

**LYRIOTHEMIS DEFONSEKAI SPEC. NOV. FROM SRI LANKA,
WITH A REVIEW OF THE KNOWN SPECIES OF THE GENUS
(ANISOPTERA: LIBELLULIDAE)**

N. VAN DER POORTEN

17 Monkton Avenue, Toronto, Ontario, M8Z 4M9, Canada; – nmgvdp@netscape.net

Received July 19, 2008 / Reviewed and Accepted November 18, 2008

Both sexes of the new sp. and its early instar larva are described and illustrated. Holotype ♂: Ratnapura district, near Kudawe, alt. 500 m, 3-VII-2007; to be deposited at the Colombo National Museum. The habitat characteristics and species behaviour are briefly outlined. The new sp. is compared to all known congeners. It closely resembles *Lyriothemis acigastra* (Sel.) and *L. elegantissima* Sel.

INTRODUCTION

Fourteen species of *Lyriothemis* are known worldwide (BRIDGES, 1994; TSUDA, 2000) and all are found in Asia (cf. Tab. I). There appear to be 2 additional undescribed species from Thailand and Andamans, respectively (M. Hämäläinen, and W.-C. Yeh, pers. comm.). Most of the species occur in the tropical parts of the Oriental region, but the ranges of *L. pachygastra*, *L. tricolor* and *L. elegantissima* extend to the Palaearctic East Asia. Three species occur exclusively in the Australasian region: *L. eurydice* in Sulawesi, *L. meyeri* in the Moluccas and New Guinea and *L. hirundo* in New Guinea. In literature, *L. acigastra*, *L. bivittata*, *L. cleis* and *L. tricolor* are recorded from the Indian subcontinent; all of them from NE India. No representative of the genus has been reported from Sri Lanka so far (FRASER, 1936; DE FONSEKA, 2000; BEDJANIČ et al., 2007).

LYRIOTHEMIS DEFONSEKAI SP. NOV.

Figures 1-11

Material. — **Holotype** ♂: SRI LANKA, Ratnapura district, near Kudawe, alt. 500 m, 03-VII-2007; — **paratype** ♀: same locality, 18-VI-2007; — larvae see below. All N. van der Poorten leg. & det. Material to be deposited at the Colombo National Museum.

Etymology. — The species is named after the late Terence de Fonseka, the author of *The dragonflies of Sri Lanka* (DE FONSEKA, 2000), which is the first book dealing exclusively with the Odonata of the island. It is unlikely that this species would have been recognized as a new species without it.

Table I
Representatives of the genus *Lyriothemis* with their known distribution ranges

Species	Distribution
<i>acigastra</i> (Selys, 1878)	Bangladesh, China (Tibet), NE India (Assam, West Bengal), Myanmar
<i>biappendiculata</i> (Selys, 1878)	Widespread in Sundaland, N to the Kra Peninsula in S Thailand. Known also from Chanthaburi, SE Thailand
<i>bivittata</i> (Rambur, 1842)	Widespread in the southern part of the continental Asia; known from Bangladesh, Nepal, NE India (Assam, W. Bengal), Laos, Myanmar, Thailand, Laos, Vietnam
<i>cleis</i> Brauer 1868	Widespread in Sundaland (in N extending to Ranong, Thailand), the Philippines and Sulawesi. Old records from Vietnam and Cambodia (MARTIN, 1904) are in need of confirmation. A recent record of a ♀ specimen from Assam, India (MITRA, 2002) should also be verified
<i>elegantissima</i> Selys 1883	Thailand, China (Fujian, Guangdong, Guangxi, Hong Kong, Fujian, Taiwan; K.D.P. Wilson, pers. comm.), Japan
<i>eurydice</i> Ris 1909	Sulawesi
<i>hirundo</i> Ris 1913	New Guinea
<i>latro</i> Needham & Gyger, 1937	Philippines; recorded from Luzon, Samar and Bohol
<i>magnificata</i> (Selys, 1878)	Widespread in Sundaland. The identity of specimens from central and northern Thailand (ASAHINA, 1988, 1990) are in need of confirmation; they may represent an undescribed species (W-C. Yeh, pers. comm.)
<i>meyeri</i> (Selys, 1878)	Widespread in New Guinea and adjacent small islands; Moluccas (Ternate and Obi)
<i>mortoni</i> Ris, 1919	A rare species recorded only from a few sites in S Myanmar and Thailand. Recently recorded also in Phu Quoc Island in S Vietnam (BUI HUU, 2007)
<i>pachygastra</i> (Selys, 1878)	The northernmost species in the genus. Widespread in China, South Korea, North Korea, extreme SE Russia (Primorye) and Japan. Known also from Phu Kradung mountain plateau in NE Thailand (HÄMÄLÄINEN & PINRATANA, 1999)
<i>salva</i> Ris 1927	Sumatra
<i>tricolor</i> Ris 1919 [syn. <i>flava</i> Oguma, 1922]	Bangladesh, NE India (Meghalaya, Assam, W. Bengal), Myanmar, China (Guangdong, Guangxi, Hainan, Taiwan), Japan (Ryukus)

MALE (Holotype). — **H e a d.** — Median lobe of labium black, lateral lobes dull yellow with brownish-black edges; mandibles black with a yellow spot on each side; labrum black, yellow basally; postclypeus yellow; anteclypeus yellow; frons dark metallic blue with small, dull yellow triangular lateral patch at the base; vesicle dark metallic blue with prominent pointed bifid tubercle; occipital triangle black. Eyes dark purplish-red above, blackish-green below, postgena black above and yellow below.

