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**THE *APICALE* SPECIES GROUP OF *ACANTHAGRION*,
WITH DESCRIPTION OF FOUR NEW SPECIES
AND A HOOK-MOVING APPARATUS
(ZYGOPTERA: COENAGRIONIDAE)**

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The 8 spp. of the group are studied and keyed. The lectotype of *A. apicale* is designated, redescribed and illustrated. From Brazil, *A. chicomendesi*, sp. n. (holotype ♂: Mato Grosso), *A. flaviae*, sp. n. (holotype ♂: Amazonas), *A. kaori* sp. n. (holotype ♂: Amazonas) and *A. triangulare* sp. n. (holotype ♂: Acre) are described. *A. apicale descendens* Fraser, 1946 is revalidated as species. A study of the penis lobes was performed, demonstrating that the median lobe is inflatable and mainly responsible for the lateral movement of the sclerotized hook, whose importance in copulation is discussed.

INTRODUCTION

LEONARD (1977) defined nine groups for the genus *Acanthagrion* based mainly on the structure of penis, appendages, and abdominal segment 10. The species of the *ablutum* group, however, have been transferred to *Oxyagrion* (VON ELLENRIEDER & LOZANO, 2008). Out of the remaining eight groups, the most well-defined is *apicale*. The species of this group can be readily identified by a pair of horns on the apex of male abdominal segment 10, penis with a main lateral lobe and middorsal carina separating mesepisternal fossae in female forming a broad-capped tubercle. In most species the ground color is orange and the penis has a pair of heavily sclerotized hooks at its distolateral part. A preliminary study of the penis of species of this group in my collection revealed that the number of species was greater than the three species known for the group. These results showed the importance of studying the lectotype (here designated) of *A. apicale* Selys, 1876 before describing new species in the group. Thanks to the kind help

of Prof. Janira M. Costa I had access to a syntype of *A. apicale*, which was in Museu Nacional Rio de Janeiro, borrowed by the late Professor Newton Dias dos Santos. The study of the penis of this specimen showed that the species described by LEONARD (1977) as *A. apicale* is actually a new species and that *A. apicale descendens* Fraser 1946, regarded by GARRISON (1991) and VON ELLENRIEDER & GARRISON (2007) as a junior synonym of *A. apicale* is a good species. It also allowed the discovery of 4 new species, thus increasing the number of *Acanthagrion* species from 40 (VON ELLENRIEDER & LOZANO, 2008) to 44, out of which 26 belong in the Brazilian fauna. According to this study the number of named species in the *apicale* group is 8 which make it the most speciose group of *Acanthagrion*. The shape of the penis provides the most important taxonomic character in *Acanthagrion* (LEONARD, 1977) and it is very complex in the species of the *apicale* group. In view of this, before the taxonomic treatment of the species, I provide a morphological study of penes lobes and have created a special nomenclature for them. During this study it was possible to verify that a group of penis structures, including three lobes are involved in moving the hook laterally and constitutes a hook-moving apparatus that is described herein.

MATERIAL AND METHODS

The four new species of *Acanthagrion* belonging to the *apicale* species group came from different areas of the Amazon region of Brazil, Peru, Ecuador and Venezuela. The lectotype of *A. apicale* has been returned to Selys-Longchamps collection in the Institut Royal des Sciences Naturelles de Belgique at Brussels. The holotype of *A. justini* sp. n. will be deposited in Museu Nacional, Rio de Janeiro the remainder holotypes specimens, at present in the A.B.M. Machado collection, will be transferred to the collection of Department of Zoology, ICB, UFMG. The penes were studied and drawn when dried and, except for *A. triangulare*, after relaxation by rapid treatment with 10% KOH followed by water, a procedure that causes the median lobe and the membranous systems of segments 1 and 2 to inflate becoming considerably larger. All measurements are given in mm. The map represents distribution records from the material studied and reliable literature records. General penis nomenclature follows KENNEDY (1916). A special nomenclature was created for penis lobes in the *apicale* group. For SEM study four penes of *A. chicomendesi* and one of *A. kaori* were removed and mounted on aluminum stubs, sputtered with gold and examined in a Quanta 200 – FE6, SEM.

Abbreviations are as follows: FW: forewing; HW: hindwing; Px: postnodal crossvein; S1-S10: abdominal segments 1 to 10, PL: principal lateral lobes, ML: median lobes, TL: triangular lateral lobes, DL: distal lateral lobes, XL: proximal lateral lobes, AL: apicolateral lobes, PC: penis cords, TP: triangular plate.

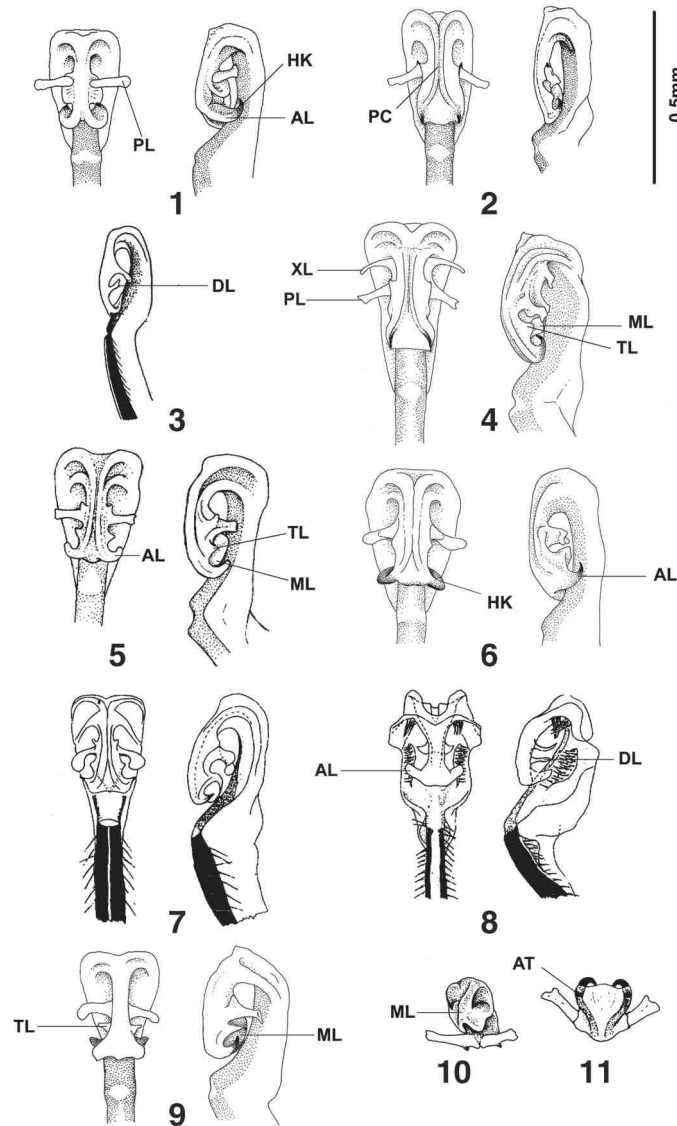
Collection acronyms used in the text are:

- ABMM Angelo B. M. Machado collection, Belo Horizonte, Minas Gerais, Brazil;
- BMNH British Museum of Natural History, London, England;
- DZUFMG Departamento de Zoologia, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil;
- FAAL Frederico A. A. Lencioni collection, Jacareí, São Paulo, Brazil;
- INPA Instituto Nacional de Pesquisas da Amazônia;
- IRSN Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgique;
- MNRJ Museu Nacional, Rio de Janeiro, Brazil;
- UMMZ University of Michigan Museum of Zoology, Ann Arbor, MI, USA.

THE PENIS LOBES OF THE APICALE SPECIES GROUP
OF *ACANTHAGRION*

Except for the presence of patches of setae in the 2nd segment of *A. phallicorne*, all taxonomically important structures of the penis in the *apicale* group are on the 3rd segment, as usual for Zygoptera. According to the shape and position, I distinguish six types of lobes on this segment as follows:

- Principal lateral lobe (PL). – Situated at about mid-length between flexure and apex (Figs 1, 4), the PL is the longest lobe of the penis and occurs in all the species of the *apicale* group. It is shaped as a cylinder with a longitudinal cleft ventrally (Fig. 49) and in *A. chicomendesi*, *A. flaviae* and *A. obsoletum* it has a posteriorly directed spine at base (Figs 2, 4, 5, 7, 13, 14, 16, 49). The PL has a connection with the triangular lobe via a tapering membranous band that ends at base of the spine (Fig. 48).
- Triangular lateral lobe (TL). – Situated between the PL and the apex (Figs 4, 5, 9), this is a triangular-shaped lobe present in all species of the *apicale* group, except in *A. descendens* and *A. phallicorne*. It is connected to the median lobe by a bridge (Figs 48, 51).
- Distal lateral lobe (DL). – Situated between PL and the apex, this elongated lobe occurs only in *A. descendens* Fraser, 1946 (Fig. 3) and *A. phallicorne* Leonard, 1977 (Fig. 8). In *A. descendens* it has been named by FRASER (1943) as a “lateral flagellum”. It is homologous to the triangular lateral lobe of the other species of the group.
- Proximal lateral lobe (XL). – Situated at about mid length between PL and the flexure, this lobe occurs only in the penis of *A. flaviae*. It is long and extends beyond the lateral borders of penis segment 2 (Figs 4, 20).
- Apicolateral lobe (AL) and the hook. – This lobe is situated at the apicolateral part of penis segment 3 (Figs 1, 5, 6, 8, 12, 21) and occurs in all species of the *apicale* group. It has a proximal membranous part and a distal, sclerotized part that forms the hook (Figs 1, 2, 4, 6, 7, 9). Except at the apex the hook is not a completely sclerotized structure, it has a membranous core limited by sclerotized borders that meet at the apex. In the dried (deflated) penis the hook is visible in its full extension only in lateral view (Figs 1, 2, 4, 6, 7, 9). In the KOH treated penis (inflated) it is also visible in ectal (Figs 12, 13, 16, 17) or ectolateral (Figs 18-21) views. In *A. descendens* and *A. phallicorne*, in which there is no sclerotized hook, the apicolateral lobe is membranous (Figs 3, 8). In *A. obsoletum* the degree of sclerotization of the apicolateral lobe varies between a merely sclerotized line visible only in the inflated penis (Fig. 15) and a heavily sclerotized hook (Fig. 7). In all species the apicolateral lobe is short but in *A. apicale*, in which it corresponds to the bifurcation branch, it is long (Figs 1, 18).
- Median lobe (ML). – All the lobes so far mentioned are paired, but there



Figs 1-11. Penes in lateral and ectal views: (1) *A. apicale*, lectotype; – (2) *A. chicomendesi*, paratype; – (3) *A. descendens*, holotype [from FRASER, 1946]; – (4) *A. flaviae*, holotype; – (5) *A. obsoleteum*, Ecuador; – (6) *A. kaori*, holotype; – (7) *A. obsoleteum*, holotype [from LEONARD, 1977]; – (8) *A. phallicorne*, holotype [from LEONARD, 1977]; – (9) *A. triangulare*, holotype; – (10) inner view of distal penis segment showing the median lobe and main lateral lobes in *A. chicomendesi* paratype; – (11) anteroventral view of penis segment 3 showing the articulation of penis cord with the hook base. – [AL: apicolateral lobe; AT: articulation; DL: distal lateral lobe; PL: main lateral lobe; ML: median lobe; XL: proximal lateral lobe; TP: triangular lateral lobe].

