, chronological order; in RMNH, unless stated otherwise): 1 ♂ (JvT 16906, in SFMD), N Celebes, Palu, Pekawa, 15 ix 1912, L. Martin; 4 ♂, 4 ♀ (JvT 5313-5320), W Celebes, Palu, Tanah Mateh, vii 1937, 180 m, J.P.A. Kalis; 2 ♂ (JvT 5428-5429), 42 km ESE Palu, Manusi, 450 m, 20 i 1966, R. Straatman; 5 ♂, 1 ♀ (JvT 5322-5327), 65 km SSE Palu, Sg. Marena (1°32'S, 120°00'E, 600 m), 16 xii 1985 sample A, J. van Tol; 2 ♂ (JvT 5328-5329), idem, foothill brooklets (1°32'S, 120°01'E), 16 xii 1985 sample C, J. van Tol; 2 ♂ (JvT 16585-16588), S Palu, Gimpu (1°40'46"S, 120°03'30"E, 450 m), 03 iv 1997, J. van Tol; 2 ♂ (JvT 16591-16592), S Palu, Gimpu (1°41'S, 120°03'E, 450 m), small river, edge of forest, 03 iv 1997, J. van Tol; 1 ♀ (JvT 16618), S Palu, N of Gimpu, outside Lore Lindu NP, gardens and forest remnants, 04 iv 1997, J. van Tol.

Diagnosis

A robust *Libellago*; as in *L. c. dorsonigra* ssp. nov., but unlike other Sulawesi *Libellago*, frons of male black without any pale (blue, orange) markings. Legs dark on inside of tibiae, occiput black, lateral lobe of pronotum black without pale markings, hind lobe of pronotum with extensive transverse marking. Synthorax with antehumeral stripe wide anteriorly, sharply tapering caudad, in live specimens pale blue coloured. Differs from *L. celebensis dorsonigra* by general absence of dark coloration on dorsum of abdomen, extremely wide antehumeral marking on mesepisternum (typically from humeral to mesopleural suture anteriorly), large yellow markings on ventral side of synthorax and usually a more robust general appearance.

Description of holotype male

Head: Labium with mentum creamish white, base of middle lobe creamish white, remainder of middle lobe and lateral lobes shining black; labrum black, punctate, semi-matt; mandibles shining black; clypeus with anterior side shining brownish black, in the corners adjoining labrum with a triangular brown marking, ca half the height of anterior side of clypeus; genae shining brownish black, remainder of head matt-black, but with faint indication of paler coloration on frons; large triangular pale blue postocular spots (Fig. 2b); antennae, including base, black.

Thorax: Pronotum (Figs 3b, 4b) matt-black with bluish yellow markings; anterior lobe with long transverse stripe, leaving only a narrow black line along anterior margin, and on either side a small pale spot on the elevated part of the extreme corners of the anterior lobe, these spots just connected to or very near the transverse stripe, and not connected to the paired large triangular markings of median lobe; median lobe otherwise black; lateral lobe black without pale spots; hind lobe with complete, rather wide, transverse stripe, somewhat constricted in the middle and retracted from

the hind margin, but medially transversed by a short, longitudinal line. — Synthorax (Fig. 5b) black with soft sheen; pale blue antehumeral stripe over mesepisternum anteriorly very wide, covering area between mesokatepisternum and meso stigmal triangle, anterior $\frac{2}{3}$ running along mesopleural suture, and then gradually narrowing posteriorly towards ante-alar triangle; mesepimeron with short and narrow stripe abutting mesopleural suture; mesokatepisternum black; metepisternum with extensive yellow markings from well anterior to metastigma to hind margin, uninterrupted, dorsal side more or less straight, but constricted in middle, area anterior to stigma black, ventral side of posterior half strongly tapering, but extreme tip slightly expanded; metakatepisternum black, metepimeron with large, triangular, yellow marking. — Legs black. — Wings: Fw with brownish black opaque marking distal to Px14, proximal side oblique; Fw without pterostigma, Hw with pterostigma near tip; Costa not distinctly widened proximal to nodus; 3-4 Ax distal to Ax2; Anal vein leaving hind margin of wing just basal to Ax1; other wing characters as for *L. celebensis anoa* ssp. n. (see above).

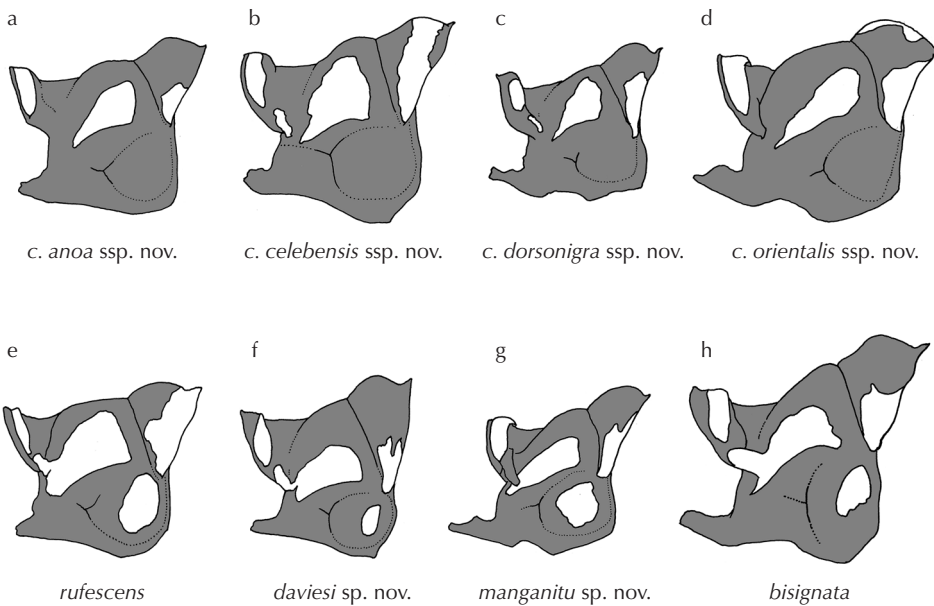


Figure 4: Pronotum of *Libellago* and *Sclerocypha* males, left lateral view — (a) *L. celebensis anoa* ssp. nov.; (b) *L. c. celebensis* ssp. nov.; (c) *L. celebensis dorsonigra* ssp. nov.; (d) *L. celebensis orientalis* ssp. nov.; (e) *L. rufescens*; (f) *L. daviesi* sp. nov.; (g) *L. manganitu* sp. nov.; (h) *S. bisignata*.

Abdomen: S1-5 dorsally mainly orange-red, remaining segments dark-red; S1 dorsally with brownish black semicircular marking in anterior half; S2-5 with faint dark longitudinal stripe next to middorsal line, somewhat darker against hind margin of each segment; ventral side of S1, anterior half of S2 and S9-10 black, and weak dark markings on ventral side of other segments; sternites brownish black. Appendages matt-black.

Measurements [mm]: Abdomen 19; Hw 25.

Description of female

Coloration remarkably different from male, and yellowish white markings similar to other Sulawesi species.

Head: Labium with middle and lateral lobes with extensive pale markings at base; mandibles and genae also whitish, clypeus black, frons with a paired marking nearly completely covering it, extending onto the vertex; scapus also pale yellowish white.

Thorax: Prothorax similar to male, but posterior lobe with two triangular lateral markings, rather than a posterior stripe along hind margin; synthorax mesepisternum with distinct pale stripe, covering anteriorly ca $\frac{2}{3}$ the height of mesepisternum, but strongly tapering posterior to posterior corner of mesokatepisternum, mesepimeron black, metepisternum with large pale stripe, starting well anterior to metastigma, posterior to stigma rectangular, posteriorly with black transverse stripe, and continued in crescent-shaped marking covering ca $\frac{2}{5}$ length of metepisternum; pale marking almost completely covering metepimeron, leaving only a narrow black dorsal margin.

Abdomen: Narrow medio-dorsal pale line on S2-7, a wider lateral stripe, covering S1-8, with a spot on S9, line interrupted on annulae, but pale marking extending further antero-ventrally, and even along margin of tergites on S3-8.

Measurements [mm]: Abdomen 18, Hw 25; without significant variation.

Variation

Male specimens from Gimpu lack the thin median longitudinal marking, projected from the broad transverse band on the posterior lobe of the pronotum (Fig. 3b), which is present in specimens from Tanah Mateh. Specimens from Tonusu near Lake Poso (leg. A. Günther) are intermediate between the nominotypical subspecies and *L. c. orientalis* ssp. nov, but specimens show significant variation, especially in the coloration of head and the pale markings on the posterior lobe of the pronotum.

Measurements [mm]: Abdomen of males 19-21; Hw 25-27.

Distribution

Palu valley, and possibly the Lariang valley, i.e. the area now covered by the western part of the Lore Lindu National Park, between 400 and 600 m a.s.l. (Fig. 6). There are no records from the northeastern side of the Lore Lindu National Park, where *Sclerocypha bisignata* inhabits areas above ca 800 m a.s.l. The latter species is also common at higher altitudes south of Lake Poso, where *L. c. anoa* and *L. c. dorso-nigra* inhabit the rivers between 0 and 600 m. Populations in streams around Lake Poso need further study.

Libellago celebensis dorsonigra ssp. nov.
(Figs 2c, 3c, 4c, 5c, 6, Plate IIb)

Etymology

Dorsonigra, dorsum (back), niger (black). An adjective.