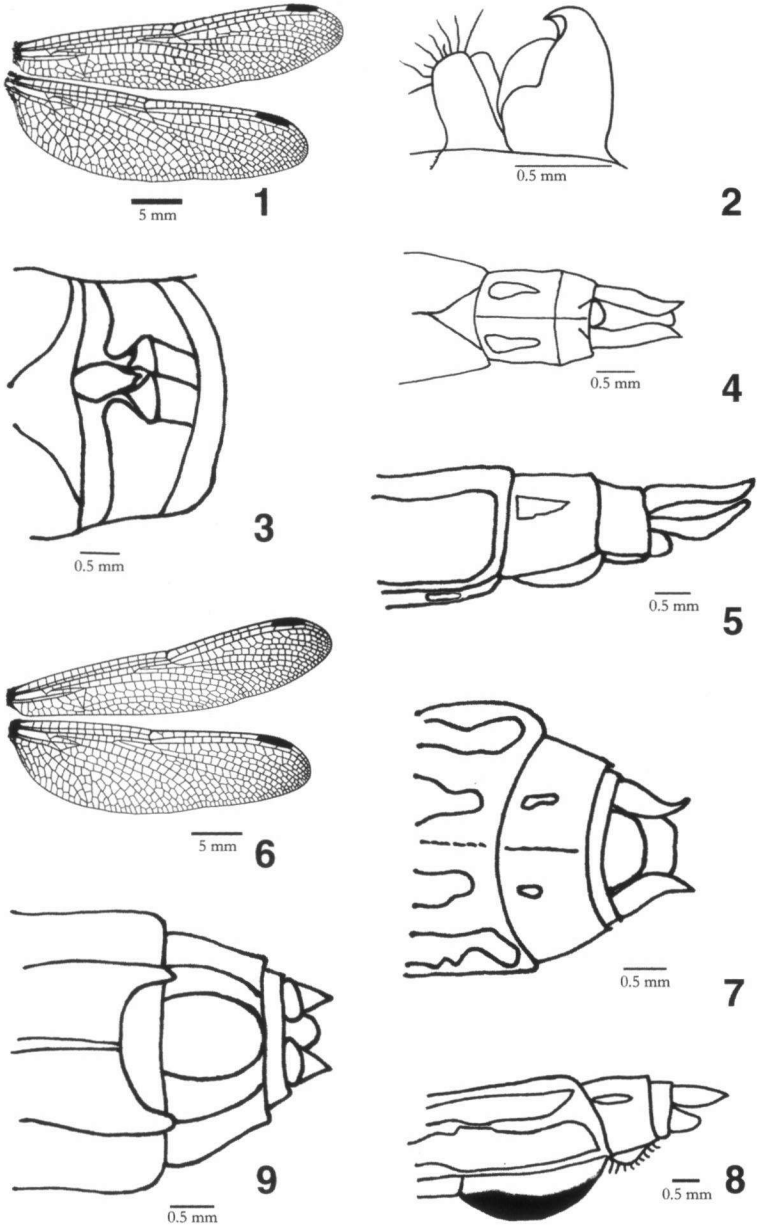
T h o r a x. — Prothorax black, anterior collar edged with yellow, median lobe with small points of yellow. Synthorax black to blackish brown with yellow markings, dull reddish brown on dorsum; a broad stripe extending from coxa of first pair of legs to about halfway up the dorsum, not touching the dorsal carina; a triangular spot at the alar sinus; broad yellow band in the metepimeron, reaching to the interpleural suture; a yellow irregular quadrate spot continues below the suture; yellow spot in the metepisternum just above the spiracle; yellow triangular area in the metepimeron, black along the metapleural suture.

Wings (Fig. 1) hyaline, forewing tinted with pale yellow-brown at extreme base; hindwing tinted with yellow-brown at extreme base and into the anal angle; membrane gray; pterostigma dark brown covering 2-3 cells; Fw antenodals 15,15, postnodals 9,10; Hw antenodals 13,12, postnodals 10,11. CUQ FW 1, HW 3. Discoidal field of forewing starts with 3 rows of cells and continues with 2 rows of cells to about half-way; then 3 or more rows, ending with 6-7 cells at the margin.