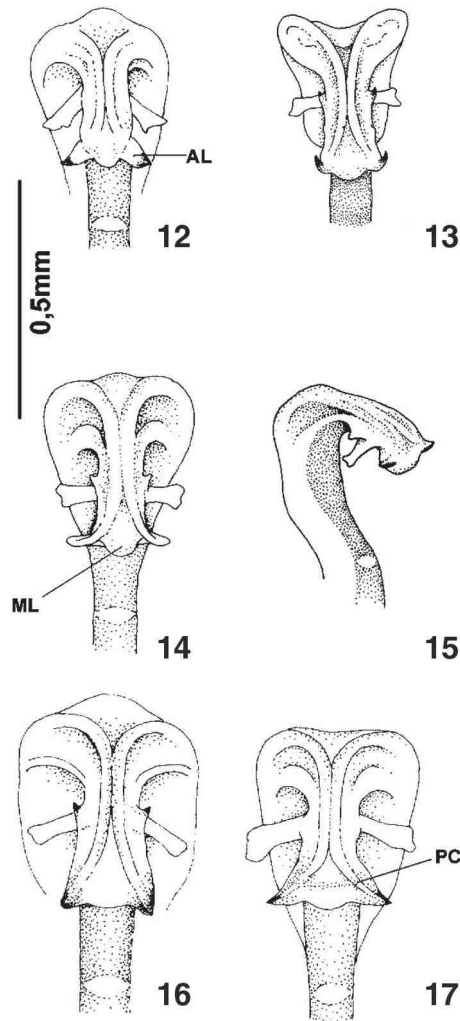
is also a single median lobe that lies within the roof of the distal portion of penis segment 3 and is visible in lateral view (Figs 4-5, 9, 47-48) between ML and the apical hook medially to the triangular lobes (Fig. 47). It occurs in all species of the group except in *A. descendens* (Fig. 3). In *A. phallicorne*, however, according to Garrison (in litt), it is reduced to a narrow fingerlike projection and therefore morphologically and most probably functionally much different from the ML here described in other species. It is hollow (Fig. 50) and in contrast with the neighboring structures ML is flexible and not sclerotized. Because of this flexibility its size diminishes when it is compressed against segment 2 as demonstrated by comparison of Figure 47 (normal) with 48 (compressed) whereas the triangular lobe maintained its size showing that it is much harder than the ML. The lateral parts of the ML are connected at each side by a bridge with the triangular lobes (Figs 48, 51) that being sclerotized, most probably gives mechanical support to it. Unlike the triangular lobe that has a smooth surface in the ML the outer surface has a typical sculpture with flat triangular fine-tipped structures perpendicular to corrugations (Fig. 54) but the inner surface is smooth. At its dorsal surface the ML bears a median longitudinal sulcus (Fig. 51) In lateral view only part of the median lobe is visible. In order to fully examine it is necessary to expose the ental surface of the distal part of penis segment 3. The fully exposed median lobe appears then as a peaked roof (Figs 10, 53) that extends distally forming a large median fold (Figs 10, 53) that ends at the border of the triangular plate (Fig. 53). I name triangular plate the triangular area of penis segment 3 limited by its distal border and by the two longitudinal cords here denominated penis cords (PC) that run along the ventral surface of segment 3, diverging distally (Fig. 52). The ectal surface of the triangular plate (Fig. 52) is smooth. Its ental surface (Fig. 53) has a sculpture similar to that of the median lobe indicating that the wall of the ML covers the inner surface of the triangular plate in the area between the hooks, and becomes attached to the border of the plate (Fig. 53). The median lobe occurs in all species of the *apicale* group except *A. descendens* (Fig. 3). In *A. phallicorne* it is reduced to a narrow digitiform process (Garrison, in litt). Although present in the penis illustrations of *A. apicale*, *A. obsoletum* (LEONARD, 1977) and *A. hartei* (MUZON & LOZANO, 2005), the only reference to the ML is that of KENNEDY (1916) who called it "median globular swelling" and in whose illustration it is possible to see the bridge connecting the ML to the triangular lobe.

THE HOOK-MOVING APPARATUS

The above described morphology refers to the ML in dried penes. In penes relaxed by rapid treatment with KOH followed by water, this morphology changes completely. The ML very rapidly inflates and becomes a bag that bulges between

the apicolateral lobes and their hooks (Figs 18-21). This phenomenon occurs even after the penis segment 3 is cut transversely at level just proximal to PL. This fact demonstrates that ML inflation is self-sustained, does not depend on liquid arriving from other penis areas but only on the surrounding water that gets in it.

In some specimens it was possible to see under the stereomicroscope small bubbles of air wandering in the liquid inside the inflated lobe most probably remnants of the air that existed in the dry lobe. Since the ML is at each side connected with an apicolateral lobe (Figs 20, 21) liquid flows from it into the apicolateral lobe (Fig. 21) that inflates and causes the lobe and the hook to move laterally by hydrostatic pressure, assuming the positions and shapes shown in Figures 12-13, 16-21. According to CORBET (2004) the shape and movements of penis in Zygoptera are controlled by muscles and occasionally (e.g. *Ischnura*) by hydrostatic pressure. Inflation of the ML and the movement lateralwards of the hook are new examples of hydrostatic pressure action in the penis of Zygoptera. Since a long time (BORROR, 1942) KOH has been used to prepare the penis of Anisoptera (mainly libellulids) for taxonomic studies and it allows separation of inflatable from noninflatable lobes. In Zygoptera, however, inflatable areas are rarer than in Anisoptera and usually of less extent (MILLER, 1987). Assuming that the morphology of the penis obtained by the above procedures simulates the morphology during copulation, it is very likely that the ML of most *Acanthagrion* of the *apicale* group inflates during copulation by an hydrostatic mecha-

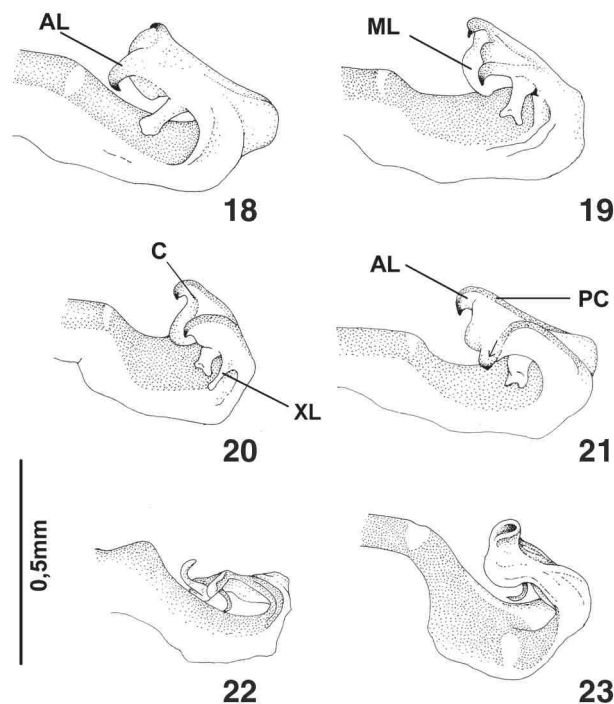


Figs 12-17. Penes inflated in ectal view: (12) *A. apicale*, Manaus; – (13) *A. chicomendesi*, paratype; – (14) *A. obsoletum*; Ecuador; – (16) *A. flaviae*, holotype; – (17) *A. kaori*, paratype. – (15) Penis in oblique ventral view, *A. obsoletum*, Ecuador. – [AL: apicolateral lobe; ML: median lobe; PC: penis cord].

nism similar to that demonstrated by MILLER (1987) for the penis membranes of *I. elegans* (Vander Linden, 1820) during copulation. In this species there is a glandular sac whose cells secrete a liquid into its internal cavity that is conveyed to the membrane system of penis segments 1, 2, thereby causing their inflation. The same probably occurs in the ML of *Acanthagrion* but this hypothesis should be proved with histological techniques that might demonstrate the presence of liquid-secreting cells on the internal surface of ML. Inflation of ML induced by KOH is a very rapid phenomenon but inflation under natural conditions certainly takes a much longer time. In *Ischnura elegans* inflation is completed only 15-20 minutes after the beginning of copulation (MILLER, 1987). Comparison in lateral view of deflated (Figs 1-2, 4-7) and inflated (Figs 18-21) ML shows that the difference in size is enormous. The main cause of this enlargement is the straightening out by hydrostatic pressure of the median fold of the deflated ML (Fig. 53) and release of that part of ML attached to triangular plate, a process that could be observed under the stereomicroscope. It is also probable that the median sulcus (MS) of the ML (Fig. 51) might straighten out during lobe inflation. As already shown, the ML is anchored, at each side, to the triangular lobe by a bridge (Figs 48, 51). By the position of the triangular lobes and their bridges and being this lobe, as already demonstrated, a hard structure we can infer that they prevent the inflating ML to dislocate proximally, a fact that would hamper its function of moving the hook. Another penis structure involved in the hook movement is a pair of longitudinal cords (penis cords - PC) that runs parallel on the ectal surface of the penis (Fig. 2), and divaricates distally, each branch directing toward a hook (Figs. 2, 4, 6-7, 12-13, 16-21). In *A. phallicorne* and presumably also in *A. descendens*, that has no hook only the straight parallel part of the cords are present (Fig. 8). In the inflated ML, a situation in which the hook is extended, it seems that the penis cord is continuous with it the hook (Figs 20-21). However, observation at high magnification of dry penes in which the hook is flexed shows that there is a gap between them that forms an articulation, the hook articulation (AT - Fig. 11). It is a symmetrical articulation (STEINMAN & ZOMBORI, 1985) in which the movable component is the hook and the fixed component, the penis cord whose tip is heavily sclerotized (Fig. 11). Thus the penis cords work as an axis upon which moves the hook and they also prevent its overlateralization. Thus, in the penis of most species of the *apicale* species group the part of segment 3 distal to the PL has a group of structures, all involved in movement of the hook, that I am now naming the hook-moving apparatus. It is composed by the median, triangular and apicolateral lobes, the triangular plate, the penis cords and the hook articulation. In *A. phallicorne* and *A. descendens* in which there is no sclerotized hook the main components of the hook-moving apparatus are lacking i.e. the triangular lobe, the median lobe (much reduced in *A. phallicorne*) the nonparallel parts of penis cords and the hook articulation. Checking on the published penis figures of *Acanthagrion*, mainly those of LEONARD (1977), and in specimens

of my collection no structure could be found fitting the morphological concept of triangular and median lobes. As to the penis cords they were either absent or represented only by the parallel components, except in *A. quadratum* Selys, 1876 in which they penetrate into the long divaricated branches of penis apex. These data are consistent with the fact that none of these species have an apical sclerotized hook. The evolutionary investment to evolve a complicated apparatus to move the hook laterally indicates that this lateralization must be very important. The hook is most probably involved in sperm displacement a function that in Zygoptera is performed by a variety of sclerotized structures such as curved hook-or whip-like appendages covered with proximally directed spines, or curved horn-or blade-like appendages or a scoop-like structure with ventrally oriented ridges WAAGE (1984). Whatever the function of the hook of the *apicale* species group of *Acanthagrion* during copulation might be, it is certainly more efficient when it is lateralized than when it is "hidden" in the apicolateral region of penis.