Specimens examined

Holotype ♂ (JvT 1812): "Kalaena, boschbeek Noord Tomoni [forest stream N Tomoni], 04 iii 1941", collector unknown [co-ordinates ca 2°40'S, 120°53'E]. — Paratypes (54 specimens, in chronological order, all leg. L.L.A. Maurenbrecher except indicated otherwise, all in RMNH): 2 ♂ (JvT 1820, 1822), C Celebes, Sg. Tomoni, 04 ix 1940; 5 ♂, 1 ♀ (JvT 1806-1807, 1821, 1823-1824, 1832), C Celebes, Sg. Tomini, 13 ix 1940; 1 ♂, 1 ♀ (JvT 1809-10), C Celebes, Sg. Baebunta, 17 iv 1940; 1 ♂ (JvT 1808), same site, 29 ix 1940; 1 ♂, 2 ♀ (JvT 1811, 9626-7), Kalaena, Korondene, 03 x 1940; 2 ♂, 1 ♀ (JvT 1813-1814, 9628), C Celebes, Sg. Tomoni, 04 x 1940; 1 ♂ (JvT 1817), Sg. Baebunta, 24 xi 1940; 1 ♂ (JvT 1818), Sg. Baebunta, 01 xii 1940; 2 ♂ (JvT 1815, 1819), Sg. Baebunta, 02 iii 1941; 2 ♂, 5 ♀ (JvT 1825, 1831, 1826-30), Palopo, S Latoepa, 02 vi 1941, E. Vonk; 7 ♂, 2 ♀ (JvT 1834-1840, 5431, 8372), 4-5 km NW of Malili, Sg. Mahulu (2°36'S, 121°05'E, 0-50 m), slowly flowing stream, width 4-6 m, mainly through cultivated area, but bordered by strip of disturbed forest, bottom coarse sand, pebbles, some boulders, half-shaded, some small falls, 30 iv - 01 v 1991, J. van Tol; 1 ♂, 1 ♀ (JvT 1634-1635), Sg. Kalaena, 25 x 1993, J. van Tol; 3 ♂, 1 ♀ (JvT 1616-1619), N of Wotu, Sg. Laimbo (2°26'27"S, 120°48'07"E), 25 x 1993, J. van Tol; 10 ♂ (1705-1714), Sabbang, tributary Rongkong (2°36'S, 120°13'E), 01 xi 1993, J. van Tol; 3 ♂ (JvT 1725-1727), 20 km NW Palopo, Sg. Lowi, tributary of Sg. Lamasi (2°51'02"S, 120°04'46"E), 02 xi 1993, J. van Tol. — Other specimens: 1 ♂, 1 ♀ (JvT 1809-10), C Celebes, Loewoe, Sg. Baebunta, 17 iv 1940, L.L.A. Maurenbrecher; 1 ♂ (JvT 5849), 15 km NNE Malili, 02 v 1991, J. van Tol [presumably mislabelled].

Diagnosis

A medium-sized *Libellago*, comparatively less robust (Hw 22-23 mm) than *L. rufescens* or *L. c. celebensis* ssp. nov. (Hw 25-27 mm). Like *L. c. celebensis* without blue or orange markings on frons, but differing from that species by having extensive black markings on the dorsum of the abdomen, and the hind margin of the posterior lobe of pronotum having two lateral spots, rather than a complete pale transverse stripe. Innerside of tibiae black, as in *L. c. celebensis*, not white as in *L. rufescens*. Female, as in *L. c. celebensis*, remarkably different from male in coloration of head, with pale markings on mandibles, gena, and frons.

Description of holotype male

Head: Labium with only base of middle lobe pale, lateral lobes completely dark; mandibles, genae, and dorsal side of head matt-black except for rather large, pale blue triangular spots in postocular area (Fig. 2c). Antenna black.

Thorax: Pronotum (Figs 3c, 4c) with transverse stripe over anterior lobe narrow, but complete, lateral spots of median lobe roughly triangular, large, blue and not connected with transverse stripe on anterior lobe; lateral lobe black; posterior lobe with pale triangular markings only in lateral corners of posterior margin. — Synthorax (Fig. 5c) with antehumeral stripe anteriorly wide and smoothly tapering posteriorly, nearly reaching ante-alar ridge, but just broken before posterior end, with separate transverse stripe reaching ante-alar ridge; no line over mesepimeron beside mesopleural suture; markings on metepisternum and metepimeron dark yellow, that on metepisternum typically broken. — Legs dark brown or black, without pale markings on tibiae. — Wings as in *L. c. celebensis*.

Abdomen: Anteriorly black and orange-yellow, posteriorly dark red; S1 black with paired triangular yellow spots reaching hind margin latero-posteriorly; S2 dorsally and ventrally black, laterally with yellow marking, anteriorly acute, posteriorly widening to double anterior width; S3-6 with black dorsal markings sequentially decreasing in size on each succeeding segment, especially retreating from anterior margin; S7-10 dorsally dark red, ventral side S9-10 completely black; sternites dark. Appendages black.

Measurements [mm]: Abdomen 18; Hw 23.

Description of female

Head: Labium with base of median lobe yellowish white, mandibles nearly fully bluish white, but dark stripe along border near labrum, gena white, frons with paired bluish white marking between antennae, both markings separated by V-shaped medial incision, scapus bluish white, and bluish white suboval postocular spots.

Thorax: Pale markings all yellowish white; anterior lobe of prothorax with transversal stripe, broadly interrupted in middle, median lobe with lateral triangular spot,

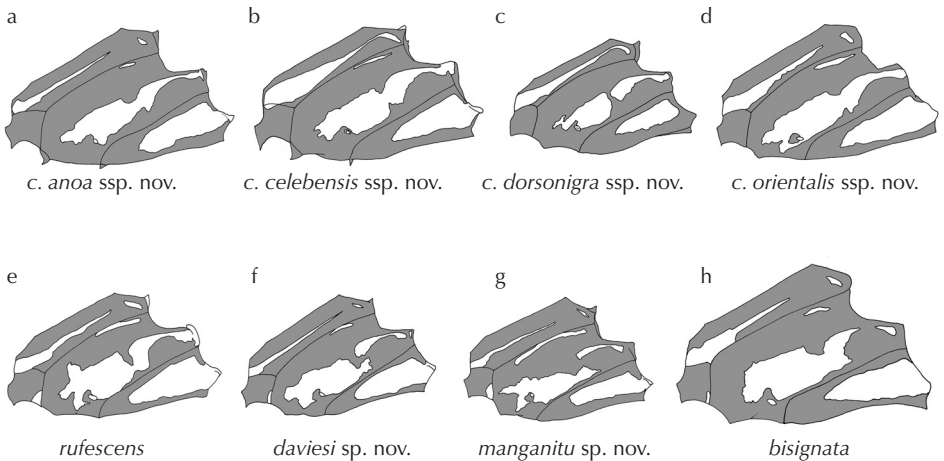


Figure 5: Synthorax of *Libellago* and *Sclerocypha* males, left lateral view — (a) *L. celebensis anoa* ssp. nov.; (b) *L. c. celebensis* ssp. nov.; (c) *L. celebensis dorsonigra* ssp. nov.; (d) *L. celebensis orientalis* ssp. nov.; (e) *L. rufescens*; (f) *L. daviesi* sp. nov.; (g) *L. manganitu* sp. nov.; (h) *S. bisignata*.

pointed anteriorly, lateral lobe without markings, posterior lobe with small triangular markings in lateral corners. Synthorax markings pale yellowish: a narrow stripe on mesepisternum, at ca $\frac{1}{3}$ from mesopleural suture, anteriorly significantly widened,

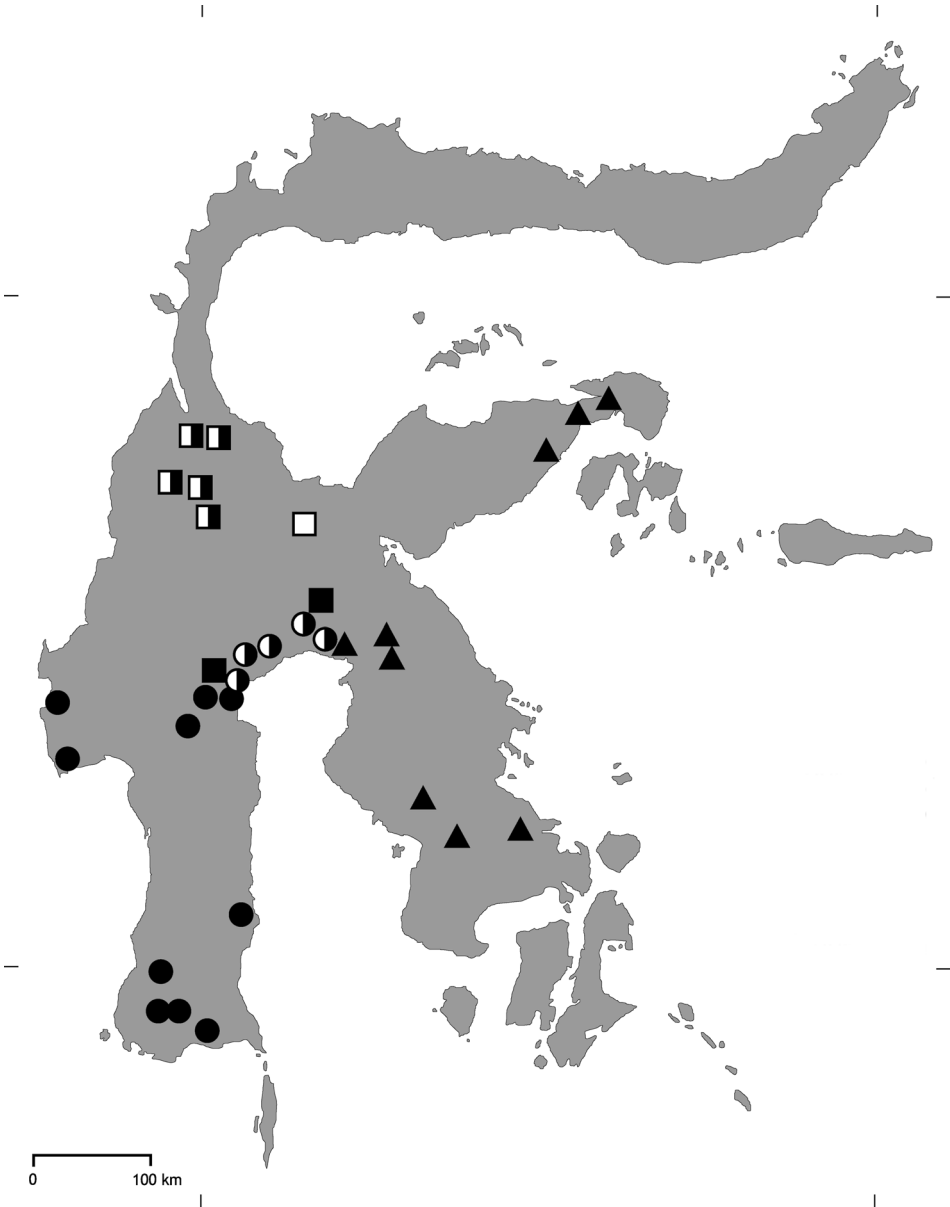


Figure 6: Distribution map of *Libellago celebensis anoa* ssp. nov. (■), *L. c. celebensis* ssp. nov. (□), *L. celebensis dorsonigra* ssp. nov. (●), *L. celebensis orientalis* ssp. nov. (▲) and *L. rufescens* (●) in Sulawesi. Intermediates between *L. c. celebensis* and *L. celebensis orientalis* (□) occur at Lake Poso

and a small marking in extreme posterior corner of mesepisternum; mesokatepisternum and mesepimeron black; metepisternum with extensive markings, a narrow zig-zag marking above metastigma, connected with subrectangular marking posterior to metastigma, and posterior to this marking an unconnected narrow crescent-shaped marking next to interpleural suture; a large triangular marking in posterior corner of metepimeron.