Legs black, anterior femora yellow on upper inside edge; trochanter yellow on all legs; hind femora with 4 short spines proximally followed by 5 spines (twice as long), terminating distally with a yet longer spine.

A b d o m e n. — Bright red with yellow and black, dorsally widest at segment 3, tapering from then on to the anal appendages. S 1 yellow with black apical and basal ring; — S 2 reddish dorsally, yellow on sides and beneath, black apical and basal rings, black transverse carina apically; — S 3 red dorsally with black apical and basal band, and strong black transverse carina about 1/3 distance from the base, mid-dorsum black, faint black subdorsal line, beneath black with large yellow spot basally and smaller yellow spot at the apical edge; — S 4 red dorsally with black apical and basal bands, and black transverse carina about 1/3 distance from the base, mid-dorsum black, faint black subdorsal line, beneath black with large yellow stripe extending from the base to the apex; — S 5 to 8 red dorsally with black apical and basal band; mid-dorsum black, faint black subdorsal line, beneath black with a yellow stripe extending from the base to the apex; — S 9 black with a subdorsal red triangular marking basally to about halfway through the segment; — S 10 black.

Secondary genitalia (Figs 2-3). — Anterior lamina blackish and flat; hamules large and very prominent in profile, blackish brown on the outside surface, leaf-shaped, pointing downwards with the tips recurved, inside surface of the mem-



Figs 1-9. *Lyriothemis defonsekai* sp. n., Figs 1-5: male, Figs 6-9: female: (1, 6) wings; - (2) male secondary genitalia, lateral view; - (3) same, ventral view; (4, 7) anal appendages, dorsal view; - (5, 8) same, lateral view; - (9) same, ventral view.

brane yellow and rounded outwards like a ball; genital lobe black with long hairs, raised at the insertion of the hairs, not constricted at base.

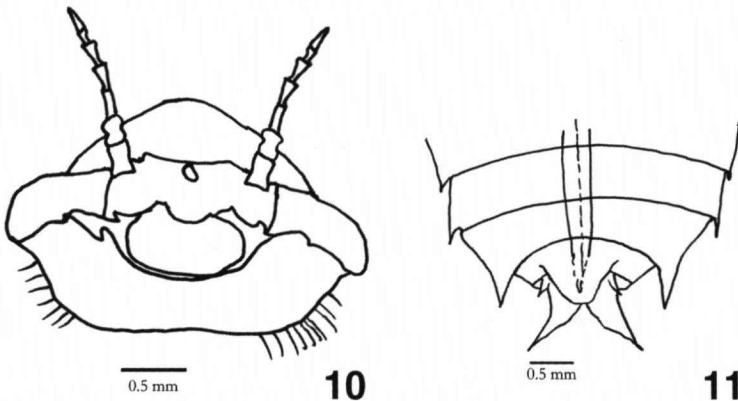
Anal appendages (Figs 4-5) black, two times longer than segment 10, inferior as long as superiors.

Measurements (mm). — Total length 38, abdomen 23 + anal appendages 3, hindwing 29, forewing 31.

FEMALE (Paratype). — **Head**. — Labium whitish yellow with black around the edges; mandibles black with large dull yellow spot on each side; labrum brownish-black, dull yellow at base; postclypeus creamy white; anteclypeus black, white above; frons two-lobed, dark metallic blue with a dull yellow triangle at each lateral, basal corner; vesicle dark metallic blue with prominent pointed bifid tubercle; occipital triangle black. Eyes dark purplish-red above, blackish-green below, postgena black above and yellow below.

Thorax. — Prothorax black, anterior collar edged with yellow, two large yellow irregular spots on the median lobe, one on each side of the mid-dorsum. Synthorax black to blackish brown with yellow markings, dull reddish brown on dorsum; a broad stripe extending from coxa of the first pair of legs to about half-way up the dorsum, not touching the dorsal carina; a triangular spot at the alar sinus; a broad yellow band in the metepimeron, reaching the interpleural suture; a yellow irregular quadrate spot continues below the suture; a yellow spot in the metepisternum just above the spiracle; a yellow triangular area in the metepimeron; black along the metapleural suture.

Wings (Fig. 6) hyaline, forewing tinted with pale yellow-brown at extreme base; hindwing tinted with yellow-brown at extreme base and just into the anal angle; membrane gray; pterostigma blackish-brown covering 2-3 cells; Fw antenodals 16, postnodals 10; Hw antenodals 13, postnodals 8. CUQ FW 2, HW 3. Discoidal field of forewing commences with 3 rows of cells and continues with 2 rows



Figs 10-11. *Lyriothemis defonsekai* sp. n., larva: (10) head, dorsal view; — (11) terminal segments of abdomen, dorsal view.

of cells to about half-way; then 3 or more rows, ending in 7 cells at the margin.

Legs black, anterior femora yellow on upper inside edge; trochanter on all legs yellow; hind femora with 4 short spines proximally, followed by 5 spines (twice as long), terminating distally with a yet longer spine.