The members of the *abunae* species group of *Acanthagrion* have a sclerotized hook projecting from about mid-length of penis segment 3. In order to verify whether these proximal hooks are moved by inflatable lobes the penis of *A. jessei* Leonard, 1977 was treated with KOH. The hook maintained its position in relation to the penis border indicating that it is not movable, Segment 3 inflated and its distal part became completely different from that of the deflated organ (Figs 22-23). This fact raised the possibility that inflatable areas potentially important for taxonomy might



Figs 18-23. Penes inflated in ventrolateral views: (18) *A. apicale*, Manaus; - (19) *A. chicomendesi*, paratype; - (20) *A. flaviae*, holotype; - (21) *A. kaori*, paratype. - [AL: apicolateral lobe; ML: median lobe; C: connection between AL and ML; XL: proximal lateral lobe]. - (22-23) *A. jessei*, Mt. Grosso: (22) dried; - (23) inflated.

occur in other species of *Acanthagrion*. In order to check this possibility the penes of the following species were treated with KOH: *A. adustum* Williamson, 1916; *A. aepiolum* Tennesen, 2004; *A. eglerti* Santos, 1961; *A. gracile* (Rambur, 1842); *A. indefensum* Williamson, 1916; *A. kennedii* Williamson, 1916; *A. lancea* Selys, 1876; *A. minutum* Leonard, 1977; *A. taxaense* Santos, 1965; *A. tepuiense* De Marmels, 1985. In all these species, as expected, segment 3 separated from segment 2 to a maximum of 45° but there was no significant change in shape or size indicating the absence of inflatable areas. Studies in other species should indicate the frequency of these areas in segment 3 of the penis of *Acanthagrion* and their taxonomic value. Since in all 5 species of the *abunae* group the general morphology of segment 3 is rather similar it is very probable that in all of them this apex is inflatable and potentially important for taxonomy.

It would be very interesting to study the penis of members of the *apicale* group during copulation with the method used by MILLER (1987) in *Ischnura elegans* in which the copulation is interrupted at different times. This would give an idea of the inflation and deflation cycle of penis during copulation, the position of the hook in the female genital organs and would lead to a better understanding of the function of the hook-moving apparatus during copulation.

KEY TO THE MALES OF THE *APICALE* SPECIES GROUP OF *ACANTHAGRION*

- 1 Distal border of penis segment 3 divided in two long curved branches (Fig. 1). No triangular plate. Hooks in inflated penis in a peduncle (Fig. 12) *A. apicale*
- 1' Distal border of penis segment 3 entire, triangular plate present (Figs 2, 4-9, 52). Hooks in inflated penis not in a peduncle (Figs 13, 16, 17) 2
- 2 Penis with a pair of proximal lateral lobes XL (Fig. 4). Dorsum of abdominal segment S8 black *A. flaviae*
- 2' Penis without a pair of proximal lateral lobes. Abdominal segment 8 blue or brown 3
- 3 Penis segment 2 with a dense patch of setae on either side of midline (Fig. 8) *A. phallicorne*
- 3' Penis segment 2 with no patch of setae 4
- 4 Horns of S10 directed posteriorly (Figs 27, 29) *A. obsoletum*
- 4' Horns of S10 directed dorsoposteriorly (Figs 24-26, 28, 31) 6
- 6 Penis with a pair of distal lateral lobes (Fig. 3). No median and triangular lobes (Fig. 3) *A. descendens*
- 6' Penis without distal lateral lobes. Median and triangular lobes well developed (Figs 2, 4-7) 7
- 7 Penis in ectal view (Fig. 9) with area distal to PL subtriangular, segment 3 with a width about half the length of PL, at mid-length. PL distally curved *A. triangulare*
- 7' Penis in ectal view (Figs 2, 6) with area distal to PL subrectangular, segment 3 as wide as the length of PL at mid-length, PL straight 8
- 8 Penis hook largely visible in ectal view its base projected laterally (Fig. 6); in the inflated penis appearing as a fine tipped pyramid-shaped structure (Fig. 17); no spine at base of PL (Figs 6, 17) *A. kaori*
- 8' Penis hooks hardly visible in ectal view, its base not projected laterally (Fig. 2); in the inflated penis not pyramid-shaped (Figs 13). Spine present at base of PL (Figs 2, 13) *A. chicomendesi*

ACANTHAGRION APICALE SELYS 1876

Figures 1, 12, 18, 24, 32, 46, 55

Acanthagrion apicale SELYS 1876: 62 (reprint); KIRBY (1890: 144); CALVERT (1909: 166); KENNEDY (1916: 325); WILLIAMSON (1916: 313); FRASER (1946: 38); KIMMINS (1970: 182); LEONARD (1977: 23); DAVIES & TOBIN (1984: 62); DE MARMELS (1989: 28; 1990: 335); GARRISON (1991: 9); BRIDGES (1994: VII-16); TSUDA (2000: 19); LENCIONI (2006: 55); VON ELLENRIEDER & GARRISON (2007: 10); HECKMAN (2008: 499), GARRISON, VON ELLENRIEDER & LOUTON (2010: 18).

THE TYPES OF *A. APICALE*. — According to KIMMINS (1970), the types of *A. apicale* are three ♂ specimens, one from Pará collected by Bates in Selys collection (IRSB) and two from Pebas in the McLachlan collection (BMNH). As the name *apicale* was a Bates MSS name, he considered the ♂ specimen in Selys collection as lectotype and the specimens in BMNH as paralectotypes. VON ELLENRIEDER & GARRISON (2007), however, found in IRSNB 2 males from “Pará” and a label stating that one specimen had been borrowed by Santos from the Museu Nacional do Rio de Janeiro. The specimen in Museu Nacional was lent to me by Prof. Janira M. Costa and has been studied herein. Kimmins lectotype designation was not valid according to the Code because he did not see the specimens. Therefore the three specimens belonging to Selys collection should be regarded as syntypes. I am now designating as lectotype the syntype borrowed by Santos that is redescribed herein. It has the following original labels: *Agrion apicale* 19. (ink, green label, Selys handwriting). *Apicale* (ink, white label, Selys handwriting), 19 (ink white label) Pará (ink, white label). Bates (ink, green label).

Two additional labels were attached to the specimen: Redescribed by MACHADO 2010 (white label) and lectotype. *Agrion apicale* Selys. Dess. MACHADO, 2010 (red label).

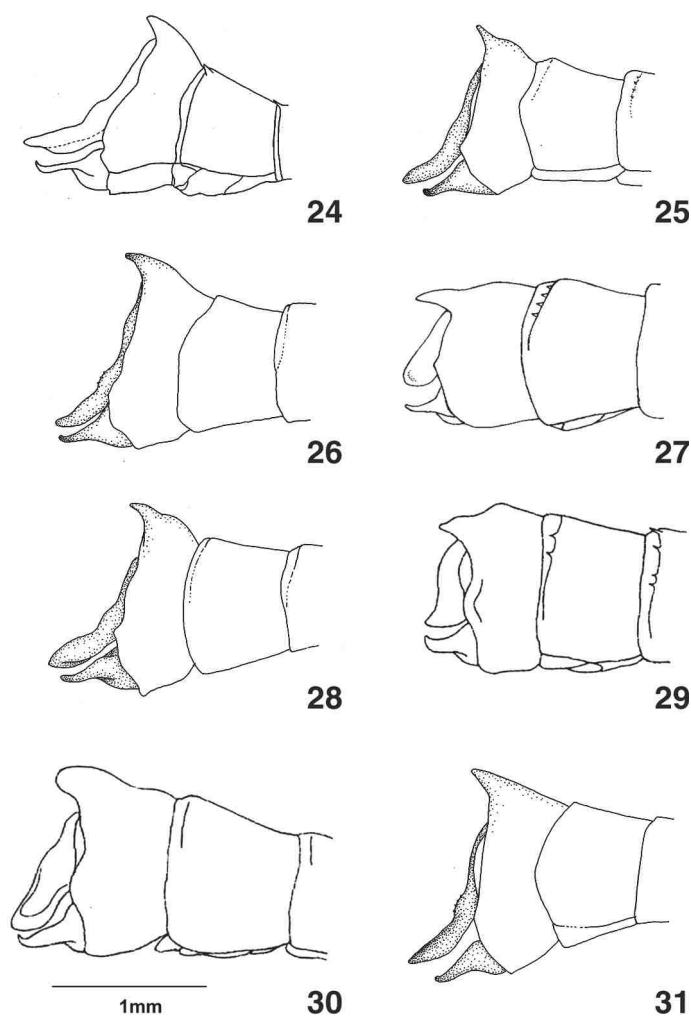
The specimen has been returned to Selys collection. The thorax with one wing and 3 three legs are pinned. The head, abdomen and three wings are in a small envelop pinned under the thorax. The penis was lost after being drawn.

Material. — **Lectotype** ♂, BRAZIL: Pará State (most probably near Belém), Bates leg. (IRSN); 1 ♂, Amazonas state, Manaus (3°08'S, 60°01'W), Road M1 Km 50, 21-XII-1960, Rodrigues leg. (ABMM); — 2 ♂, Pará state, Portel, Igarapé Cacuri, FLONA de Caxiuanã (2°9'S, 51°45'W), 25-VI-2009, L. Juen leg. (FAAL).

REDESCRIPTION. — **MALE (Lectotype).** — **Head.** — Labium orange yellow; labrum orange with a midposterior and posterolateral black markings, genae, base of mandibles and anteclypeus orange yellow, postclypeus orange with a black stripe at the limit with the antefrons continuous with a pair of rectangular spots, and an anteromedial black dot; Antefrons orange brown. Upper part of head black with a small orange spot on each side of medium ocellus and posterior to antennae base. A rounded orange postocular spot. Prothorax missing. Accord-

ing to SELYS (1876), it is black laterally bordered with reddish yellow.