Abdomen: Narrow medio-dorsal pale line on S2-7, and a wider lateral stripe, covering S1-7, with spots on S8 and S9, interrupted on annulae.

Measurements [mm]: Abdomen 15, Hw 20.

Variation

The most significant variation is in size.

Measurements [mm]: male: Abdomen 16-18 mm, Hw 22-23.

Biology

Inhabits lowland streams; males defend territories from boulders or emerging sticks in fast flowing water just above the water surface.

Distribution

Central Sulawesi around the northernmost part of the Teluk Bone between Palopo and Malili, south of the Kambuno and Balease mountains (Fig. 6); species of lowland rivers, not found at higher altitudes. Geographically isolated from *L. c. celebensis* by Tineba mountain range. *L. c. anoa* occurs in the mountains at higher elevations between 400-600 m, and *L. c. orientalis* is found east of this area. Syntopic with *L. rufescens* near Palopo.

Libellago celebensis orientalis ssp. nov.

(Figs 2d, 3d, 4d, 5d, Plate IIc)

Etymology

Orientalis (Latin), eastern, because of its eastern distribution within Sulawesi. An adjective.

Specimens examined

All specimens in RMNH, unless stated otherwise. — Holotype ♂ (JvT 5385): “1989 RMNH Expedition to Sulawesi. Indonesia Sulawesi Tenggara: S of Sanggona: Mokowu river near Mokowu camp, foot of Watuwila Mts, 150 m asl, 3°48'S 121°39'E. Rivulet with ponded areas, clear water, bottom with boulders, some sand, largely shaded. Sample 89JvT031. 4 November 1989, Leg. J. van Tol”. With hand-written annotation in Dutch 'Gefotografeerd in verg. met *L. ruf.* van Centipede c.' [this specimen was photographed in comparison with *L. rufescens* [recte: *Watuwila vervoorti*] from Centipede camp]. — Paratypes (147 specimens, per province in chronological order): **Sulawesi Tengah.** 1 ♂ (JvT 6635), 15 km NNE of Luwuk: Sg. Biak, 150 m,

clear running water with rapids and pools, 27 i 1989, J. van Tol; 1 ♂, 2 ♀ (9480, 16943-4), 25 km NE of Luwuk: tributary of Sg. Bantayan (0°49'S, 123°00'E), clear running water, shaded by disturbed primary forest, 30 i 1989, J. van Tol; 12 ♂, 4 ♀ (16945-60), 28 km NE of Luwuk: Sg. Bantayan near crossing road Kajutanju-Siuna, ca 100 m, muddy water over boulders, partly shaded by disturbed primary forest, 30 i 1989, J. van Tol; 6 ♂, 2 ♀ (JvT 6722-5, 6757-9, 16961), Banggai Peninsula, 15 km NNE of Luwuk, Sg. Biak at road Biak to Poh, river with ponded sites and currents, nearly unshaded, some emergent vegetation, semi-cultivated area, 06/22 x 1989, J. van Tol; 5 ♂, 1 ♀ (JvT 6726-31), Banggai Peninsula, 28 km NE of Luwuk, Sg. Bantayan near crossing with road Kayutanyo to Siuna, rather wide stream with boulders, partly shaded by primary forest, 07 x 1989, J. van Tol; 1 ♀ (JvT 6732), Banggai Peninsula, 20 km ENE of Biak: Sg. Takilalang, stream 2-3 m wide in somewhat disturbed lowland evergreen rain forest, clear water, bottom sand and uplifted coral reef; mostly shaded, 08 x 1989, J. van Tol; 20 ♂, 1 ♀ (JvT 6733-53), Banggai Peninsula, NNW of Batui: Batui river at Sinsing camp, 90 m, middle size stream through primary forest, width 20-25 m, depth 20-50 (80) cm, fast flowing with quiet sites, boulders, some sand, clear water, no water vegetation, several pools, pH 8.5, conductivity 240 µS/cm, 15-17 x 1989, J. van Tol; 2 ♂, 1 ♀ (JvT 6754-6), Banggai Peninsula, 20 km ENE of Biak: Sg. Takilalang, stream 2-3 m wide in somewhat disturbed lowland evergreen rain forest, clear water, bottom sand and uplifted coral reef, mostly shaded, 20 x 1989, J. van Tol. — **Sulawesi Selatan.** 14 ♂, 1 ♀ (JvT 5850-5853, 16882-92), 15 km NNE Malili, 150 m, rivulet through disturbed tropical rain forest (tributary of Sg. Malili), fast flowing clear water, coarse pebbles, ponded sites with fine sand, half shaded, rapids (ca 2°38'S, 121°12'E), 01/02 v 1991, J. van Tol; 2 ♂, 1 ♀ (JvT 16718-20), Soroako, W of Matano village, small stream, width = 0.2 - 1.0 m, depth = 0.1 - 0.3 m, shade 25-75%, 100 m sample, 09:30 - 15:00 h, locality 11, 16 ix 1993, M.T. Wasscher; 4 ♂ (JvT 1387-1390), Soroako, Sg. Lamapu near outlet in Danau Towuti (2°40'32"S, 121°24'53"E), 17 x 1993, J. van Tol; 2 ♂, 1 ♀ (JvT 1452-4), E of Malili: Crocodile river (2°38'09"S, 121°12'18"E, 150 m), 21 x 1993, J. van Tol. — **Sulawesi Tenggara.** 9 ♂, 2 ♀ (JvT 5399-5407, 6614-5), 30 km WSW Kendari, Sg. Amoito, small stream and trickles through disturbed forest N of Pegunungan Boroboro, clear water, 100 m, 05 ii 1989, J. van Tol; 1 ♂ (JvT 5408), 18 km ENE Kolaka, Sg. Koloimba near crossing with road, blackwater stream with vegetation, 07 ii 1989, J. van Tol; 4 ♂ (JvT 5409-5412), S of Sanggona, foot of Watuwila Mts, Mokowu river near Mokowu camp, 150 m, rivulet with ponded areas, clear water, bottom with boulders, some sand, 19/20 x 1989, J. Huisman; 42 ♂, 6 ♀ (JvT 5364-84, 5386-98, 5413-26), S of Sanggona, Mokowu river near Mokowu camp, foot of Watuwila Mts, 150 m, rivulet with ponded areas, clear water, bottom with boulders, some sand, largely shaded, 29-31 x 1989, 04-06 xi 1989, J. van Tol [same site as holotype].

Diagnosis

A rather robust *Libellago*, anterior side of head of male – mandible, gena, anterior side of scapus – black, markings on frons blue, posterior lobe of pronotum with two spots in lateral corners and a median spot, mesepisternum with bluish white longitudinal stripe wide anteriorly, strongly tapering posteriorly; other markings of synthorax yellow, some parts with bluish tinge, tergites of abdomen mostly red, sternites

black. Male differs from other *Libellago* from Sulawesi by combination of black mandibles and gena, blue markings on frons, three spots on posterior lobe of pronotum, red dorsum of abdomen; *L. c. celebensis* and *L. c. dorsonigra* have no pale markings on frons, while these markings of *L. rufescens* are yellow. Differs from *L. c. anoa* by its three pale markings on posterior lobe of pronotum, rather than a transversal stripe, and a wide and bluish stripe on mesepisternum, rather than a narrow yellow stripe, and by mostly red ventral parts of the abdominal tergites (black in *L. celebensis anoa*).

Description of holotype male

Head: Labium with base of median lobe dirty white, remainder black; mandibles, labrum, gena, clypeus black, all parts except postclypeus shining; frons with paired blue spots, anteriorly irregular and separated by nearly the width of one spot, continued on dorsum of head between antennae, here nearly touching, rest of head matt-black, two suboval bluish white postocular spots (Fig. 2d), occiput black.

Thorax: Pronotum (Figs 3d, 4d) black with bluish white markings as follows: anterior lobe with long and wide transverse marking; median lobe with large pale triangular markings adjoining lateral lobes, pointed anteriorly; lateral lobes black without pale markings; posterior lobe laterally with a triangular spot at each corner, and a short transverse median stripe. — Synthorax (Fig. 5d): mesepisternum with bluish marking anteriorly wide, distinctly narrowed in posterior half, posteriorly acute; suboval spot in posterior corner of mesepisternum close to mesopleural suture; mesokatepisternum black; mesepimeron black, except for a small elongate marking in posterior quarter near mesopleural suture; metepisternum with prominent yellowish marking, covering virtually complete anterior half except area around metastigma; a small squarish dorsal emargination halfway, ventrally broadly emarginate in posterior two-fifths; metepimeron with yellow marking in ventro-posterior corner. — Legs black, some pruinosity. — Wings long and narrow, Fw with opaque brownish black tip distal to Px 11, without pterostigma, Hw clear, with oblong pterostigma near wing tip, other characters as for genus.

Abdomen: Scarlet red, but S1 and anterior part of ventral side more yellowish red, intersegmental annulae bordered black; ventral sides of S1, S2 and S10, and all sternites, black; anal appendages black.

Measurements [mm]: Abdomen 21; Hw 25.

Description of female

Head: Pale markings yellowish white, some parts with bluish tinge, distinctly more extensive than in male; labium with base of median lobe pale, mandibles and gena pale; clypeus black, except for a paired small spot in lateral corner of postclypeus near frons; anterior side of base of antenna pale; frons with paired subrectangular marking, somewhat extended in latero-anterior corner, posteriorly continued on head to level of posterior side of median ocellus; rest of head matt-black with oval postocular spots. Antenna black, except anterior side of base.