A b d o m e n. — Yellow with black. S 1 black basally, yellow apically; — S 2 with black basal and apical rings incomplete below, black on the mid-dorsum, lateral carina black, beneath black mid-ventrally; — S 3 with black basal, mid-transverse and apical dorsal rings incomplete below, black on the mid-dorsum, lateral carina black; — S 4 with black basal and apical rings incomplete below, another black incomplete ring about 1/5 distance from the base, black on the mid-dorsum, lateral carina black, beneath black mid-ventrally; — S 5 to 8 black apical and basal rings incomplete below, black on the mid-dorsum, lateral carina black, beneath black mid-ventrally; — S 8 moderately dilated, borders black; — S 9 black with faint yellow subdorsal basal spots; — S 10 black, very short. Vulvar scales very small.

Anal appendages (Figs 7-9) black, superior appendages pointed and 2x segment 10; inferior appendage same length as segment 10.

M e a s u r e m e n t s (mm). — Total length 31, abdomen 21, hindwing 28, forewing 29.

VARIATION IN SIGHTED SPECIMENS. — Photographs were taken of some individuals and the following variations were noted: the irregular yellow spots on the median lobe of the prothorax cover the whole lobe; the yellow pattern on the thorax and abdomen is slightly variable.

EGGS. — Whitish, elongate, 1 mm length, 0.5 mm wide.

LARVA. — Eggs that were clustered outside the vulvar lamina of the paratype female were collected and placed in water. The larvae emerged 13 days later. The larvae were slow moving and frequently stayed outside or just on the edge of the water. Two individuals reached a size of 9 mm after 4 months, at which time the outer pair of wing buds reached to the middle of the third abdominal segment but they died soon after. It was not possible to count the number of moults.

Description of 4 month old larva: Total length 9 mm; length of abdomen 7.5 mm; head (Fig. 10) 1.5 mm long and 3 mm wide, eyes in a band across mid-head; antennae have 7 segments: the 5 apical segments of the same length; the basal two segments longer and wider, penultimate basal segment rounded, total length 2mm; femur of the legs striped, length of posterior femur 3mm; wing-buds to mid-3rd segment; mid-dorsal spines on segments 4-9; lateral spines on 8 that reach 1/3 distance of segment 9; lateral spines on 9 that reach to base of paraproct; 3 rows of brown mottling on dorsum of abdomen; cerci shorter than epiproct; paraproct one-third longer than epiproct (Fig. 11).

Larvae of *Lyriothemis cleis*, *L. magnificata* and *L. tricolor* have been reported from phytotelmata (ORR, 2003, 2005; LIEFTINCK et al., 1984) and larvae of *L. elegantissima* have been recorded from marshes and the muddy bottoms of ditches in Taiwan (LIEFTINCK et al., 1984).

HABITAT. — Semi-disturbed, hilly dipterocarp forest with bamboo and tree ferns in the wet zone (rainfall 3000-6000 mm annually, elevation 500 m) in the south-west of the island near a small perennial stream with abandoned paddy fields across from the stream. June 18, 2007: several fresh females seen; no males seen. July 3, 2007: an older, brownish female and 3 fresh males seen at same location.

Other *Lyriothemis* species have been recorded in similar marshy, forested habitats. *L. biappendiculata* is reported from marshy dipterocarp forests up to 600 m in Borneo (ORR, 2003), swampy forested areas from 0-600 m and semi-disturbed lowland forest near seepages (LIEFTINCK, 1954; ORR, 2005) and lowland forests in Thailand (HÄMÄLÄINEN & PINRATANA, 1999). *L. cleis* is reported from mixed dipterocarp forest understorey from 0-1000 m in Peninsular Malaysia (ORR, 2005) and pristine dipterocarp forest to 1000 m in Borneo (ORR, 2003). *L. elegantissima* is reported in or near woodland areas in Hong Kong, where it occurs in marshes, pools in forests and sluggish stretches of forested streams (WILSON, 1995). *L. tricolor* and *L. bivittata* are reported from heavy jungle near marshes in India (FRASER, 1936). *L. pachygastra* seems to prefer more open habitats as it has been reported from paddy fields, open marshland, and settled among reeds beside a river on the borders of fairly open jungle in Japan (FRASER, 1936).

BEHAVIOUR. — Females observed sitting on vegetation beside a forest path at a height of 2-1/2 to 3 feet from the ground; males observed nearby perched on bare branches about ten feet above ground; one male seen perching twenty feet above ground.

DISCUSSION

The genus *Lyriothemis* is widespread across Asia. It belongs to the lineage that includes the genera *Micromacromia* and *Neodythemis*, which are Afrotropical in distribution, and *Amphithemis*, *Hypothemis*, *Orchithemis*, and *Hylaeothemis*, which are Australasian in distribution (DIJKSTRA & VICK, 2006).