T h o r a x. – Mesostigmal lamina orange, outer 1/9 black. Interlaminal sinus black; dorsum of mesepisternum and antealar ridge black, antealar sinus orange, antehumeral stripe orange occupying about 1/2 of mesepisternum. Humeral stripe black occupying about 2/3 of mesepimeron. Metapleuron yellowish orange with black stripe on metepisternum following 2nd lat-



Figs 24-31. S9-S10 in lateral view: (24) *A. apicale*, lectotype; – (25) *A. chicomendesi*, holotype; – (26) *A. flavae*, holotype; – (27) *A. obsoletum*, Ecuador; – (28) *A. kaori*, holotype; – (29) *A. obsoletum*, holotype [from LEONARD, 1977]; – (30) *A. phallicorne*, holotype [from LEONARD, 1977]; – (31) *A. triangulare*, holotype.

eral suture reaching 1/2 the width of the sclerite at mid-length tapering below up to the level of the metastigma. Wings hyaline pterostigma ferruginous, surmounting 1 or 4/5 of a cell. Px in both wings 12. Petiolation at Ac in both wings. Legs reddish yellow external surface of femorae dark brown.

A b d o m e n. — S1 dorsally black laterally orange yellow, S2 dorsally black laterally yellowish orange. S3-S7 dorsolaterally black, S8 ventrally orange remainder black except for the distal 1/3 that is yellowish orange dorsally. S9 bluish, S10 black. Cercus black with base orange, paraproctus yellowish.

STRUCTURAL CHARACTERS. — Penis with distal border of segment 3 splitted in two long curved branches (apicolateral lobes), each one ending into a sclerotized hook (Fig. 1). Non sclerotized part of the apicolateral lobe about 3X the sclerotized part (Fig. 1). No triangular plate. (Fig. 1) Triangular and median lobes visible in lateral view. Dorsum of S10 in lateral view (Fig. 24) smoothly curved prolonged in a blunt tipped horn directed dorso-posteriorly, in dorsal view as in Figure 32; cercus in lateral view with a convexity at mid-length (Fig. 24). Paraproctus as in Figure 24.

M e a s u r e m e n t s (mm). — Abdomen 27; Hw 17.

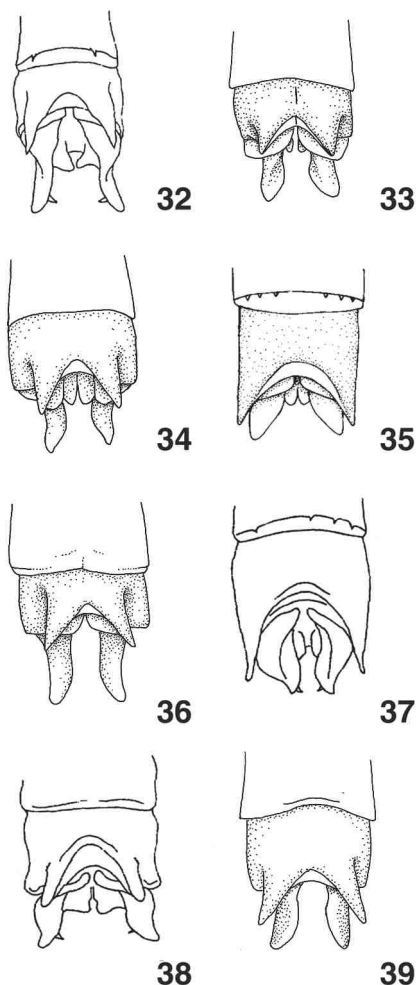
REMARKS. — The above description corresponds well with that of SELYS (1876). The specimens from Manaus and Portel differ from the lectotype by having the penis branches a little shorter than lectotype. When relaxed (Figs 12, 18) their penis show the hook in a peduncle (Fig. 12). By having the apex of penis segment 3 splitted in two long branches *A. apicale* is unique in the genus. The penis of *A. apicale* is much different from that illustrated by LEONARD (1977) as belonging to *A. apicale* from Rio Seco, Peru. The horn of S10, also illustrated now for the first time, is blunt tipped, (Fig. 24) whereas in the species illustrated by LEONARD (1977), it is fine tipped. Thus, the specimen from Peru described by LEONARD (1977) is not *A. apicale* but most probably a new species very close to *A. chicomendesi* sp. n. According to Dr Mark O'Brien (in litt.), curator of the entomological collection of UMMZ where the specimens studied by Leonard are stored, the material from Rio Seco, Peru, could not be found. Indeed by a problem of labels a great number of specimens studied by Leonard cannot be correlated with the specimens in his thesis (O'BRIEN, 2000). The penis illustrated by KENNEDY (1916, figs 3-4), as belonging to *A. apicale* differs from that of this species by having the anterior border entire. These results cast doubt on the geographical distribution of *A. apicale* given by LEONARD (1977) and, for the moment, the only reliable localities of *A. apicale* are that of the lectotype: Pará, (most probably Belém), Portel and Manaus in Pará and Amazonas respectively.

ACANTHAGRION CHICOMENDESI SP. NOV.

Figures 2, 10-11, 13, 19, 25, 33, 40, 46-55

Material. — **Holotype** ♂: BRAZIL: Mato Grosso state, SINOP (55°30'S, 11°51'W), X-1975, M. Alvarenga leg. (ABMM). **Allotype** ♀: Brazil, Amazonas state, Tapurucuara (0°24'S, 65°02'W), 13-VII-1966, Oliveira leg. (ABMM). **Paratypes**: 1 ♂ same data as allotype; — 5 ♂ same data as holotype; — 25 ♂ Mato Grosso state SINOP, X-1976, Braulio & Roppa leg. (MNRJ); — 4 ♂ Juina, Ecological Station of Iquê (12°36'S 59°30'W) 21-IV-2010, A. Nemésio leg. (ABMM); — 2 ♂ Rondonia state, Porto Velho (8°46'S, 63°54'W), 24-V-1922, J.H. Williamson & J.W. Strohm leg. (MNRJ); — 1 ♂ Ariquemes (10°50'S 63°7'W), Fazenda Rancho Grande, 16-14-III-1989, S.W. Dunkle leg. (ABMM); — 1 ♂ Amazonas state, Benjamin Constant (4°22'S, 70°02'W), Parko leg. (MNRJ); — 5 ♂ Barcelos (0°58'S, 62°57'W), 10-VIII-2009, V.G. Neiss leg. (INPA); — 2 ♂ Tefé (3°22'S, 64°42'W), 27-IV-1953, M. Alvarenga leg. (ABMM); — 3 ♂ São Paulo de Olivença (30°27'S, 68°48'W), 5-X-1964, J. Pereira leg. (ABMM); — 1 ♂ Pará state, Fordlandia (3°51'S, 55°28'W), A.B.M. Machado & F.S. Pereira leg. (ABMM); — 1 ♂ Cachimbo (8°57'S, 54°54'W), X-1955, F.S. Pereira leg. (ABMM); — 1 ♂ PERU: Loreto department, Yarinacocha (03°40'S, 72°15'W) 145, 29-V-1972, D.L. Pearson leg. (FAAL); — 1 ♂ Indiana, Amazonas river 60 km from Iquitos, VI-2000, A. Chacon leg. (ABMM); — 1 ♂ San Martin (6°03'S, 77°05'W), 900m, F. Woytkowski leg. (MNRJ); — 2 ♂ ECUADOR: Napo province, west branch of river Ishpinga-Yacu (1°2'S, 77°47'W), 500m, 18-IX-1942, W.C. Macintyre leg. (MNRJ); — VENEZUELA: Departamento Rio Negro; 1 ♂, Neblina Base Camp (Upper Rio Baria), 140 m, (0°49' N 66°09' W), 13/15-III-04, J. De Marmels leg. (ABMM); — 1 ♂ San Carlos de Rio Negro (1°55' N 67°04' W), 4-13-III, 1984, J. De Marmels leg. (ABMM); — 1 ♂ Camp Base, upper Mavaca river (2° 31' N 65° 11' W), 14-II-6-III, 1989, J. De Marmels leg. (ABMM); — 1 ♂ San Simon del Cocuy 21-XI-1982, Chacón leg. (ABMM); — 1 ♂ Departamento Bolivar, Uputa, (8°6' N 61°40' W), 23-VIII-2009, H. Escalona leg. (ABMM). — Total: 63 ♂, 1 ♀.

Etymology. — This is an Amazonian species named in honor of the leader of the rubber tapper from Acre State, *Chicomendes*, who was assassinated while defending the Amazon forest.



Figs 32-39. S9-S10 in dorsal view: (32) *A. apicale*, lectotype; — (33) *A. chicomendesi*, holotype; — (34) *A. flaviae*, holotype; — (35) *A. obsoletum*, Ecuador; — (36) *A. kaori*, holotype; — (37) *A. obsoletum*, holotype [from LEONARD, 1977]; (38) *A. phallicorne*, holotype [from LEONARD, 1977]; — (39) *A. triangulare*, holotype.

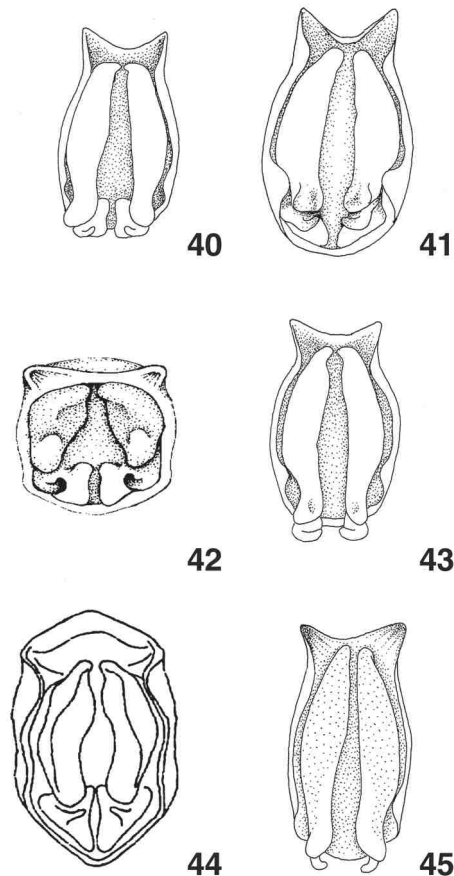
MALE (Holotype). – **H e a d.** – Labium yellow, labrum orange margined with black posteriorly, with a posteromedial oval black spot; genae, base of mandibles and anteclypeus orange, postclypeus black, margined with orange posterolaterally; antefrons dominantly orange, antennae scape orange, upper part of head black with orange postocular spots.

T h o r a x. – Pronotum with anterior lobe dominantly orange, median and hind lobes black, propleuron orange yellow. Mesepisternum black with a large antehumeral orange stripe. Mesepimeron black anteriorly and orange yellow posteriorly; mesepisternum orange yellow with a black stripe adjacent to the 2nd

lateral suture; metepimeron yellowish white with an orange stripe posteriorly. Legs femora laterally black medially yellowish white; tibiae orange yellow except for lateral surface of protibiae which is black, tarsi brownish. Wings hyaline, pterostigma brown surmounting one cell. Px in FW 12, in HW 11, R3 arising near Px 5 in both wings. Petiolation ceasing distal to Ac by a distance 1/2 the length of Ac.