Thorax: Markings yellowish white, but shape very similar to those of male; median marking of posterior lobe of pronotum smaller than in male, or absent. Legs black, but mostly more pruinose than in male. Wings as in male, but pterostigma in both Fw and Hw, no dark marking in Fw.

Abdomen: Stout, black, with pale yellowish markings as follows: narrow stripe medially along abdomen, from posterior half of S2 to S7; a wide pale stripe on lateral side of abdomen, from S1 to S9, interrupted at intersegmental annulae, marking on each separate segment somewhat tapered posteriorly, but distinctly expanded just before posterior border of segment; markings of S8-9 incomplete, on S8 very narrow anteriorly, on S9 restricted to oval spot in posterior half; S10, anal appendages and valves black; ventral side of tergites with extensive yellowish markings, including intersegmental annulae, on S3-7; yellow markings squarish in anterior half of S3, and connected to a virtually complete band along lateral margin of tergites, markings gradually expanded posteriorly on each following segment.

Measurements [mm]: Abdomen 18, Hw 23.

Variation

Males show variation in black markings on ventral side of tergites. Measurements of males [mm] – SE Sulawesi : abdomen 20-21, Hw 25-27; Banggai peninsula (Luwuk): abdomen 18-19, Hw 22-25; Malili: abdomen 19-20, Hw 22.

Biology

Inhabits medium-sized lowland streams. At higher elevations around Teluk Bone replaced by *L. c. anoa* and above ca 800 m by *Sclerocypha bisignata*, in southeast Sulawesi replaced by *Watuwila vervoorti* above 900 m. No observations from higher altitudes in Banggai peninsula.

Distribution

Widespread in the southern and eastern parts of Central Sulawesi (politically partly Sulawesi Selatan), and in Southeast Sulawesi (Fig. 6).

Libellago daviesi sp. nov.

(Figs 2f, 3f, 4f, 5f, 7, Plate IId)

Libellago rufescens [nec Selys] — van Tol (1987: table 3, North Sulawesi, Dumoga Bone NP).

Libellago rufescens (Selys) ssp. nov. — Askew et al. (1989: 117, North Sulawesi, Dumoga Bone).

Etymology

Named after David Allen Lewis Davies (1923-2003), who recognized this as a new species at my presentation during the 1985 S.I.O. Symposium in Paris.

Specimens examined

Holotype ♂ (JvT 4909) in RMNH: “Noordarm Celebes / XIV / heuvelland Kwandang 200 mbz / (Gorontalo) 9-VII-'40. leg. CdR [= Coomans de Ruiter]”. — Paratypes (54 specimens, all in RMNH, unless stated otherwise), specimens from the

Minahasa, northern arm of Sulawesi, in chronological order: 1 ♀ (JvT 4918), Noord Celebes, Tondano, C. van Braekel, acquired 11 vi 1935; 1 ♂ (JvT 4907), Minahasa, Manado region, 19 v 1940, L. Coomans de Ruiter; 2 ♂ (JvT 4911-2), Airmadidi, riverbed, 09 vi 1940, L. Coomans de Ruiter; 1 ♂, 1 ♀ (JvT 4913-4), Minahasa, road Manado-Tomohon, mountain stream, 450 m, 14 vii 1940, L. Coomans de Ruiter; 2 ♂ (JvT 4916-7), Minahasa, Ranotongkor, fish ponds and fast running stream, 300 m, 02 viii 1940, L. Coomans de Ruiter; 2 ♂ (JvT 4915, 6610), Tanahwangko-Ranotongkor, 04 viii 1940, L. Coomans de Ruiter; 1 ♂ (JvT 4908), Minahassa, Kajoeroja, 100-120 m, 10 xi 1941, F. Dupont; 7 ♂ [in RSME] (JvT 6826-6832), Sulawesi Utara, River Tumpah and tributary, 220 m, 05/18 iii 1985, R.R. Askew; 3 ♂ (JvT 1759, 4927-8), Dumoga-Bone National Park, Waterfall creek (tributary of river Tumpah), fast running brooklet with ponded areas, through multistratal evergreen forest, mainly shaded, boulders and sand, 225-250 m, 21 iv 1985, J. van Tol; 1 ♂ (JvT 4922), same site, 22 iv 1985; 1 ♀ (JvT 4929), same site, 26 v 1985; 1 ♂ (JvT 4925), Dumoga-Bone National Park, river Tumpah between Waterfall creek and confluence with river Toraut (UTM XL0062 – 0°34'N, 123°54'E), 200-225 m, middle-sized river, up to 80 m wide, current velocity up to 1 m/s, large boulders, rapids, edge of somewhat disturbed multistratal evergreen forest, 23 iv 1985, J. van Tol; 1 ♂ (JvT 4924), same site, 26 iv 1985; 1 ♂ (JvT 4926), same site, 18 v 1985; 2 ♂ (JvT 4921, 8365), same site, 19 v 1985; 1 ♂ (JvT 4933), Dumoga-Bone National Park, Tumpah river near Edward's camp, river through undisturbed multistratal evergreen forest, ca 600 m, 29 iv 1985, J. van Tol; 2 ♂, 1 ♀ (JvT 4930, 4936, 4931), same site, 30 iv 1985; 1 ♀ (JvT 4932), same site, 01 v 1985; 1 ♂, 1 ♀ (JvT 4935, 4934), same site, 03 vi 1985; 1 ♂, 1 ♀ (JvT 4919, 4920), Dumoga-Bone National Park, 8 km N of Malibagu, upper course of Sungai Pononontuna ("Restaurant on Malibagu road"), small stream through semi-cultivated area, 07 v 1985, J. van Tol; 1 ♂, 2 ♀ (JvT 27749-27751, in IRSN), Dumoga-Bone Nat. Park, River Tumpah, 200m, 22 x 1985, R. Bosmans & J. Van Stalle (I.G. no. 26.977), Station 045; 2 ♀ (JvT 27752-3, in IRSN), Dumoga-Bone Nat. Park, Gunung Poniki, 1,810 m, 02 xi 1985, R. Bosmans & J. Van Stalle, Station 074 [presumably mislabelled]; 2 ♂ (JvT 27754-5, in IRSN), Dumoga-Bone Nat. Park, Waterfall trail, 280 m, Station 094, 14 xi 1985, R. Bosmans & J. Van Stalle. I.G. no. 26.977. — Localities outside Minahasa, from north to south: 4 ♂, 1 ♀ (JvT 4910, 4937-40), Gorontalo, Kwandang, mountain stream with boulders, shaded forest and open pool, 09 vii 1940, L. Coomans de Ruiter (same site as holotype); 1 ♂ (JvT 4941), Donggala, 04 i 1941, J.J. van der Starre; 1 ♂ (JvT 6016, in ZMAN), Onan, Sg. Parabaya, 58 km N of Majene, strongly disturbed rain forest, 19 xi 1993, J.P. & M.J. Duffels. — Without precise locality data: 1 ♂ (JvT 4906), Celebes.

Diagnosis

A rather delicate red-coloured *Libellago* species, the males differing in various respects from other red Sulawesi *Libellago*, viz. the unevenly thickened Costa of the Fw, the bright white tibiae of all legs, and the iridescent black marking of the abdomen. Similar to *Sclerocypha bisignata* in various respects; *S. bisignata* can be distinguished by its larger size, its unmarked red abdomen, ca 7 Ax between Ax2 and the nodus, and the dark opaque marking in the Fw at level of nodus.

Description of holotype male

Right hind leg missing (see also Fig. 5f).

Head: Labium with glossy sheen, mentum and base of middle lobe dirty yellow, lateral lobes with only a trace of pale coloration; labrum shining black; mandibles shining brownish black; clypeus with anterior part convex and shining black, lateral parts brownish black, posterior side matt-black; remainder of head matt-black with the following pale markings (Fig. 2f): frons with orange-yellow paired marking covering most of frons anterior to antennae, each segment anteriorly semicircular, the two divided medially by a black V-shaped incision; marking extending posterior to the base of the antennae around median ocellus; a narrow yellowish line over occiput, and a small spot on postocular area next to vertex.

Thorax: Pronotum (Figs 3f, 4f) matt-black with pale markings yellow, anterior lobe with a transverse pale stripe covering ca half the width of lobe, constricted and briefly broken in the middle; median lobe laterally with a rather large, roughly semicircular marking (appearing as a line in dorsal view), posterior lobe with paired short markings in the corners meeting lateral lobes; lateral lobes with roundish yellow spot. — Synthorax (Fig. 5f) with mesepisternum with narrow yellow stripe tapering posteriorly from mesostigmal lamina, running well inside mesopleural suture, ending well before ante-alar ridge; mesepimeron with short yellow stripe in dorso-posterior corner; mesokatepisternum with small yellow spot in ventro-posterior corner; metepisternum anteriorly with an irregularly shaped elongate marking, posteriorly meeting intersegmental suture a long crescent-shaped marking, sometimes connected with anterior marking; metepisternum nearly completely covered by a subtriangular marking. — Legs black, but innerside of fore femur with long white stripe, and innerside of fore, middle and hind tibiae clear white. — Wings: Fw with Costa thickened from ca second primary Ax to nodus; Fw without pterostigma; no additional Ax between the primaries, and 3 or 4 Ax posterior to Ax2; sectors of Arculus arising from one point, sharply angled; R2 not arched forward; anal vein arising just proximal to Ax1.

Abdomen: Pale brick-red, with a dorsal semi-transparent, somewhat metallic, black stripe along mid-dorsal line, black of S1-2 and S9-10 opaque; ventral side of tergites red, except for S10, which is completely black; sternite of S1 black, of S2-9 red. Appendages black.

Measurements [mm]: Abdomen 18; Hw 22.5.

Description of female

Blackish ground colour, but pale bluish white markings rather similar to the male; wings with Costa not thickened.

Head: Labium pale only at base, mandible largely pale except for a triangular marking in dorso-median corner, gena and scapus pale, pale markings on frons, occiput and postocular area as in the male.