Although the species within the genus *Lyriothemis* appear heterogeneous, RIS (1909) divided the species into four groups based on wing characters and secondary genitalia. His groupings are described below.

— **Group 1:** *L. eurydice*, *L. meyeri* (RIS, 1909) and *L. hirundo* (RIS, 1919). Characterized by narrow wings, a short and blunt anal loop, many cubital nervures in both wings, and elongated hamules that extend horizontally.

— **Group 2:** *L. biappendiculata*. Characterized by broader hindwings, longer anal loop, fewer cubital nervures in the forewing (only 2), and a discoidal field in the forewing that is wide at the wing margin. The hamules are similar to the next group but the anterior lamina is distinct. *L. salva* was determined as being intermediate between *L. eurydice* and *L. biappendiculata* (RIS, 1927) but was not assigned to any group.

– **Group 3:** *L. cleis*, *L. magnificentata* and *L. bivittata*. Characterized by broad hindwings, a well-developed anal loop, recurved main veins (R3, IR3 R4+5 and MA) and broader, bowl-shaped hamules. The main veins of *L. cleis* are strongly recurved; those of *L. bivittata* and *L. magnificentata* less so. *L. tricolor* was not assigned to a group by Ris (1919) when he described the species, but it fits the characteristics of group 3. *L. latro* was not assigned to a group when it was described by NEEDHAM & GYGER (1937) though they stated that it was related to *L. tricolor*. *L. latro* also fits the characteristics of group 3.

– **Group 4:** *L. elegantissima*, *L. pachygastra* and *L. acigastra*. Described as the Sino-japanese group. Characterized by broad hindwings, a well-developed anal loop, few cubital nervures, main veins not recurved, longer genital lobes, longer more angular hamules with a prominent inner yellow membrane. *L. mortoni* was not assigned to a group by RIS (1919) when he described it but it displays characteristics consistent with those of group 4. *L. defonseikai* fits the characteristics of group 4.

The following is a comparison of *L. defonseikai* to all described congeners:

L. acigastra – Smaller. Male: thorax and abdomen similar in coloring and pattern; anterior lamina of secondary genitalia more pronounced, yellow membrane of the hamules shaped differently. Female: abdomen reddish-yellow. Wings: dark ochreous stigma, black membrane, anal loop shaped differently, nodal index lower (RIS, 1919; FRASER, 1936).

L. biappendiculata – Similar size. Male: thorax brownish with no markings; abdomen bright red; secondary genitalia shaped differently. Female: abdomen brownish. Wings: anal loop shaped differently, some female specimens with brown wing tips (RIS, 1909).

L. bivittata – Larger. Male: abdomen red with some yellow; thorax with two yellow lateral bands; secondary genitalia shaped differently. Female: abdomen red on segments 1-7, black on segments 8-10, segment 8 only slightly dilated. Wings: bases with brownish-black streak in subcostal and cubital spaces, nodal index slightly higher (RAMBUR, 1842; FRASER, 1936)

L. cleis – Larger. Male: abdomen dull red; thorax brown with yellow ante-humeral stripes; hamules square in profile, genital lobe shaped differently. Female: abdomen ochreous or reddish-yellow with black, segment 8 not dilated. Wings: main nervures (R3, IR3 R4+5 and MA) strongly recurved at the posterior margin of the hind wing, anal loop shaped differently (BRAUER, 1868; FRASER, 1936).

L. elegantissima – Slightly larger. Male: thorax and abdomen similar in coloring and pattern except that underside of abdomen has yellow spots; inferior anal appendages yellow; genital lobe and hamules more angular. Female: thorax and abdomen similar in coloring and pattern. Wings: wing characters similar except that wings are clear (SELYS, 1883; WILSON, 1995).

L. eurydice – Similar size. Male: abdomen red with black on segment 1, black

and yellow on segment 2 and extensive black on segments 6 to 10; hamules shaped differently. Female: abdomen brownish with vague yellow markings. Wings: anal loop shaped differently, discoidal field of forewing starts with 2 rows of cells (RIS, 1909).

L. hirundo – Larger. Male: thorax with bright yellow markings that form a horizontal line; abdomen black on segments 8-10. Female: thorax with bright yellow markings that form a horizontal line; abdomen red with black, segments 8 to 10 entirely black, segment 8 strongly dilated. Wings: anal loop shorter, wing tips dark (RIS, 1913, 1919; LIEFTINCK, 1933).

L. latro – Larger. Male: thorax with broader lateral markings; abdomen with less black; superior anal appendages brownish, shaped differently and with four or five denticles at the tip; inferior anal appendages yellow with a pair of black denticles; hamules shaped differently. Female: not yet described. Wings: somewhat similar but main veins strongly recurved and discoidal field of forewing consists of 3 or more rows throughout its length (NEEDHAM & GYGER, 1937).