A b d o m e n. – S1-S3 dorsally black, laterally orange yellow, S4-S7 dorsolaterally black, ventrolaterally brownish orange; S8-S9 dorsally grayish blue, ventrally yellowish orange; S10 black, cercus black with distal half of medial surface brown.

STRUCTURAL CHARACTERS. – Penis with median and triangular lobes well developed (Fig. 2). Distal border of segment 3 entire (Figs 2, 13, 52). Principal lateral lobe not dilated distally, having a spine at base (Figs 2, 13, 49). Apicolateral lobe provided with a heavily sclerotized hook visible in lateral view (Fig. 2) and also in ectal view in the inflated penis (Fig. 13). Horns of S10 in lateral view (Fig. 25) straight and directed dorsoposteriorly, in dorsal and posterior views as in Figures 33, 40. Ap-



Figs 40-45. S10 and appendages in posterior view: (40) *A. chicomendesi*, holotype; – (41) *A. flaviae*, holotype; – (42) *A. obsoletum*, Ecuador; (43) *A. kaori*, holotype; – (44) *A. obsoletum*; – (45) *A. triangulare*, holotype.

pendages as in Figures 25, 33, 40.

Measurements (mm). – Abdomen 29.5; Hw 19.1.

VARIATIONS IN PARATYPES. – Postclypeus color variable even within the same locality as follows: totally black (30.6%), dominantly black with a pair of orange stripe or spot (53.7%), dominantly orange with a pair of small black stripe (15.6%). Wings flavescens predominantly in specimens from Juina, Tapurucuara and Barcelos whereas hyaline wings predominated in specimens from Cachimbo and SINOP.

Color of S7 variable as follows: totally black as in the holotype (64%); black with a pale (probably blue in vivo) triangular dorsal spot occupying the proximal 1/8 of S7 (24%); black with a pale tapering dorsal stripe occupying about the proximal 2/5 of S7 (12%).

Penis (n. = 25): spines at base of PL at least 1 (100%) or 2 (16.0%), brown (62.5%) dark brown (25.0%) or black (12.5%). Triangular lobe present (100%), median lobe present (100%); distal border of segment 3 entire (100%). Measurements. HW 17.8-20.1 (mean 18.9), abdomen 28.7-32.8 (mean 30.6)

FEMALE (**Allotype**). – H e a d. – Labium yellow, labrum orange with a posteromedial black spot, genae, base of mandibles, anteclypeus and antefrons orange yellow, postclypeus black with a central transverse yellowish stripe at each side. Upper part of frons black with orange yellow postocular spots.

T h o r a x. – As in the male, except that pale colors are orange yellow. Legs: extensor surfaces of femora dark brown, flexor surfaces orange yellow, tibiae and tarsi yellowish brown. Wings hyaline, pterostigma brown surmounting one cell. Px in FW 11 in HW 10, R3 arising near Px 5 in FW, Px 4 in HW. Petiolation ceasing distal to Ac by distance 1/2 the length of Ac.

A b d o m e n. – S1-S2 dorsally black, laterally greenish yellow; S3-S8 dorsally black laterally, orange yellow gradually becoming yellowish orange on the more distal segments; S9 predominantly black with a large grayish orange area occupying its dorsal and posterolateral aspects; S10 dorsally grayish laterally yellowish orange. Cercus dark brown.

STRUCTURAL CHARACTERS. – Mesepisternal tubercle erect (Fig. 46c) dorsally smooth and polished (Fig. 46a), separated from anterior border of interlaminar sinus by a

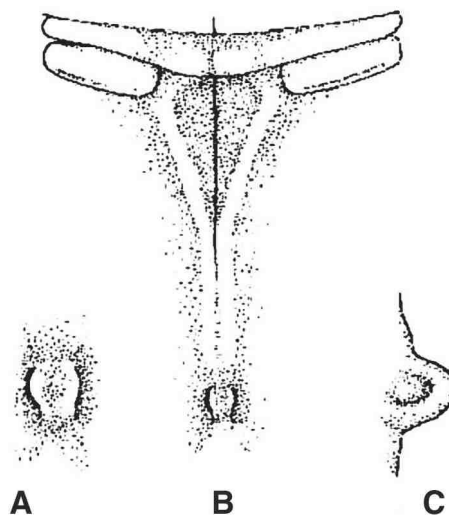


Fig. 46. *A. chicomendesi* allotype ♀, mesepisternal structures in dorsal view.

distance about equal to combined width of sinus and the two mesostigmal laminae (Fig. 46b). Tubercle deeply impressed along middorsal line (Fig. 46c). Posterolateral margins of sinus slightly convex (Fig. 46b).

M e a s u r e m e n t s. — Abdomen 31.3; Hw 19.2.

REMARKS. — *A. chicomendesi* is close to *A. kaori* sp. n. differing by the character given in the key. The mesepisternal structures of the female of *A. chicomendesi* are very different from those of *A. obsoletum* (LEONARD, 1977, fig. 147) and *A. phallicorne* (LEONARD, 1977, fig. 147) but very close to that described and illustrated by LEONARD (1977) as being the allotype (sic) of *A. apicale*. They differ, however, by the shape of the mesepisternal fossae. It is unlikely that the female described by LEONARD (1977) from Belém belongs to the species he called *A. apicale*, from Peru (Rio Seco). As a matter of fact, since the type locality of the true *apicale* is near Belém it is likely that the female he described might well be that of *apicale*. *A. chicomendesi* is the most common species of the *apicale* group and the one with the largest distribution (Fig. 55) and it is very likely that most of the localities registered by LEONARD (1977) for *A. apicale* might well be localities of *A. chicomendesi*.

The study of a fairly large number of specimens showed variations in color confirming LEONARD (1977) who stated that color is of little a taxonomic value in *Acanthagrion*. On the other hand, the study of the penis in 25 specimens of several localities revealed a remarkable uniformity a fact that agrees with LEONARD (1977) who, after studying the penis of several hundreds specimens of *Acanthagrion* including *A. apicale*, found “no detectable variation from normal pattern”.

ACANTHAGRION DESCENDENS FRASER, 1946

Figures 3, 55

Acanthagrion apicale descendens FRASER (1946: 38); KIMMINS (1970: 184); LEONARD (1977: 147); DAVIES & TOBIN (1984: 62); GARRISON (1991: 9); BRIDGES (1994: VIII.1); TSUDA (2000: 9); LENCIONI (2006: 55); VON ELLENRIEDER & GARRISON (2007: 10); HECKMAN (2008: 499).

M a t e r i a l. — None.

DISTRIBUTION. — Perú, Loreto department, Mishuyacu.

REMARKS. — This species was described by FRASER (1943) as a subspecies of *A. apicale* based in a single male from Mishuyacu, deposited in BMNH. The description is adequate and accompanied by a figure of the penis in lateral view and segments S9-S10 in lateral and posterior views. However GARRISON (1991) synonymized *A. apicale descendens* to *A. apicale* and VON ELLENRIEDER & GARRISON (2007), after examining the holotype in BMNH, confirmed this synonymy without any justification. According to FRASER (1943), *A. descendens* differs from *A. apicale* by the ground color blue instead of ochreous and by the shape

of the penis, which has two lateral “flagellae” converging towards one another on each side. Figure 3 shows that what FRASER (1943) called the two lateral flagellae corresponds to the PL and the distal lateral lobe. With regards to the differences in ground color recent studies have shown that in *A. ascendens* and *A. obsoletum* mixed series can be blue or orange Garrison (in litt.). Thus, color is not a reliable character to separate *A. descendens* from *A. apicale*. However there are structural characters of the penis that shows that these two species are different as shown in Table I.

The main difference is the lack of a sclerotized hook in the penis of *A. descendens* and consequently the lack of a hook-movement apparatus, a feature that *A. descendens* shares with *A. phallicorne* that also lacks a sclerotized hook. In view of the above considerations I am now revalidating *Acanthagrion apicale descendens* FRASER, 1946 as a species since there are no zoogeographic data to maintain it as subspecies.

Table I
Differences between *A. apicale* and *A. descendens*

| Character | <i>A. apicale</i> | <i>A. descendens</i> |
|--------------------------|---|---|
| Apical sclerotized hooks | Present (Figs.1, 18) | Absent, replaced by a spatulate-like structure (Fig. 3) |
| Median lobe | Present (Figs 1-18) | Absent (Fig. 3) |
| Triangular lobe | Present (Fig. 1) | Absent (Fig. 3) |
| Distal lateral lobe | Absent (Figs 1, 18) | Present (Fig. 3) |
| Apex of penis segment 3 | Splitted in two long branches (Figs 1-18) | If branched at all with short branches (Fig. 3) |

ACANTHAGRION FLAVIAE SP. NOV.

Figures 4, 20, 26, 34, 41, 55

Material. – **Holotype** ♂, BRAZIL: Amazonas state, Maribo Indian village at the Curuça river (4°75'S, 71°74'W), V-1991, F.R. Machado leg. (ABMM).

Etymology. – Named after my daughter, Dr Flávia R. Machado, who collected this specimen during a medical visit to the Maribo Indian village at the Curuça river in the Amazon.

MALE (Holotype). – **Head.** – Labium yellow, genae, base of mandibles and labrum orange yellow the later laterally black with a mid posterior black dot. Anteclypeus and antefrons orange yellow, the latter with a narrow black stripe at the clypeofrontal suture connected medially with the black area of the head dorsum. Postclypeus black with a pair of small orange markings at its posterior limit. Upper part of head black with two orange yellow postocular spots. Rear of head dorsally black, ventrally yellowish white.

T h o r a x. — As described for *A. chicomendesi* sp. n. Wings hyaline, pterostigma reddish brown, surmounting one cell. Px in FW 12 in HW 11, R3 arising near Px5 in both wings. Petiolation ceasing slightly distal to Ac in both wings.

A b d o m e n. — S1-S2 dorsally black laterally orange yellow. S3-S6 dorsally black, ventro laterally yellow. S7-S8 black. S9 dorsally blue, laterally black. S10 black. Cercus black brownish yellow inferiorly. Paraproctus orange yellow, distally brown.

STRUCTURAL CHARACTERS. — Penis (Fig. 4) with triangular lateral lobes and median lobe well developed. Distal border of segment 3 entire (Fig. 4). A pair of proximal lateral lobes at about mid-length between PL and the flexure (Figs 4, 20). The horn of S10, in lateral view (Fig. 26), is directed dorsoposteriorly with a slight dorsal convexity tapering in a blunt tip. In dorsal and posterior views as in Figures 34 and 41. Appendages as in Figures 20 and 29.

M e a s u r e m e n t s. — Abdomen 26.0; Hw 24.4.

REMARKS. — *A. flaviae* can be easily separated from the other species of the *apicale* group by the presence of proximolateral lobes and by having S8 totally black.

ACANTHAGRION KAORI SP. NOV.