Thorax: Markings on pronotum as in male; markings on synthorax largely as in male, but pale markings on metepisternum distinctly smaller, anterior marking only half the segment height, dorsal trilobate, posteriorly rounded; posterior marking distinctly separated from anterior marking, small and crescent-shaped, in dorso-posterior corner.

Abdomen: Dorsally black with fine pale median line on S2-7, lateral stripe on S1-8, interrupted on annulae, and a small spot on S9, S3-7 with irregular pale markings against margin of tergite; sternites black.
Measurements [mm]: Abdomen 16, Hw 23.

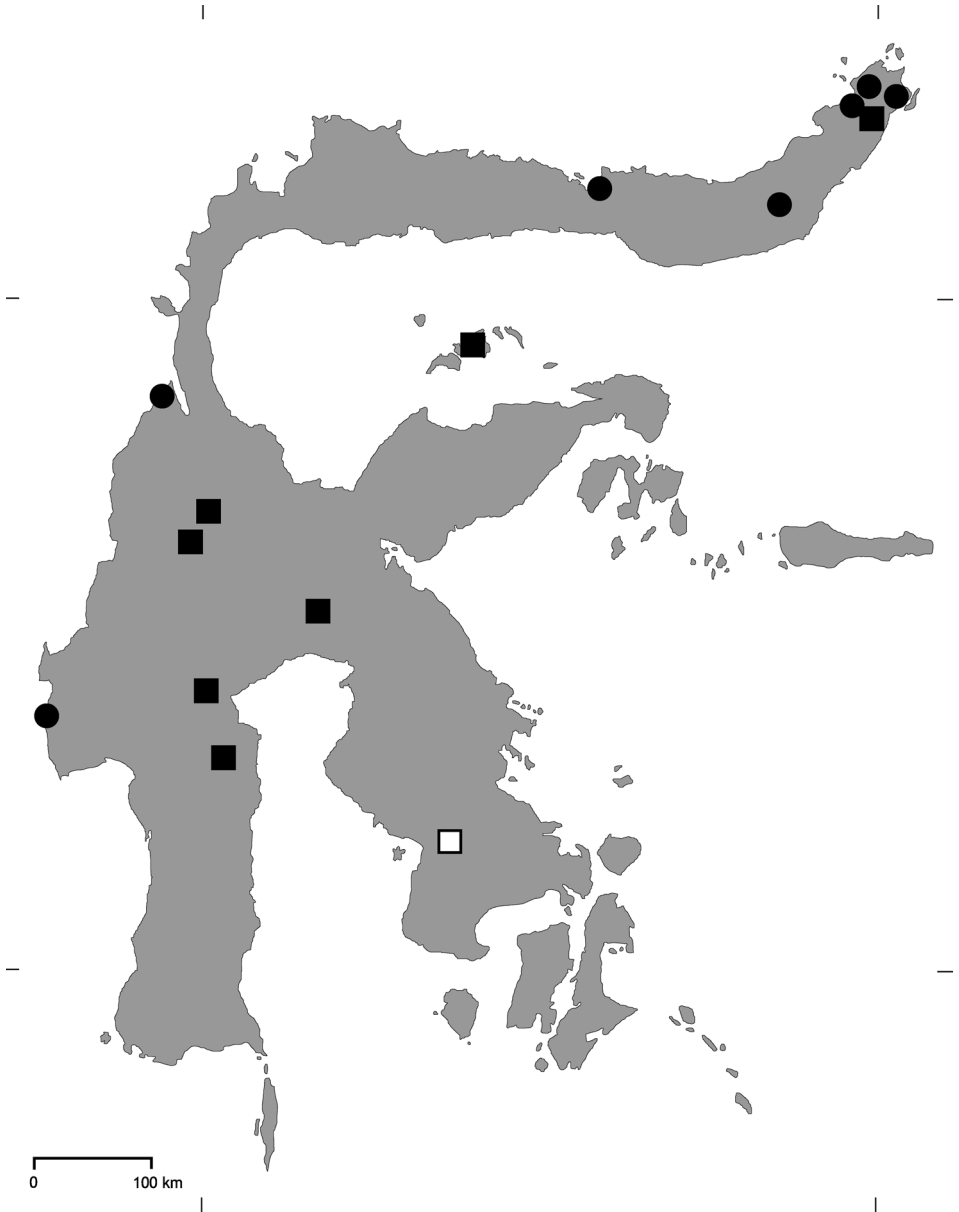


Figure 7: Distribution map of *Libellago daviesi* sp. nov. (●), *Sclerocypha bisignata* (■) and *Watuwila vervoorti* (□) in Sulawesi.

Variation

Insignificant variation in coloration. Measurements [mm]: abdomen 16-18, Hw 21-23.

Biology

Males are territorial in middle of larger streams in Minahasa. They hold a position on stones or logs just a cm above the water surface, where they are frequently disturbed by larger waves. A female (JvT 4934, Dumoga Bone NP) oviposited in a piece of dead wood, ca 5 cm under water (observation J. van Tol).

Distribution

Widespread in Minahasa, with scattered records west of this region (Fig. 7). Apparently not rare in the Gorontalo area in the 1940s, but no recent records, presumably due to little collecting effort since that time. The record in Central Sulawesi near Onang, 58 km N of Majene, is of particular interest. It is far from other known sites, but this species is almost certainly absent from the mountainous areas south of Palu. Remarkably, *L. rufescens* was collected on the same site, also rather isolated from the rest of its otherwise southern range. Both lowland species apparently dispersed along the coastal area. Due to widespread disturbance and pollution of the original habitats both species are now rare outside their distributional centres.

Libellago manganitu sp. nov. (Figs 2g, 3g, 4g)

Etymology

Manganitu, after the type locality. A noun in apposition.

Specimens examined

Holotype ♂ (JvT 5352, in RMNH): “Sangihe Islands, Manganitu: riverine gardens, coconut plantations, secondary forest, 3°35'N 125°32'E, 10-25 May 1985, F.G. Rozendaal”. — Paratypes (all in RMNH): 5 ♂, 8 ♀ (JvT 1758, 5350-5351, 5353-5362), same site as holotype; 1 ♂ (JvT 5363), Sangihe Islands, SSW of Liwung, NW slope Gn [Gunung] Sahendaruman (600-650 m), primary forest and forest edge, water trickle and small stream, 12/19 v 1985, F.G. Rozendaal.

Diagnosis

A rather delicate *Libellago*, Hw ca 22 mm. Presumably closely related species to *L. daviesi* sp. nov., based on general coloration, thickened Costa, and white inner-side of tibiae, but pale markings on head blue (not yellow); yellow markings of synthorax pale yellow rather than dark yellow; Costa thickened over 1 or 2 cells anterior to nodus (not from Ax2), and dark pattern of abdomen only complete on S1-2. Wings remarkably narrow.

Description of holotype male

Head: Labium with glossy sheen, mentum and most of middle lobe creamish yellow, lateral lobes with traces of pale coloration; labrum shining black, mandibles and genae dark brown; frons with a paired blue subrectangular marking, separated ca the width of a marking; scapus black; blue marking between antennae and median ocellus only separated by thin black line, posteriorly with V-shaped incision to accommodate median ocellus; postocular spots small, yellow (Fig. 2g).

Thorax: Pronotum (Figs 3g, 4g) pattern similar to *L. daviesi*, anterior lobe with complete transverse stripe not quite reaching the outermost corners, corners with pale spots that are connected with a longitudinal stripe on median lobe beside lateral lobes; posterior lobe with corners pale coloured and a very small lozenge-shaped spot in middle of lobe; lateral lobes with knob covered by pale roughly circular marking. — Synthorax (Fig. 5g) black with pale yellow markings, dorsal carina not indicated by a yellow line; longitudinal stripe on mesepisternum running from mesokatepisternum, then running well inside mesopleural suture, gradually narrowing, ending $\frac{1}{4}$ th the length of stripe before ante-alar ridge; a short marking parallel to ante-alar ridge just before the ridge; mesepimeron with long longitudinal stripe along mesopleural suture starting ca at $\frac{1}{4}$ th the length and ending ca the width of the stripe anterior to ante-alar ridge; metepisternum anteriorly covered by an irregular pale marking, ventrally not extending over metakatepisternum or metepimeron, dorsally irregularly shaped, posteriorly ending rather acutely at ca $\frac{3}{5}$ of length of metapleural suture, dorso-posteriorly on metepisternum a large but narrow crescent-shaped marking; metepimeron with large pale yellow marking, more or less following the shape of the sclerite, but leaving a broad black margin dorsally, ventrally and anteriorly, posteriorly touching hind margin. — Legs brownish black, but innerside of fore femur creamish white, innerside of fore tibia creamish white, distal $\frac{3}{5}$ th of middle tibia creamish white, and distal $\frac{2}{5}$ of hind tibia creamish white. — Wings long and slender, reaching ca $\frac{1}{5}$ beyond S10 including appendages; no additional Ax between primaries, and ca 3 Ax between Ax2 and nodus; sectors of Arculus arising from one point, sharply angled; R2 weakly arched towards R1; no pterostigma in Fw; distal $\frac{1}{6}$ of Fw opaque dark brown, the proximal margin rounded; Costa of Fw thickened over 2 cells basal to nodus, with red coppery sheen; anal vein arising just distal to Ax1.

Abdomen: Pale brick-red densely set with short stout setae; transparent dark coloration with metallic sheen on dorsum of S3-8, most conspicuous in distal $\frac{1}{6}$ of each segment; dorsum of S1-2, distal $\frac{3}{5}$ of S9 and S10 fully opaque black; all sternites black; anal appendages black.

Measurements [mm]: Abdomen 16, Hw 23.

Description of female

Costa not thickened, coloration similar to male, as follows:

Head: Labium extensively creamish white, mandibles creamish white, except for a dark line against labrum; labrum with paired trapezoid pale spots, clypeus black except for a small spot in lateral corners, frons with subquadrangular paired spots between antennae, scapus creamish white, subtriangular spot between antennae in front of median ocellus, occiput with narrow pale stripe, small suboval postocular spots.

Thorax: Prothorax and synthorax with markings as the male, but creamish white instead of yellow; legs dark on innerside; wings similar to male, but Costa not thickened and pterostigma present in all wings.