L. magnificata – Larger. Male: thorax brown with no antehumeral stripes; abdomen red; genital lobe pointed, hamules triangular in profile. Female: abdomen brownish. Wings: anal loop longer, nodal index lower; female hind wing broader (SELYS, 1878; RIS, 1909).

L. meyeri – Smaller. Male: antehumeral stripes oval shaped; abdomen with less black; hamules shaped differently, genital lobe undeveloped. Female: abdomen colored black-brown with whitish markings on segments 1-7 and deep black on segments 8 to 10. Wings: anal loop shaped differently, discoidal field in the forewing is 2 rows of cells for most of its length (SELYS, 1878; RIS, 1909, 1913, 1919).

L. mortoni – Smaller. Male: abdomen black with yellow markings, basal segments pruinosed; hamules longer, genital lobe more angular. Female: similar pattern and coloring but yellow on abdomen more extensive, extending to segments 9 and 10. Wings: anal loop shaped differently, FW discoidal field starts with 2 rows of cells and continues with 2 for most of its length, nodal index lower (RIS, 1919; FRASER, 1936; ASAHINA, 1988).

L. pachygastra – Similar size. Male: abdomen blue with some yellow; genital lobe longer and more slender. Female: similar pattern and coloring but yellow is more extensive, extending to segments 9 and 10; shape of abdomen less cylindrical. Wings: hind wing broader, nodal index lower (SELYS, 1878; RIS, 1909).

L. salva – Similar size. Male: antehumeral stripe more oval; yellow on sides of thorax more diffuse; abdomen with less black; anterior lamina larger and shaped differently, hamules shaped differently, genital lobes smaller. Female: undescribed. Wings: nodal index lower, fewer CUQ (RIS, 1927).

L. tricolor – Larger. Male: thorax with two broad yellow stripes and antehumeral stripe; abdominal markings somewhat similar but with less black; genital lobe angulated, hamules more rounded. Female: abdomen red and yellow, segment

8 only slightly dilated. Wings: anal loop longer, discoidal field of the forewing 3 rows of cells wide along the whole length (RIS, 1919; FRASER, 1936)

L. defonsekai shows affinity to both *L. acigastra* and *L. elegantissima*. The color and patterning of the abdomen and thorax of the male of *L. defonsekai* resembles that of the male *L. acigastra*; the females of the two species are less similar. The anal appendages and the secondary genitalia of the males are similar but the anterior lamina of *L. acigastra* is more pronounced. The wings of both species show a similar configuration for the discoidal field in the forewing but other wing characters are less similar: the wings of *L. acigastra* have fewer cells overall, the nodal index is lower and the anal loop is shorter. *L. defonsekai* resembles *L. elegantissima* in color and patterning of the abdomen and thorax for both sexes. The configuration of the wings (density of cells, nodal index and configuration of the anal loop) is also similar in both species. However, the secondary genitalia are dissimilar in the configuration of the anterior lamina, the hamules and the genital lobe.

In summary, the color and patterning of the abdomen and thorax of the male of *L. defonsekai* is morphologically similar to the males of *L. acigastra* and *L. elegantissima*. The color and patterning of the abdomen and thorax of the female of *L. defonsekai* is morphologically similar to the female of *L. elegantissima*. The secondary genitalia are more similar to *L. acigastra* but the wings are more similar to *L. elegantissima*.

The evolutionary relationship of *L. defonsekai* to its proximate congener is uncertain and it is not known how or when a representative of the genus *Lyriothemis* colonized Sri Lanka. It appears that the distributions of *L. defonsekai* in SW Sri Lanka and *L. acigastra* in NE India are so far apart that there could be no relationship between them. However, it is well known that some closely related taxa that inhabit the different wet zones of the Indian subcontinent exhibit such disjunct distributions. For example, insects of the family Blephariceridae show such a disjunct distribution. They are found in the wet zones of NE India, SW India and Sri Lanka but nowhere else in the subcontinent (SINGH, 1974). It appears more difficult to explain an evolutionary relationship between *L. defonsekai* and *L. elegantissima* because the latter has a more northern and eastern distribution. A study of the molecular phylogeny of the genus would be helpful in elucidating the relationship of *L. defonsekai* to *L. elegantissima* and *L. acigastra*.

There are three hypotheses that might explain how *Lyriothemis* colonized Sri Lanka. It has been postulated that odonate species that are centred in the Asian or Australian regions can colonize new areas to the west. Colonization may take place by active flight dispersal using the winds that blow from east to west for part of the year (DIJKSTRA, 2007). LAIDLAW (1951) proposed two other possibilities that related specifically to the colonization of Sri Lanka and south India by odonates of Malaysian or Indochinese stock: 1. passive dispersal by the winds that blow from the north-east from November to May and; 2. active movement around the Bay of Bengal and along the Indian coast during Pleistocene times

when Sri Lanka was physically connected to peninsular India and when the sub-continent may have been more extensively covered by rain forests. It is unlikely that the genus originated in Sri Lanka and spread eastward because the genus reaches its greatest diversity far to the east of Sri Lanka.