Figures 6, 17, 21, 28, 36, 43, 55

M a t e r i a l. — **H o l o t y p e** ♂: BRAZIL: Amazonas state, Manaus (3°08' S, 60°01' W), 26-XII-1960, F. Rodrigues leg. (ABMM). **P a r a t y p e** ♂: Pará state, Wai-Wai Indian village at the Mapuera river (0°48' S, 58°8' W), 20-VI-1982, Machado and Kaori leg. (ABMM).

E t y m o l o g y. — Named for *K a o r i* the Wai-Wai indian who guided me through the forest during my visit to the Wai-Wai indian village at the Mapuera, river where one paratype was collected.

MALE (Holotype). — **H e a d.** — As in *A. chicomendesi* sp. n.

T h o r a x. — Prothorax similar to that of *A. chicomendesi* except for the presence of an orange rounded spot on the proepimeron. Pterothorax as in *A. chicomendesi*. Wings weakly flavescent, pterostigma yellowish brown surmounting one cell. Px in both wings 10, R3 arising near Px 5 in FW, Px 4 in HW. Petiolation ceasing at Ac in both wings.

A b d o m e n. — S1 dorsally black laterally orange yellow. S2 dorsally black laterally yellowish orange, the black area widened on the distal 1/3. S3-S6 dorsally black, ventrolaterally yellow. S7 dorsally black, with a cuneate bluish yellow stripe occupying its distal 1/3, ventrolaterally yellow. S8 yellowish blue, S9 blue, S10 black ventrally yellowish, appendages black, base of paraproctus orange yellow.

STRUCTURAL CHARACTERS. — Penis with triangular and median lobes well developed (Fig. 6). Distal border of segment 3 entire (Fig. 6) PL without basal spine (Figs 6, 17). Apicolateral lobes with a pair of heavily sclerotized hooks (Fig. 6) whose bases in ectal view projects laterally (Fig. 6). In the inflated penis (Fig. 17) the hooks appear as a fine tipped pyramid-shaped structure. Dorsum of S10

in lateral view (Fig. 28) with a concavity that marks the base of a slightly curved horn directed dorsoposteriorly (Fig. 28). Horn in dorsal and posterior views as shown in Figures 36 and 43. Appendages as in Figures 28, 36 and 43.

Measurements. – Abdomen 29.5; Hw 20.3.

REMARKS. – The penis hook base in ectal view projected laterally and the shape of the hook in the inflated penis are characters unique of *A. kaori*.

ACANTHAGRION OBSOLETUM (FÖRSTER, 1914)

Figures 5, 7, 14-15, 21, 27, 35, 37, 42, 55

Myagrion obsoletum FÖRSTER, (1914: 68), *Acanthagrion leonora* GLOGER (1967: 52), *Acanthagrion obsoletum* LEONARD (1977: 56), *Acanthagrion luna* RIS (1918: 122).

Material. – 1♂ ECUADOR: Napo province, Napo (1°2'S, 77°47'W), 20-IV-1934 W.C. Macintyre leg. (MNRJ); – 1♂ Napo province, river Patrum Yacu, (1°28'S, 78°6'W), I-1935 W.C. Macintyre leg. (ABMM).

DISTRIBUTION (Fig. 55). – Colombia: Villavicencio, Umbria; Ecuador: Napo, Mera; Peru: Madre de Dios, Rio Seco.

REMARKS. – *A. obsoletum* is unique in having the horns of S10 directed posteriorly (Figs 27, 29) and not dorsoposteriorly as in the other species of the group. Two specimens from Ecuador were studied and initially regarded as new. They differ from the specimens described by LEONARD (1977) by lack of a heavily sclerotized hook (Fig. 5) apex of PL not dilated (Fig. 5) and cercus straight (Fig. 27). However GARRISON (in litt.), after studying 28 males of *A. obsoletum* revealed that these three characters are individually variable and therefore not taxonomically valuable. According to him the degree of sclerotization observed is variable between the heavily sclerotized hook shown in Leonard's thesis (our Fig. 7) and a sclerotized line observed only in the inflated penis (Fig. 15). The presence of a well developed hook-moving apparatus is a character that the specimens from Ecuador herein studied shares with those studied by Garrison and Leonard.

ACANTHAGRION PHALLICORNE LEONARD, 1977

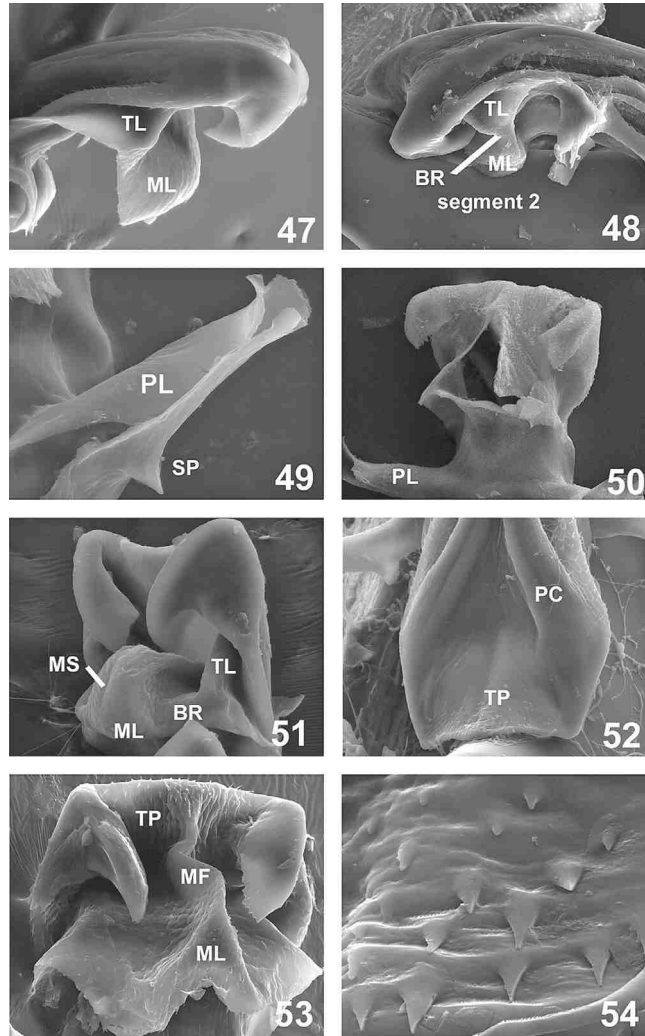
Figures 8, 30, 38, 44, 55

Material. – None.

DISTRIBUTION (Fig. 55). – Brazil, Rondonia state, Porto Velho.

REMARKS. – The penis of *A. phallicorne* shares with that of *A. descendens* the presence of an apicolateral lobe without sclerotized hook (Fig. 8) a character used by LEONARD (1977) to separate *A. phallicorne* from *A. apicale* and *A. obsoletum*. Coherent with this fact these two species also lack the components

of the hook-moving apparatus although in *A. phallicorne* there is a remnant of the ML. *A. phallicorne* differs from the other species of the *apicale* group by the presence of patches of setae in the 2nd segment of the penis.



Figs 47-54. S.E.M. photos of penes segment 3 in *A. chicomendensis*: (47-48) paratypes in lateral view; (49-51, 53) same in ventral view, (49) showing the main lateral lobe (PL) with its spine (SP), (50) the median lobe (ML) broken, (51) the distal part of segment 3 with median lobe (ML), its median sulcus (MS), and its bridge (BR) to triangular lobe (TL); – (47) the triangular plate (TP) and the median lobe with its median fold (MF); (52) in ectal view the apex of segment 3 showing the triangular plate (TP) and the two divaricated cords (PC); – (54) detail of the cuticular sculpture of the median lobe.

ACANTHAGRION TRIANGULARE SP. NOV.

Figures 9, 31, 39, 45, 55

Material. – **Holotype** ♂: BRAZIL: Acre state, Mancio Lima; Divisor National Park (7°27'23" S, 73°38'17" W), 20-VII-1996. Dionisio leg. (ABMM).

Etymology. – Name is an allusion to the fact that the part of the penis distal to PL is subtriangular.

MALE (Holotype). – **Head.** – Labium yellowish white; genae, base of mandibles, labrum and anteclypeus orange yellow with a black narrow stripe at the posterior part of labrum connected with a middorsal posterior spot. Postclypeus orange with a middorsal and a pair of lateral black markings; antefrons orange with a transverse black stripe at the border with postclypeus. Upper part of head black with orange at the postocular spots and the antennae scapes. Rear of head black with a rounded yellow ventral spot.

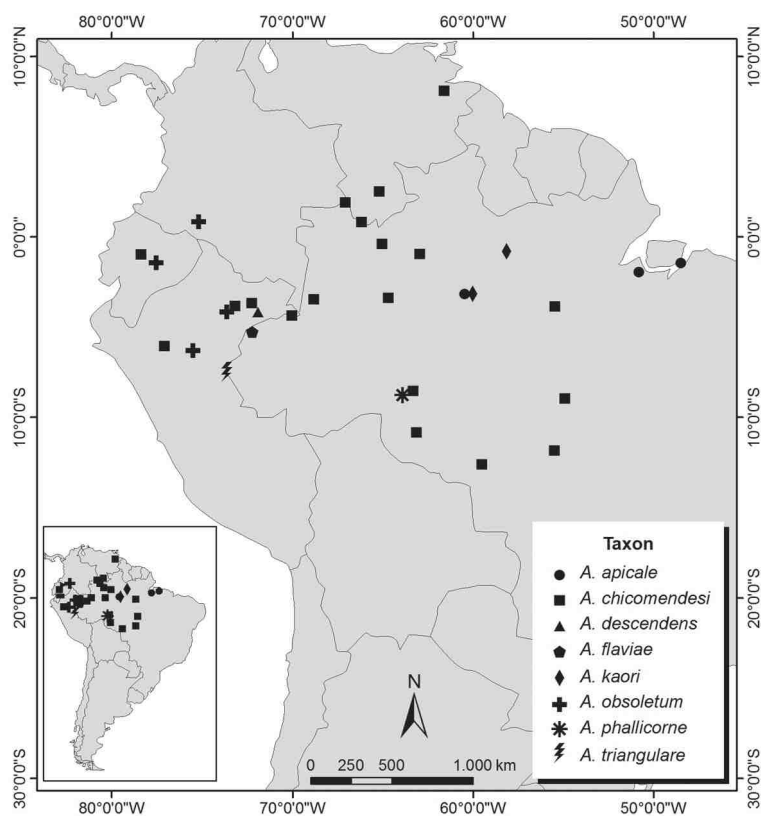


Fig. 55. Distribution map.

T h o r a x. — Mesepisternum black with a complete stripe occupying its middle 1/3; mesepimeron anteriorly black posteriorly yellowish orange. Metapleuron orange yellow with a black longitudinal stripe anteriorly to 2nd lateral suture. Legs brownish yellow with the extensor surface of femorae black. Wings weakly flavescens, pterostigma brown surmounting one cell. Px in both wings 10; R3 arising near Px 6 in FW and Px 5 in HW. Petiolation ceasing at Ac in both wings.