Abdomen: Stout, black with dirty white markings; S3-7 with thin median stripe; S1-7 with lateral stripe, interrupted on S5-7 and on intersegmental annulae, smaller pale spots in line with this stripe on S8 and S9; lateral border of tergites 3-7 near sternites with narrow pale stripe.

Measurements [mm]: Abdomen 15, Hw 22.

Variation

Insignificant variation in coloration and measurements; abdomen of many specimens difficult to measure as they are broken.

Distribution

Only known from Sangihe Islands (Kepulauan Sangir), to the northeast of the tip of the Minahasa peninsula of northern Sulawesi.

Libellago rufescens (Selys, 1873)

(Figs 2e, 3e, 4e, 5e, 6, Plate IIe)

Micromerus rufescens Selys, 1873: 64-65 (sep.), original description; — Ris (1916: 305-308, figs 1-2 [not fig. 3], key to *Libellago* of Sulawesi, records, variation in thoracic markings illustrated).

Libellago rufescens (Selys) — Kimmins (1969: 309, lectotype designation); — Askew et al. (1989: 117, records SW Sulawesi, Maros); — Bridges (1994: VII.205, catalogued); — Tsuda (2000: 75, catalogued).

Specimens examined

Holotype ♂: “Celebes or Menado”, [before 1873, presumably collected by A.R. Wallace], in BMNH [examined]. — Other specimens, arranged from north to south, most localities in concise form (329 specimens, in RMNH): 2 ♀, 12 km NW Palopo, Bambalu River, 500 m, 27 iv 1991, J. van Tol; 2 ♀, Tojambu, 800 m, 20 vii 1936, L.J. Toxopeus; 3 ♂, 2 ♀, Tojambu, 29 x 1993, J. van Tol; 14 ♂, 10 ♀, 10 km NW of Palopo, km 15 road Palopo – Rantepao, Salo Tandung, 250 m, 27 iv 1991, J. van Tol; 4 ♂, 1 ♀, 10 km NW of Palopo, Sg. Tandung and tributaries upstream from bridge, 300-600 m (2°57'11"S, 120°07'29"E), 30 x 1993, J. van Tol; 1 ♂, 1 ♀, Palopo, km 23, 29 iv 1991, J. van Tol; 1 ♂, Palopo, km 24, 31 x 1993, J. van Tol; 1 ♂, 1 ♀, Nanggala, 900 m, ix 1937, F.C. Drescher; 1 ♂, Palopo, 04 v 1941, H. and E. Vonk; 1 ♂, Palopo, road km 17, 400 m, 11 v 1941, H. and E. Vonk; 12 ♂, 8 ♀, Palopo, Latoepa River, 02 vi 1941, H. and E. Vonk; 3 ♂, Onan, Sg. Parabaya, 58 km N of Majene (3°07'S, 118°46'E), 19 xi 1993, J.P. and M.J. Duffels; 1 ♂, Madjene, 23 iv 1940, J.J. van der Starre; 7 ♂, 3 ♀, 35 km S of Makale, 05 v 1991, J. van Tol; 2 ♂, 2 ♀, Pakoetekang, S Bone, Saloe Tjimpang, 300 m, 21 v 1937, K.W.M. Steup; 104 ♂, 51 ♀, Maros area, incl. Bantimurung, Pattunuang Asue and Biseang Labboro, many dates from 1878-1991, various collectors; 58 ♂, 24 ♀, Bonthain area, incl. Paladingan, Malino, road Makassar-Malino, Loha [= Loka?], Borong Rapoa, Berang river and Parigi, 1936, 1938, 1941, 1949, 1982, 1985, various collectors.

Diagnosis

A rather robust *Libellago*; male with conspicuous blue marking on frons, pale coloration on thorax orange-yellow, dorsum of abdomen brick-red; innerside of tibiae of middle and hind legs dirty white, of fore legs only basally so or not at all.

Redescription of male

Head: Labium with mentum creamish white, base of middle lobe creamish white, rest of middle lobe and lateral lobes shining black; labrum shining black; mandibles shining brownish black; clypeus with anterior side shining brownish black, but laterally in basal $\frac{2}{3}$ with longitudinal brown stripe (ca $\frac{1}{4}$ the width of clypeus), genae shining brown; remainder of head basically matt-black, with the following pale markings (Fig. 2e): frons between antennae and anterior to median ocellus with rectangular paired pale blue spots, anterior side somewhat irregular, posterior sides slightly extended around median ocellus; spots separated by a thin black line; a small blue spot latero-posteriorly of lateral ocelli, ca size of ocellus; occiput along hind margin with a yellow stripe, postocular areas with a small yellow trapezoid-shaped spot. Antennae black.

Thorax: Pronotum (Figs 3e, 4e) matt-black with extensive orange-yellow markings, anterior lobe nearly completely covered by a transversal yellow stripe, leaving a narrow black line along anterior margin; sides of median lobes with large pale marking, with narrow extrusion in latero-anterior corner near corner of anterior lobe; hind lobe with relatively broad yellow stripe along hind margin, laterally widening and filling the lateral corners completely; lateral lobes with large transverse mark, dorsally nearly touching the corner of hind lobe. — Synthorax (Fig. 5e) moderately glossy black with orange-yellow markings: mesepisternum with large yellow longitudinal antehumeral stripe from ventro-anterior corner near mesostigmal lamina along mesokatepisternum, inner side of stripe straight, outer side at $\frac{2}{5}$ of the length emarginate and then gradually converging with inner side into a sharp point posteriorly; a short transverse stripe near ante-alar ridge; mesepimeron with a longitudinal stripe in posterior half along mesopleural suture, not reaching subalar ridge, mesokatepisternum with a pale triangular spot in ventro-posterior corner; metepisternum black and brownish black with a large rectangular marking starting anteriorly well before metastigma, dorsally extending over mesepimeron, dorsal side somewhat irregular and ventral side with triangular emargination before and partly over metastigma; a second large marking in posterior half of metasternum (ventrally connected to anterior marking in other specimens), separated ca the width of stigma from anterior marking, anterior side from intersegmental suture towards but not connected with metapleural suture, dorsal side in a semi-circular line towards posterior corner; metepimeron with large pale-coloured triangular marking, broadly bordered with black along metapleural suture and ventral side. — Legs black with white areas as follows: basal half of innerside of fore tibiae, innerside of middle and hind tibiae, except for small rings against femur and tarsus; base of innerside of hind femur brown rather than black. — Wings hyaline with amber shade at base; no additional Ax between Ax1 and Ax2; sectors of Arculus not separated, no pterostigma in Fw; tip of Fw with opaque dark brown marking with some metallic sheen, proximal border rounded.

Abdomen: Dorsum red, S1 with black marking along anterior margin, posterior side rounded; S2 anteriorly with small triangular black marking; other segments, including S10, red; ventral side of tergites mainly red, but some black spots on anterior or posterior margins of some segments (varying amongst specimens); inter-segmental annulae red; sternites brownish black, but paler in posterior extremity of each segment. Anal appendages black.

Measurements [mm]: Abdomen 19-21, Hw 23-25.

Redescription of female

Head: Labium base creamish white, labrum shiny black, mandibles, genae and frons creamish white, pale markings of gena and frons connected, but area around scapus black, anterior side of scapus creamish white; paired pale spots lateral to lateral ocelli, pointed anteriorly, occiput with narrow stripe against hind margin, laterally pointed; a paired elongate spot in postocular area.

Thorax: Pronotum generally as in male, with pale spots on lateral lobe fairly large, sharply pointed dorsad; synthorax with pale stripe on mesepisternum starting from margin of mesokatepisternum, then medially along segment, reaching $\frac{4}{5}$ of segment; mesokatepisternum with triangular pale spot in ventro-distal corner; a rather long, thin stripe close to mesopleural suture on metepimeron, extensive pale markings on mesoepisternum, irregular, anteriorly touching mesokatepisternum, broken at ca $\frac{2}{3}$ of length, a triangular emargination around metastigma; large triangular spot on metepimeron, leaving all sides, except posterior side, with black margin. Legs black, no white markings on innerside of tibiae.

Abdomen: Mainly black, but yellowish markings as follows: a narrow median line on S3-7; a pale lateral stripe on tergites 1-9, interrupted on intersegmental annulae, on S8 and 9 only in posterior half, on other segments tapering posteriorly, but just before posterior end distinctly expanded; S10 and anal appendages black; small pale markings on lateral margin of tergites 3-8, shape irregular, but somewhat larger on each following segment from S3 to S7, that on S8 rather small.

Measurements [mm]: Abdomen 17, Hw 25.

Biology

Lowland streams with water depth of ca 10-50 cm. The males defend territories in full sunlight, from boulders emerging just above the water surface, and usually not far from the banks. My observations indicate that females oviposit rather close to the banks.

Distribution

The only species of this complex in southwest Sulawesi (Fig. 6); inhabits coastal region (0-300 m) of the western part of central Sulawesi; sympatric with *L. c. anoa* and *L. c. dorsonigra* in the Palopo area. Collected from sites where it is syntopic with *L. c. dorsonigra*.

Libellago xanthocyana (Selys, 1869)
(Figs. 1, 8a, b, Plate II f)

Libellago (Micromerus) xanthocyanus Selys, 1869: 22 (sep.), original description; — Ris (1916: 305, 308, fig. 4, key to *Libellago* of Celebes, references, material, diagnosis); — Lieftinck (1971: 119, lectotype designation, status).

Libellago xanthocyana (Selys) — Askew et al. (1989: 117, records North Sulawesi, Dumoga Bone National Park); — Bridges (1994: VII.254 catalogued); — Tsuda (2000: 75, catalogued).

Libellago xanthocyanea (Selys) — van Tol (1987: 154, records North Sulawesi, Dumoga Bone National Park). [Lapsus].