It is interesting to note that in his account on the zoogeography of the odonate fauna of Sri Lanka, LAIDLAW (1924, 1951) noted that some genera of the Libellulidae that are otherwise widely distributed in the Oriental region are not represented in Sri Lanka. He singled out the genus *Lyriothemis* as one example. Although Sri Lanka is geographically and zoogeographically considered part of the Indian subcontinent, it is quite distinct from the Western Ghats and S India with which it is often grouped. Of the 117 species of odonates reported from the island (DE FONSEKA, 2000; BEDJANIĆ et al., 2007), 46 species are considered endemic at the species level, while 7 are considered endemic at the sub-species level. This is an exceptionally high level of endemism that matches that of Borneo and Sulawesi (KALKMAN et al., 2008). Although a taxonomic revision of some species is necessary, there are additional endemic species in the process of description. This new species further adds to the distinctive character of the odonate fauna of the island.

AMENDMENT OF EXISTING KEYS

The key in FRASER (1936) includes the 5 species that were known from India, Sri Lanka and Burma (*L. acigastra*, *L. bivittata*, *L. cleis*, *L. mortoni* and *L. tricolor*). Note, however, that the specimen from Burma, which was identified as *L. cleis*, was misidentified; it was actually *L. tricolor* (RIS, 1919). The key is modified as follows:

Couplet 3 - modify the second set (add the text that is underlined) to:

No black streaks at base of wings; discoidal field beginning with 2 or 3 rows 4*

Couplet 4* add another set:

Medium sized species with abdomen about 26 mm in length; two converging antehumeral stripes on dorsum of thorax, broad all along; sides with yellow stripes and spots *defonsekai*

In addition, the key should be properly titled as a “Key to the males of the Indian species of *Lyriothemis*”.

* Fraser states in the description that the discoidal field of *L. tricolor* starts with 2 or 3 rows of cells which is confirmed in the specimens examined.

The key in RIS (1909) included the 9 species known at the time and is modified as follows from $\beta\beta^*$:

B. Larger species

bb. Almost always only 1 cubital nervure in forewing.

$\beta\beta'$. Bases of wings only slightly yellowish.

$\beta\beta^*$ Hindwing with anal loop shaped similar to *bivittata* but the loop is a bit shorter at the end. Arc situated variably, usually at antenodal 2 or 2-3, only exceptionally 1-2.

Male abdomen scarlet with wide black dorsal lines. = ~~L.~~ *elegantissima*

$\beta\beta^{**}$ FW discoidal field with at least 3 rows of cells all along; inferior anal appendage yellow = *L. elegantissima*

$\beta\beta^{***}$ FW discoidal field with at least 1 row of 2 cells; inferior anal appendage black = *L. defonsekai*

A complete determination key to all species of *Lyriothemis* is in preparation.

ACKNOWLEDGEMENTS

MATJAŽ BEDJANIČ for advice, references and a critical review of the manuscript. MATTI HÄMÄLÄINEN for help with references, a critical review of the manuscript and other advice and information, particularly the distributions of the members of the genus. VINCENT KALKMAN for advice, references, and help with translations. J. VAN TOL. ELENA MALIKOVA and OLEG KOSTERIN for information about Russian species. DINARZARDE RAHEEM for help in obtaining reference materials. DAVID GOODGER of the Natural History Museum, London, England for help with specimens. CAROLINE PEPERMANS for loan of specimens from the National Museum of Natural History, Leiden, The Netherlands. G.E. ROTHERAY and RICHARD LYSZKOWSKI from the National Museum of Scotland, Edinburgh for photographs of the type specimen of *L. mortoni*. K.D.P. WILSON for information. GUNTHER THEISCHINGER for help with translations. KAREN CONNIFF for a critical review of the manuscript. GEORGE VAN DER POORTEN for photography, illustrations and a critical review of the manuscript.

REFERENCES

- ASAHINA, S., 1988. A list of the Odonata from Thailand, 19: Libellulidae-1. *Tombo* 31: 9-26.
- ASAHINA, S., 1990. A list of the Odonata recorded from Thailand, 21: Supplement. *Tombo* 33: 2-20.
- BEDJANIČ, M., K. CONNIFF & G. DE SILVA WIJEYERATNE, 2007. *A photographic guide to the dragonflies of Sri Lanka*. Jetwing Eco Holidays. Colombo.
- BRAUER, F., 1868. Neue und wenig bekannte vom Herrn Doct. Semper gesammelte Odonaten. *Verh. zool.-bot. Ges. Wien* 18: 167-188.
- BRIDGES, C.A., 1994. *Catalogue of the family-group, genus-group and species-group names of the Odonata of the world*. 3rd edn., Bridges, Urbana, Illinois.
- BUI HUU, M., 2007. *Danh lục bang hình ảnh các loài chuồn chuồn Phú Quốc, Odonata*. Wildlife At Risk, Ho Chi Minh. – [Available also on internet at <http://www.wildlifeatrisk.org/UserFiles/Publication/PQ-Dragonfly-book-20072.pdf>].
- DE FONSEKA, T., 2000. *The dragonflies of Sri Lanka*. Wildlife Heritage Trust, Colombo.
- DIJKSTRA, K-D. B., 2007. Gone with the wind: westward dispersal across the Indian Ocean and island speciation in *Hemicordulia* dragonflies (Odonata: Corduliidae). *Zootaxa* 1438: 27-48.
- DIJKSTRA, K-D.B. & G.S. VICK, 2006. Inflation by venation and the bankruptcy of traditional