A b d o m e n. — S1 dorsally black laterally yellow. S2 dorsally black laterally yellowish orange. S3-S7 dorsally black ventrolaterally brownish orange; S8-S9 ventrally yellow, laterally black, dorsally greyish blue; S10 black. Cercus black, except for the distal 1/2 of medial surface, which is brownish orange. Paraproctus black, basally yellow.

STRUCTURAL CHARACTERS. — Penis (Fig. 9) with very large triangular and median lobes, in ectal view (Fig. 9) the portion distal to PL subtriangular; distal border entire (Fig. 9). Apex of PL in ectal view distally curved; width of segment 3 at mid-length about half the length of PL (Fig. 9). Dorsum of S10 in lateral view prolonged into a fine tipped horn, directed dorsoposteriorly (Fig. 31). In dorsal view (Fig. 39) with tips reaching laterally beyond the level of the lateral borders of paraproctus, in posterior view as shown in Figure 45. Appendages as shown in Figures 31 and 45.

M e a s u r e m e n t s. — Abd. 27.2; Hw 17.1.

REMARKS. — *A. triangulare* can be identified by the narrow penis segment 3 by having the portion of penis distal to PL subtriangular and the curved PL.

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I am grateful to Prof. JANIRA MARTINS COSTA and ULISSES GASPAS NEISS for allowing me to study material from the MNRJ and INPA collections respectively. I am also grateful to J. DE MARMELS for the gift of specimens from Venezuela and FREDERICO A.A. LENCIONI for the loan of specimens and for critically reviewing the manuscript. I thank ROSSER GARRISON for valuable information on *A. descendens*, *A. obsoletum* and *A. phallicorne*. I am grateful to MYRIAN MORATO DUARTE for the drawings illustrating this paper and to Center of Microscopy of Universidade Federal de Minas Gerais for providing the facilities for the studies with the Scanning Electron Microscope.

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**ODONATA FROM THE KINGDOM OF TONGA,
WITH A DESCRIPTION OF *PSEUDAGRION
MICROCEPHALUM STAINBERGERORUM* SSP. NOV.
(ZYGOPTERA: COENAGRIONIDAE)**

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The odon. fauna from the Kingdom of Tonga have been reviewed using published literature combined with recent data by the author. Some important taxonomic considerations are discussed and a complete reference list is provided. A species checklist is presented with a total of sixteen taxa so far known for the island groups within the country. Seven new species for the Kingdom of Tonga are reported here including *P. m. stainbergerorum* ssp. nov. (holotype ♂: Tonga, Tongatapu Isl., 26-IV-2010). The new subspecies is compared with its closest relatives known from elsewhere in the Pacific, their relationships briefly discussed, and suggestions for future studies given.

INTRODUCTION

Odonata of the three major divisions of the Pacific, namely Micronesia, Melanesia and Polynesia, have generally been inadequately studied. While species checklists have been prepared for larger island groups like New Caledonia (DAVIES, 2002) and Fiji (EVENHUIS & POLHEMUS, 2007), less attention has been paid to small nations and isolated archipelagos, like Kiribati, Palau, Tuvalu, Niue, etc. Information about them is either scattered among general faunistic or taxonomic papers or non-existent.

The Kingdom of Tonga exemplifies this situation. No specific paper dealing with its odonate fauna has been published. This archipelago was not included in the most recent conservation appraisal which featured the South Pacific Region and Australasia (ROWE, 2004). Information pertaining to the Kingdom of Tonga's odonates comes from faunistic investigations done on neighbouring regions or taxonomic discussion of world distributions. The detailed reference list

provided highlights the main contributions and all other data available for the country. World species catalogues are not considered because of previously encountered constraints discussed in MARINOV (2010). Table I lists the odonate species in chronological order. Each is represented with the original published species name followed by the currently accepted one, verbatim locality name, literature source and page.

KIRBY (1884) appears to be the first who reports any information about Odonata of the Tongan archipelago. He published two species with *Diplax pacificus* described as a new to science. It was later, however, synonymised with *Diplacodes bipunctata* (Brauer, 1865) by RIS (1909-1919). In the same extensive study RIS (1909-1919) gave two additional species for the Kingdom of Tonga, one of which was new for the country.

Similar controversy of opinions are observed around *Hemicordulia oceanica* Selys, 1871. It was initially given for Tongan islands by RIS (1913, 1915) and recalled in CAMPION (1921). LIEFTINCK (1975) transferred specimens from New Caledonia originally published as *H. oceanica* to the described by him *Hemicordulia hilaris* spec. nov. The author also made a short comment about the possible conspecific with *hilaris* specimens collected elsewhere from Fiji, Tonga and

Table I
Chronological literature review of Odonata records from Kingdom of Tonga

| No | Verbatim species | Valid species name | Verbatim locality | Page | References |
|----|--|--|-------------------------------|------|------------------|
| 1 | <i>Pantala flavescens</i> | <i>Pantala flavescens</i> | Tongatabu | 454 | KIRBY (1884) |
| 2 | <i>Diplax pacificus</i> | <i>Diplacodes bipunctata</i> | Tongatabu | 455 | KIRBY (1884) |
| 3 | <i>Lathrecista asiatica asiatica</i> | <i>Lathrecista asiatica asiatica</i> | Tonga-Pacific | 130 | RIS (1909-1919) |
| 4 | <i>Gynacantha stevensoni</i> | <i>Gynacantha stevensoni</i> | Nukualofa, Tonga | 36 | FRASER (1927) |
| 5 | <i>Tramea limbata</i> | <i>Tramea limbata</i> | Vavau, Nukualofa, Tonga | 41 | FRASER (1927) |
| 6 | <i>Macrodiplax cora</i> | <i>Macrodiplax cora</i> | Vavau, Tonga | 41 | FRASER (1927) |
| 7 | <i>Tramea transmarina</i> | <i>Tramea transmarina</i> | Tonga | 281 | ARMSTRONG (1973) |
| 8 | <i>Hemicordulia hilaris</i> | <i>Hemicordulia hilaris</i> | Tonga | 156 | LIEFTINCK (1975) |
| 9 | <i>Ischnura heterosticta</i> | <i>Ischnura heterosticta</i> | Tonga | 71 | WATSON (1976) |
| 10 | <i>Agriocnemis exsudans</i> | <i>Agriocnemis exsudans</i> | Tongatapu Island group, Tonga | | this paper |
| 11 | <i>Ischnura aurora</i> | <i>Ischnura aurora</i> | Tongatapu Island group, Tonga | | this paper |
| 12 | <i>Pseudagrion microcephalum stainbergerorum</i> | <i>Pseudagrion microcephalum stainbergerorum</i> | Tongatapu Island group, Tonga | | this paper |
| 13 | <i>Anaciaeschna jaspidea</i> | <i>Anaciaeschna jaspidea</i> | Tongatapu Island group, Tonga | | this paper |
| 14 | <i>Anax guttatus</i> | <i>Anax guttatus</i> | Tongatapu Island group, Tonga | | this paper |
| 15 | <i>Orthetrum serapia</i> | <i>Orthetrum serapia</i> | Vava'u Island group, Tonga | | this paper |
| 16 | <i>Tholymis tillarga</i> | <i>Tholymis tillarga</i> | Tongatapu Island group, Tonga | | this paper |

Samoa, given originally as *oceanica*. Having this note in mind one should exclude *H. oceanica* from the faunistic list of the Kingdom of Tonga unless the specimens reported in RIS (1913, 1915) and CAMPION (1921) are revised considering the contemporary taxonomy. For the same reasons specimens published in FRASER (1927) for Tonga as *Hemicordulia pacifica* Fraser, 1925 are excluded from the species check list for the country.

In analysing a collection by G.H.E. Hopkins, FRASER (1927) has published the most significant contribution of Odonata of the Kingdom of Tonga to date. The paper is dedicated to the dragonflies of neighbouring Samoa with a few species discovered in the Kingdom of Tonga as well. This collection adds three new species for the country with *Gynacantha stevensoni* new to science. *Tholymis tillarga* (Fabricius, 1798) is reported for the country by SCHMIDT (1938) who refers to FRASER (1927). This record, however, is considered here as doubtful because FRASER (1927) does not specify the sampling localities for *T. tillarga*. SCHMIDT (1938) has possibly been confused by the statement of FRASER (1927) that "Specimens of both sexes were taken by Dr. Armstrong on the same dates and in the same localities as *P. flavescens*." without considering the fact that the specimens from Tongan archipelago were provided by G. Hopkins while all other species collected by Armstrong come from Samoa. Therefore *T. tillarga* is included in Table I as a new addition to the fauna of the country.

Since the late 1930's data on Odonata of the Kingdom of Tonga have been difficult to obtain. Only four papers were identified however additional literature may reveal some more additions to the Tongan fauna made occasionally while reporting the range extension of particular species. KIMMINS (1966) recorded all odonate types established by Fraser that are kept in the British Museum and gave the type localities. The only species ever described from the Kingdom of Tonga was included. ARMSTRONG (1973) referred to the collection with particular emphasis on *Tamea transmarina* Brauer, 1867. It was compared with other specimens sampled within the Pacific and given as an inhabitant of Tonga. LIEFTINCK (1975) included one species recorded in Table I however it must be treated in combination with the considerations commented upon above with regard to the *H. oceanica*-*H. hilaris* problem. WATSON (1976) also gave one species with its global distribution reaching the Kingdom of Tonga.

It is evident from the review of Pacific Odonata literature that the Tongan archipelago has been largely overlooked by previous researchers. Some possible reasons are discussed below and suggestions to overcome this problem are proposed. The present paper makes additional contribution to the faunal species list and is also intended to increase the awareness of this island group and provide an incentive for future studies.

MATERIAL AND METHODS

The material for this study was collected from all over the Kingdom of Tonga. A short geographic and climatic description is presented from THOMPSON (1986).

The Kingdom of Tonga includes all the islands between the latitudes from 15°S to 23.5°S and between longitudes from 173°W to 177°W (Fig. 1a). Three main islands groups are defined: the Tongatapu group, the Ha'apai group, and the Vava'u group (Fig. 1b). The capital city of Nuku'alofa lies on the largest group of Tongatapu. All islands in the three groups are predominantly flat to hilly areas with only a few high peaks. The highest point of Tongan islands is an extinct volcano, Kao, rising to 1,030 m, in the Ha'apai group. Apart from 'Eua (rising to 330 m), south-east of Tongatapu, there are no other distinct mountains, although on Vava'u hills rise to between 150 and 300 metres. The remainder of the Tongan islands form a chain of recently formed volcanic islands, some of which contain active volcanoes.

Two seasons are clearly identified: dry between May-October and wet between November-April. There are significant variations in the mean rainfall between the two seasons. The highest fluctuation, measured for Vava'u group, was 1,555 mm (wet season) to 757 mm (dry season).