Specimens examined

Localities in concise form, from north to south, specimens in RMNH, unless stated otherwise, total 103 specimens. — Minahassa: Tondano, 1935, 09 vi 1940, 03 ix 1940; Pandoe, 26 v 1940; Mapanget, 06 vi 1940, v 1949; Tonsea Lama, 14 viii 1941; Tangkoko, 04 v 1985; Dumoga Bone National Park, v 1985; Poniki Mts, 02 xi 1985 (in IRSN). — Gorontalo: Limbotto (type locality), 1863 [type ♂ in RMNH, examined]; same, Modelido, 1863; Paleleh, 08 vii 1940. — Between Palu and Gorontalo: Donggala, 30 x 1940, 07 xii 1940; Dondo Bay, 02 xi 1940; Bombaipoela, 27 xii 1940; Semelie, 03 i 1941. — Eastern Sulawesi: Tombugu, 1882 (in ZMHB). — Mamasana region: Baebunta river, 17 iv 1940, 08 ix 1940, 25 v 1941; Bone Bone, 23 v 1940; Lamoang river, 14 vi 1940; Mahulu and Waimane rivers, 30 iv 1991; Laimbo and Wailanti rivers, 25 x 1993. — Polewali region: 13 viii 1940; 24 ix 1940. — Banggai peninsula: Batui river, 28 i 1989. — Banggai archipelago: Peleng, 31 vi 1941. — Pulau Kabaena: Batuawu, 11 xi 1989.

Diagnosis

Males unmistakable; dorsum of S1-5 with extensive blue markings, orange markings at least on dorsum of S8, but on S6-8 in some parts of its range. *L. xanthocyana* can be distinguished from *L. asclepiades* by the coloration of its abdomen (see key).

Redescription of male

Head: Labium with divided middle lobe, both middle and lateral lobes glossy black, although paler at base; labrum glossy, but with distinct punctuation, purplish black with anterior extremity dark yellow; mandibles shiny black, smooth; clypeus with convex anterior part black with blue and purple metallic sheen, lateral $\frac{1}{5}$ to $\frac{1}{6}$ anteriorly with a longitudinal pale stripe not quite touching the sharp edges; posterior surface of rhinarium black, matt; remaining part of head matt-black except for small paired spots just lateral to the posterior ocelli, and paired spots near the hind margin of the head. Antennae black. Eyes black.

Thorax: Pronotum matt-black, with slight coppery-metallic sheen on median lobe; a small diamond-shaped median pale spot meeting hind margin of posterior lobe. — Synthorax semi-matt black with narrow pale markings as follows: dorsal carina bluish yellow, antehumeral stripe brownish yellow, very narrow and frequently

intermittent, posteriorly ending at ca $\frac{1}{3}$ of length of humeral suture, but longer in some specimens; mesepimeron and mesokatepisternum black; metepisternum black with three pale markings as follows: a small oval brownish marking ca halfway along interpleural suture ca halfway, in posterior part again against interpleural suture a yellowish blue oblong marking, ca $\frac{1}{6}$ the length of the interpleural suture, half as high as long, with a long side anteriorly and more or less acute posteriorly, finally a small crescent-shaped marking the subalar ridge; metepimeron black, with a triangular posterior marking, partly darkened in some specimens. — Legs brownish black. — Wings with brownish-yellow tinge, hyaline, Fw distal to Px 11 with dark brown opaque marking running oblique to hind margin of wing; Hw with distal extremity, i.e. the last row of cells, darkened; Fw without pterostigma, Hw with rather long pterostigma, covering ca 3 underlying cells, situated close to tip of wing; Fw and Hw with 3 Ax distal to Ax2; Arculus not stalked, just posterior to Ax2.

Abdomen: Dorsally with conspicuous pattern of caerulean blue and brick-red, ventrally black; pattern of specimens of northern arm of Sulawesi (Fig. 8a) with S1-5 blue, S6 unmarked black, S7-8 brick-red, S9-10 black. S8 with middorsal black stripe, S2 with blue marking somewhat wider than long, not touching anterior margin of segment, medio-posteriorly with small spatulate extrusion, reaching hind margin of segment; S3-4 with sub-quadrangular blue marking, virtually touching anterior border of segment, leaving posteriorly ca $\frac{1}{6}$ of segment length black; marking on S5 approximately as on S4, but hind margin with deep median black incision continuing almost to anterior margin as narrow black line; S6 (with much variation between individuals) entirely black or with paired triangular brick-red markings, each with base not quite reaching anterior margin of segment, apex at ca $\frac{2}{3}$ of length of segment; S7 (again with much individual variation) black, or with brick-red markings as on S6, but much larger, laterally covering more than $\frac{2}{3}$ the segment length; red marking of S8 quadrangular, covering most of segment, from the base nearly to the apex. Anal appendages black, superiors to some extent bent inwards, the tips not touching; inferiors short and flat, ca half the length of superiors.

Measurements [mm]: Abdomen 15, Hw 18.

Redescription of female

Pale markings much more extensive than in male.

Head: Pale, yellowish white markings as follows: mandibles pale except for base, labrum with pale basal stripe, front of rhinarium laterally with broad pale stripe, tapering dorsally, postclypeus with triangular markings laterally meeting frons, and smaller paired markings near median line, gena with extensive pale coloration, frons with quadrangular paired pale markings, somewhat extended latero-anteriorly, base of antenna pale, paired suboval spots just before central ocellus, and similar spots lateral to each lateral ocellus; small triangular pale postocular spots.

Thorax: As male. Legs dark brown; wings clear, all with pterostigma, covering ca 3.5 underlying cells.

Abdomen: Matt-black, with longitudinal pale stripes as follows: a median stripe over S2-8, usually somewhat tapering posteriorly on each segment, and paired lateral stripes on tergites 1-8, on S1 only in posterior half, marking on other segments somewhat constricted on each segment at ca $\frac{2}{3}$ of its length; ventral side of abdomen black.

Measurements [mm]: Abdomen 14, Hw 19.

Variation

Significant variation occurs, especially in the colour pattern of the dorsum of the male abdomen. Specimens from the northern peninsula (Gorontalo, Minahasa) have extensive red markings on S6-8 (Fig. 8a). Banggai peninsula specimens (Fig. 8b) may have S6, or S 6 and S7 completely black, and S7 and S8, or only S8 with limited orange markings, while the blue coloration of especially S5 may be distinctly restricted in the middle. There is also considerable variation in size; the only specimen available from Kabaena is extremely small.

Biology

Mostly found on fast flowing lowland streams of more than 5 m wide with persistent spots of sunlight on the water, but also in some smaller streams outside the forest. In the rivers males are usually found near overhanging shrubs or dense emergent aquatic vegetation, and less commonly found sitting on rocks or vegetation in fast flowing water. Females in trees or shrubs near the water. Confined to lowland areas. Although very colourful, extremely inconspicuous even in sunlight.

Distribution

Widespread in Sulawesi (Fig. 1) and rather common in suitable habitat in the Minahasa and Gorontalo districts, less common in central Sulawesi, the Banggai peninsula and Banggai archipelago, uncommon in the southeastern arm and Pulau Kabaena; unknown from the southwestern arm.

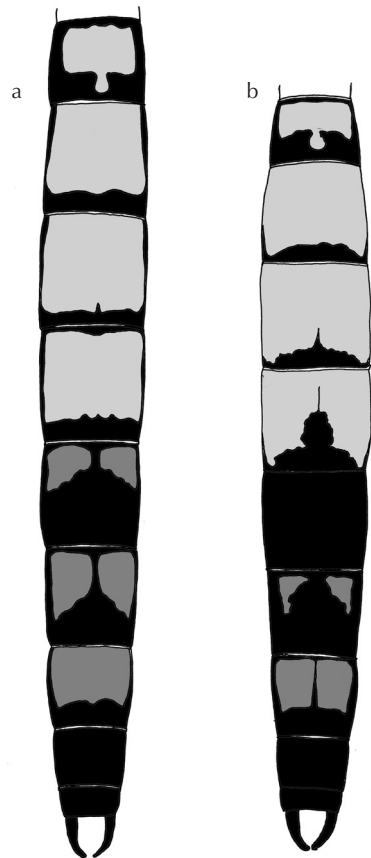


Figure 8: Abdomen of male *Libellago xanthoxyana*, dorsal view — (a) specimen from northern arm of Sulawesi; (b) specimen from Banggai peninsula.

Sclerocypha Fraser, 1949

Sclerocypha Fraser, 1949: 7, fig. 2.1, original diagnosis, pair of wings.

Diagnosis

The original diagnosis includes the following characters for the genus to distinguish it from *Libellago*: 8-9 Ax and at least one secondary placed between the two primaries; a long section of the Costa, immediately proximal to the nodus, in the Fw of male greatly and noticeable thickened; similar but slighter thickenings of MA and IA distal to the discoidal cell; in addition to the black apical fascia of Fw of male, which extends proximally to the basal end of the pterostigma, a broad blackish band at the level of nodus.

Sclerocypha differs from *Watuwila*, which also has a somewhat thickened Costa, and ca 9 Ax, by the absence of a pterostigma in the Fw, Arculus arising from one point; R2 vein parallel to R1 (not arched towards R1).

Although not indicated by Fraser, I consider *Sclerocypha* feminine, in analogy to *Rhinocypha*. Presently, only the type species is assigned to *Sclerocypha* (e.g. Bridges 1994, Tsuda 2000).

Type species: *Micromerus bisignatus*, by original designation.

Sclerocypha bisignata (McLachlan, 1870) (Figs 2h, 3h, 4h, 5h, 7, Plate IIIb).

Micromerus bisignatus McLachlan, 1870: 168-169; — Selys (1873: 31-32); — Ris (1916: 304-305, key to *Libellago*, references); — Fraser (1949: fig. 2.1, pair of wings); — Kimmins (1969: 308, holotype BMNH, label data, generic placement). *Libellago* (*Sclerocypha*) *bisignata* (McLachlan) — Bridges (1994: VII.33, catalogued).

Sclerocypha bisignata (McLachlan) — Tsuda (2000: 78, catalogued).