- genera: the case of Neodythemis and Micromacromia, with keys to the continental African species and the description of two new Neodythemis species from the Albertine Rift (Odonata: Libellulidae). *Int. J. Odonatol.* 9(1): 51-70.
- FRASER, F.C., 1936. *The fauna of British India including Ceylon and Burma: Odonata*, Vol. 3. Francis & Taylor, London.
- HÄMÄLÄINEN, M. & A. PINRATANA, 1999. *Atlas of the dragonflies of Thailand: distribution maps by provinces*. Brothers of St. Gabriel in Thailand, Bangkok.
- KALKMAN, V.J., V. CLAUSNITZER, K.-D.B. DIJKSTRA, A.G. ORR, D.R. PAULSON, J. VAN TOL, 2008. Global diversity of dragonflies (Odonata) in freshwater. *Hydrobiologia* 595: 351-363.
- LAIDLAW, F.F., 1924. A catalogue of the dragonflies (Odonata) recorded from Ceylon, based on material collected by Mr. E.E. Green, with description of a new species. *Spolia zeylan.* 12(47/48): 335-374.
- LAIDLAW, F.F., 1951. A note on the derivation of the Odonate fauna of the island of Ceylon. *Ent. News* 62: 77-83.
- LIEFTINCK, M.A., 1933. The dragonflies (Odonata) of New Guinea and neighbouring islands, 2: Descriptions of a new genus and species of Platycneminae (Agrionidae) and of new Libellulidae. *Nova Guinea (Zool.)* 17: 119-184.
- LIEFTINCK, M.A., 1954. Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malaya Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. *Treubia* 22 (Suppl): xiii + 202 pp.
- LIEFTINCK, M.A., J.C. LIEN & T.C. MAA, 1984. *Catalogue of Taiwanese dragonflies (Insecta: Odonata)*. Asian Ecol. Soc., Taichung, Taiwan.
- MARTIN, R., 1904. Liste des névroptères de l'Indo-Chine. *Mission Pavie Indo-Chine* 3: 204-221.
- MITRA, T.R., 2002. Geographical distribution of Odonata (Insecta) of eastern India. *Mem. zool. Surv. India* 19(1): 1-208.
- NEEDHAM, J.G. & M.K. GYGER, 1937. The Odonata of the Philippines. *Philip. J. Sci.* 63(1): 21-101, pls 1-10 excl.
- ORR, A.G., 2003. *A guide to the dragonflies of Borneo: their identification and biology*. Nat. Hist. Pubs (Borneo), Kota Kinabalu, Malaysia.
- ORR, A.G., 2005. *Dragonflies of Peninsular Malaysia and Singapore*. Nat. Hist. Pubs (Borneo), Kota Kinabalu, Malaysia.
- RAMBUR, P., 1842. *Histoire naturelle des insectes. Névroptères*. Roret, Paris.
- RIS, F., 1909. Libellulinen monographisch bearbeitet. *Collns zool. Edm Selys Longchamps* 9: 1-120, pl. 1 excl.
- RIS, F., 1913. Die Odonata von Dr. H.A. Lorentz' Expedition nach Südwest-Neu-Guinea 1909 und einige Odonata von Waigöu. *Nova Guinea* 9(3): 471-512.
- RIS, F., 1919. Libellulinen monographisch bearbeitet. *Collns zool. Edm Selys Longchamps* 16(2): 1043-1278.
- RIS, F., 1927. Odonaten von Sumatra, gesammelt von Edward Jacobson. *Zool. Meded., Leiden* 10(1): 1-49.
- SELYS LONGCHAMPS, E. de, 1878. Odonates de la région de la Nouvelle Guinée. *Mitt. zool. Mus. Dresden* 3: 289-323.
- SELYS LONGCHAMPS, E. de, 1883. Les odonates du Japon. *Annls Soc. ent. Belg.* 27: 82-143.
- SINGH, S., 1974. Some aspects of the ecology and geography of Diptera. In: M.S. Mani, [Ed.], *Ecology and biogeography of India*, pp. 500-516, Junk, The Hague.
- TSUDA, S., 2000. *Distributional list of World Odonata*. Tsuda, Osaka.
- WILSON, K.D.P., 1995. *Hong Kong dragonflies*. Urban Council of Hong Kong.