Specimens examined

Localities in Sulawesi and arranged from north to south, all specimens in RMNH, unless stated otherwise. — Holotype ♂, Tondano, [late vi / early vii 1859, cf. Bradley & Betrem 1967], A.R. Wallace, in BMNH [examined]; 1 ♂, Tondano, acquired vii 1933, C. van Braekel; 18 ♂, 9 ♀, 50 km SE Palu, Lore Lindu near Dongi Dongi shelter (1°13'S, 120°11'E, 950 m), 04-08 xii 1985, J. van Tol; 3 ♂, 2 ♀, Mamoe, S Kulawi, 1,000 m, locality "CdR XXIV" [no. XXIV of Coomans de Ruiter], 09 x 1940, Felix; 1 ♀, Kulawi: Winatu, 750 m, 14 ii 1941, Felix; 20 ♂, 2 ♀ (1 ♂ in coll. Hämäläinen), 40 km N of Wotu, Batas, small stream at km 4 (2°13'30"S, 120°46'30"E, 1,200 m), 24 x 1993, J. van Tol; 1 ♂, 10 km WNW Palopo near Tojambu (2°46'S, 120°07'E), Johan R. [local collector]; 1 ♂, Tojambu and surroundings, 02 xi 1993, Gala [local collector]; 1 ♀, Latimodjong Mts, Uru (800 m), viii/ix 1930, G. Heinrich; 1 ♀, Baraka between Pasongken and Rante Lemo, 05 xi 1993, J. van Tol. — 2 ♂, Togian Inseln, [no date], A.B. Meyer (in ZMHB).

Diagnosis

For differentiation from other red-coloured Sulawesi Chlorocyphidae, see genus diagnosis.

Redescription of male

Head: Labium shiny, mentum and base of middle and lateral lobes dirty creamish yellow, remaining part shining black; labrum black, rather heavily punctate with soft sheen; mandibles shining brownish black; genae brownish black; clypeus black, latero-basally with paler, brownish markings, anterior side punctulate and glossy; remaining part of head matt-black, except for the following pale markings: frons anterior to antennae with small paired yellow markings, ca the diameter of a marking apart; another pair of markings between the antennae before the median ocellus, rectangular and ca the width of antenna apart, small yellow spot just outside each lateral ocelli, ca the diameter of ocellus wide; a narrow and broken line along hind margin of occiput; postocular area with yellowish triangular spots (Fig. 2h), close to occiput and not touching hind margin; antennae black; long setae on dorsal part of head.

Thorax: Pronotum (Figs 3h, 4h) with anterior lobe with relatively wide transverse stripe, yellow; corners of anterior lobe with triangular yellow spot; middle lobe laterally with crescent-shaped yellow marking, with convex part dorsally, anteriorly connected to triangular yellow spot of anterior lobe; hind lobe black with lateral corners with yellow markings; lateral lobes with rounded yellow marking in middle; hind and lateral lobes with tufts of long setae. — Synthorax (Fig. 5h) especially dorsally with sparse, long setae; coloration generally black with orange markings; mesepisternum with longitudinal stripe running from mesokatepisternum and mesostigmal lamina, running to $\frac{3}{4}$ of length of mesepisternum, basal half more than twice as wide as remaining part, a small spot beside ante-alar ridge close to mesopleural suture; mesokatepisternum black except for a very small yellow spot in ventro-posterior corner; mesepimeron with short yellow stripe along mesopleural suture, ca length of stripe from subalar ridge; metepisternum with extensive pale coloration, from metastigma in a more or less rectangular dorso-anterior extension running posterior to ca $\frac{3}{5}$ the length of metapleural suture, then in a dorsally directed curve nearly towards hind margin; dorsal side with rectangular emargination; another small marking in posterior extremity of metepisternum; metepimeron nearly fully covered by pale yellow marking, only touching posterior margin and leaving a narrow black stripe along other sides. — Legs black with extensive white markings as follows: innerside of fore tibia and femur, innerside of middle femur, and distal half of middle tibia, hind legs with both inner femur and inner tibia white. — Wings long and slender, without pterostigma in Fw; one additional Ax between the primaries, sectors of Arculus arising from one point, R2 not arched towards R1; Costa of Fw thickened over 3 cells anterior to nodus; Fw just proximal to nodus with transverse semi-opaque brownish black stripe covering 2-3 cells in middle of wing, tip of Fw with brownish black opaque marking with proximal side oblique.

Abdomen: Dark orange red, with black annulae between segments and also black markings along hind margin of each segment; ventral sides of tergites densely set with short stout setae; S1 laterally yellow, dorsally black; S2 with small triangular spot at anterior margin; S3-4 without black markings; S5-8 with a broken ring at

posterior margin of segment, broader on more posterior segments; S9-10 dorsally without black markings; postero-ventrally tergites with black markings, gradually increasing in size on the more posterior segments, S9-10 virtually black on ventral side; sternites black, but with some red spots on S9. Anal appendages black.

Measurements [mm]: Abdomen 22-24; Hw 28-29. Specimens from the Sopu valley and from the area between Poso and Teluk Bone are of similar size.

Redescription of female

Head, thorax and abdomen black with extensive pale markings; pale markings generally creamish white or pale yellow, some parts with bluish hue.

Head: Pattern on head similar to male, but more extensive, viz. labium and labrum as male, mandibles extensive creamish yellow with basally some black coloration, shiny, anteclypeus shiny with indistinct punctation, medially with broad longitudinal black stripe, laterally with large triangular pale brown to creamish markings, but anterior side of clypeus bordered by narrow black stripe, rest of head matt-black with genae creamish white, anterior side of scapus creamish white, and a yellow stripe next to eye lateral to antennal base, rest of pale markings on head as in male, but creamish white, and anterior spot on frons larger than in male.

Thorax: Markings on pronotum and synthorax similar to male, but yellowish or creamish white; legs brownish black, including innerside of tibiae; wings long and slender, with additional Ax between primaries, Costa not thickened.

Abdomen: Stout, dorsum with median pale stripe, short on S1, over full length over S2-7, interrupted by intersegmental annulae, S8 with oval spot in distal half, S9 with oval spot in distal third, S10 black, lateral and ventral parts of tergites pale, covering most of sides of tergites 1-7, but with increasingly larger distal black emarginations towards posterior; S8 with lateral suboval spot, anteriorly distinctly narrower than posteriorly, ventrally emarginate, and an indistinct spot at ventro-anterior margin, a larger oval and more yellowish spot in posterior half of S9, not touching posterior margin of segment; cerci long and slender, terebra reaching hind margin of S10.

Measurements [mm]: Abdomen 18-21, Hw 27-30.

Biology

Usually found on sunny streams of 2-6 m wide, in mountainous regions between ca 800 and 1,200 m, where *Libellago* species of the *rufescens*-group of Sulawesi do not occur.

Distribution

Widespread in the mountains of Central Sulawesi, southwards to the Latimojong area. One 19th century record from the Togian islands. Remarkably, the type was collected near Tondano in the eastern tip of the northern peninsula. Only one other specimen is known from the northern arm of Sulawesi, from exactly the same locality. Collecting in this area by Coomans de Ruiter, a collector of many uncommon species of Odonata, never revealed another specimen. In January 1989, the area was heavily disturbed (personal observation). The waterfall at ca 600 m was used as a hydro-electric power plant, while the mountains above the lake were used for agriculture.

KEY TO THE MALES OF THE CHLOROCYPHIDAE OF SULAWESI

1. R2 vein arched towards R1; sectors of Arculus separated 2
- 1'. R2 vein straight in line with superior sector of Arculus (Rs); sectors of the Arculus arise from one point 3
2. Anal vein present, leaving hind margin of wing distal to Ax2; Arculus at Ax2; wings with extensive dark markings *Rhinocypha*
Note: at least four species in Sulawesi. A revision is in preparation by J. van Tol and A. Günther.
- 2' Anal vein absent (actually fused with hind margin of wing); Arculus far distal to Ax2; wings clear *Disparocypha*
Note: one species only, *D. biedermanni*.
3. Wings with more than 8 Ax, including an additional Ax between the primaries 4
- 3'. Wings with ca 6 Ax; no additional Ax between the primaries 5
4. Males with pterostigma in all four wings; Fw clear at level of nodus; Costa only indistinctly thickened proximal to nodus *Watuwila*
Note: only *W. vervoorti*.
- 4' Males with pterostigma in Hw only; Fw with distinct brownish black opaque band at level of nodus; Costa distinctly thickened proximal to nodus (Plate IIIb) *Sclerocypha*
Note: only *S. bisignata*.
5. Abdomen scarlet red, scarlet red with black metallic sheen, or scarlet red with black markings 6
- 5'. Abdomen blue and/or orange or brick red with black, but without scarlet red (Plate II f, III a) 12
6. Costa of Fw distinctly thickened proximal to nodus 7
- 6'. Costa of Fw between base and nodus not thickened 8
7. Abdominal segments dorsally with purplish black metallic sheen (Plate II d); northern Sulawesi *L. daviesi* sp. nov.
- 7'. Abdominal segments dorsally red, with small crescent-shaped black metallic markings distally on each segment. Sangir Islands *L. manganitu* sp. nov.
8. Tibia on innerside white (sometimes inconspicuous in preserved specimens); occiput with orange stripe (Fig. 2e); lateral lobe of pronotum with a smaller or larger pale spot (Fig. 4e) *L. rufescens*
- 8'. Tibia innerside black (in some specimens some pruinosity); occiput black; lateral lobe of pronotum black, without pale marking (Figs 4a-d) (*L. celebensis* sp. nov.) 9
Note: the couplets provide a key to the four subspecies recognized. Especially around Lake Poso, intermediate forms were found. Whether they represent a separate taxon, or a hybrid population is presently unknown.
9. Frons black, without blue or orange markings (Figs 2b, c) 10
- 9'. Frons with conspicuous blue or orange markings (Figs 2a) 11

10. Abdomen red, or with small black markings medially on S1; posterior lobe of pronotum with a complete transversal bluish yellow stripe (Figs 3b, 4b, Plate IIa) *L. celebensis celebensis* ssp. nov.
- 10'. Abdomen red, but tergites of most or all segments dorsally and ventrally with extensive black markings (Plate IIb); posterior lobe of pronotum with sub-triangular bluish markings in lateral corners (Figs 3c, 4c) *L. celebensis dorsonigra* ssp. nov.
11. Antehumeral stripe wide and blue (Fig. 5d, Plate IIc); hind lobe of pronotum with a smaller or larger median pale spot (Fig. 3d) *L. celebensis orientalis* ssp. nov.
- 11'. Antehumeral stripe narrow (Fig. 5a), orange; hind lobe of pronotum medially black (Fig. 3a) *L. celebensis anoa* ssp. nov.
12. S4+5 blue *L. xanthocyana*
- 12'. S4+5 orange or brick-red *L. asclepiades*

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