Mean annual temperature shows great dependence on the latitude. They vary from about 26.0°C at Niuafu'ou and Keppel (situated further to the North of Vava'u group and not presented on Fig. 1) to 23.0°C on Tongatapu. Maximum temperatures in excess of 33.0°C are seldom measured. The highest recorded temperature was 35.0°C on Vava'u. The lowest recorded temperature in the country has been 10.6°C.

The Kingdom of Tonga is poor in surface waters. The predominant types of wetlands are lentic waters. Lake Tu'anuku, situated on the south-west part of the main island from the Vava'u group is the biggest of the country. Apart from a mangrove on Tongatapu, and lakes on some volcanic islands (Tofua and Niuafu'ou) there are no other large wetlands. Lotic waters are almost completely lacking within the territory; the exception being 'Eua Island. It is also the only island from the Tonga group that retains the typical rainforest.

The three island groups were visited between 24 April and 11 May 2010 as part of a project aiming to identify single stranded DNA viruses transmitted by insect vectors. Opportunistic field samples of adult Odonata were taken as well. They were caught with entomological net and either killed in 90% ethanol or frozen. Specimens were later dried at air temperature and kept in paper envelopes. Below is a list of the sampling localities:

Tongatapu group (Fig. 1c).

- (1) Concrete pool at the "Tonni's guest house" and secondary road south of it (21°09'20.1" S; 175°14'19.5" W; 25-30 m a.s.l.): 25, 28-30-IV and 04-V-2010.
- (2) Beach at the far north-east corner of the main island (21°04'17.7" S; 175°20'03.3" W; 0 m a.s.l.): 25-IV-2010
- (3) Grass field near a restaurant at Keleti International Resort (21°12'20.6" S; 175°13'54.1" W; 15 m a.s.l.): 25-IV-2010.
- (4) Mangrove between the villages Hofua and Sapu, Tongatapu Island (21°07'49.1" S; 175°13'33.4" W; 12 m a.s.l.): 26, 28-29-IV-2010.
- (5) Ministry of Agriculture and Food, Forests and Fisheries Station (21°12'33.3" S; 175°11'56.0" W; altitude not measured): 27-IV-2010.
- (6) Private farm (21°10'19.9" S; 175°14'27.0" W; altitude not measured): 29-IV-2010.
- (7) Nuku'alofa waterfront (21°08'24.5" S; 175°11'14.0" W; 0 m a.s.l.): 30-IV-2010 and 11-V-2010.

Ha'apai group (Fig. 1d).

- (8) Flying Anisoptera observed at two places by two of the members of the plant virologists group (in the Acknowledgements) with no voucher specimen obtained (19°48'13.2" S; 174°21'05.4" W; 0 m a.s.l. and 19°48'21.9" S; 174°20'49.3" W; 0 m a.s.l.): 06-10-V-2010.

Vava'u group (Fig. 1e).

- (9) Hinakauea beach (18°42'14.4" S; 173°59'23.5" W; 0 m a.s.l.): 01-V-2010.
- (10) Tu'anuku village (18°40'17.2" S; 174°02'15.1" W; 48 m a.s.l.): 02-V-2010.
- (11) Lake Tu'anuku by the Tu'anuku village (18°39'45.4" S; 174°01'47.1" W; 21 m a.s.l.): 02-V-2010.
- (12) Mala Island (18°41'23.9" S; 174°01'14.4" W; 0 m a.s.l.): 03-V-2010.

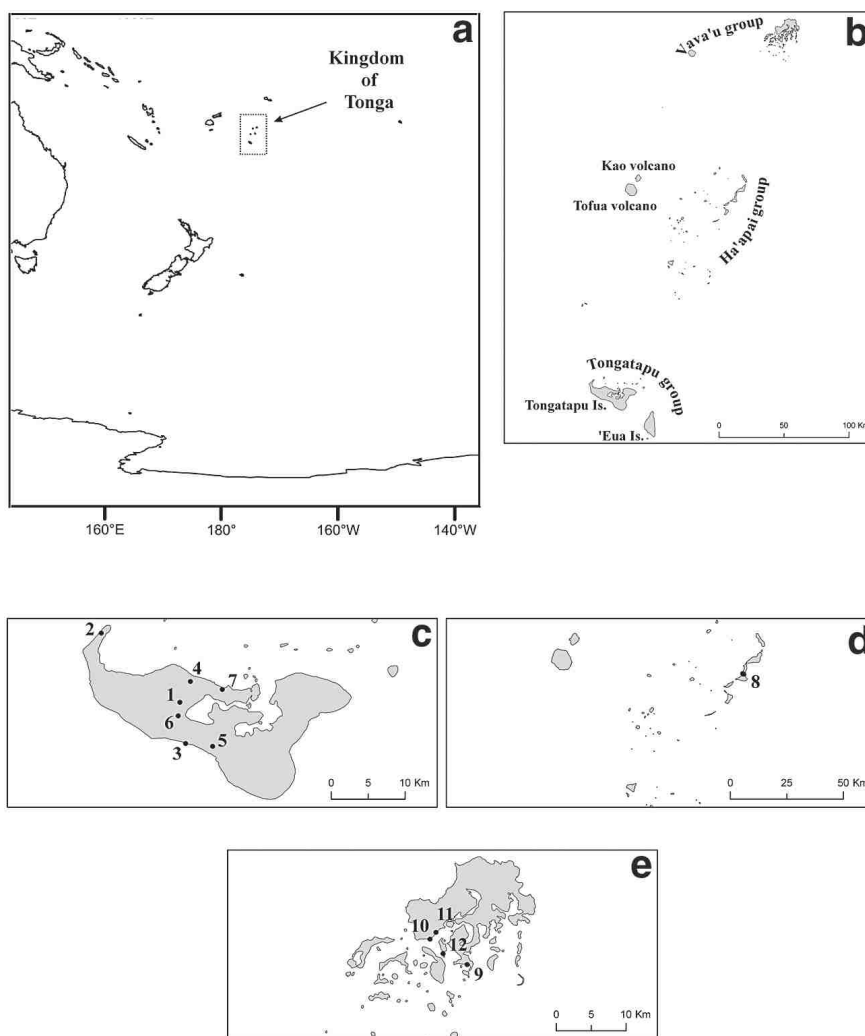


Fig. 1. The Kingdom of Tonga and Odonata sample sites on the three main island groups: (a) general situation of the Kingdom; – (b) island groups of Tonga; – (c) Tongatapu group; – (d) Ha'apai group; – (e) Vava'u group.

CHECKLIST OF ODONATA OF THE KINGDOM OF TONGA

The list has been compiled from all information collected so far for the country including the new data presented here. Total of 13 species have been collected from the three main groups during the current study. They are represented below with the locality number and date where a site has been sampled in more than one occasion. New species for the country are asterisked.

COENAGRIONIDAE

- *Agriocnemis exsudans* Selys, 1877*
This paper: 1 (28-IV-2010), 4, 7 (11-V-2010), 11.
- *Ischnura aurora* (Brauer, 1865)*
This paper: 1 (25-IV-2010), 4, 7.
- *Ischnura heterosticta* (Burmeister, 1839)
Previous records: Range extension (WATSON, 1976).
This paper: 4.

AESHNIDAE

- *Anaciaeschna jaspidea* (Burmeister, 1839)*
This paper: 4 (28-29-IV-2010).
- *Anax guttatus* (Burmeister, 1839)*
This paper: 4 (28-29-IV-2010).
- *Gynacantha stevensoni* Fraser, 1927
Previous records: 1 ♂, Nuku'alofa, Tongatapu, 17-II-1925, G.H.E. Hopkins leg. (FRASER, 1927).

CORDULIIDAE

- *Hemicordulia hilaris* Lieftinck, 1975
Previous records: No locality name provided (LIEFTINCK, 1975).
This paper: 1 (25-IV-2010), 7 (30-IV-2010).

LIBELLULIDAE

- *Diplacodes bipunctata* (Brauer, 1865)
Previous records: 1 ♂, Tongatapu, July 1874 (KIRBY, 1884); 1 ♂, Tongatapu (RIS, 1909-1919); Vava'u island group (FRASER, 1927).
This paper: 1 (25, 29-IV-2010), 2, 4 (26, 29-IV-2010), 6, 7, 10, 11, 12.
- *Lathrecista a. asiatica* (Fabricius, 1798)
Previous records: 2 ♂♂ R. Martin leg., Tonga; 1 ♀ Tongatapu, ex Mus. Godeffroy (RIS, 1909-1919); 1 ♂, 4 ♀♀, Nuku'alofa, Tongatapu, February 1925 G. H. E. Hopkins leg.; 1 ♂, Vava'u island group 04-III-1925 G. H. E. Hopkins leg. (FRASER, 1927).
This paper: 7 (30-IV-2010).
- *Macrodiplax cora* (Kaup in Brauer, 1867)
Previous records: 1 ♂, Vava'u island group 05-III-1925 G. H. E. Hopkins leg. (FRASER, 1927).
- *Orthetrum serapia* Watson, 1984*
This paper: 11.
- *Pantala flavescens* (Fabricius, 1798)
Previous records: Tongatapu, July 1874 (KIRBY, 1884); Tongatapu (RIS, 1909-1919); Nuku'alofa, Tongatapu G. H. E. Hopkins leg. March 1925; Vava'u island group G. H. E. Hopkins leg.

February 1925 (FRASER, 1927)¹.

This paper: 1 (25, 28, 29-IV-2010), 2, 6, 7 (30-IV-2010), 9, 11.

– *Tholymis tillarga* (Fabricius, 1798)*

This paper: 1 (28-29-IV-2010), 4 (28-29-IV-2010).

– *Tramea limbata* (Desjardins, 1832)

Previous records: Nuku'alofa, Tongatapu G. H. E. Hopkins leg. 20-II-1925; Vava'u island group G.H.E. Hopkins leg. 08/09-III-1925 (FRASER, 1927).

– *Tramea transmarina* Brauer, 1867

Previous records: Range extension (ARMSTRONG, 1973).

This paper: 1 (04-V-2010), 3, 5, 7 (30-IV-2010), 10.

PSEUDAGRION MICROCEPHALUM STAINBERGERORUM
SSP. NOV.

Figure 2 (a-k)

Material. – **Holotype** ♂: Kingdom of Tonga, Tongatapu Island, mangrove between Hofua and Sapu, 26-IV-2010, M. Marinov leg. – **Paratypes**: 3 ♂, same data as holotype. Holotype and paratypes deposited at the Lincoln University Entomology Research Museum, New Zealand. Additional male specimen was used for initial morphological description. Its body was completely torn apart in order to obtain better landmarks for comparison. Some of the figures presented below are taken from this male. It is also included in the analysis of the morphological variability.

Etymology. – The species name is derived from the family names of two University of Canterbury students: Daisy Stainton and Simona Krabeger. They were very passionate about finding a new species and suggested the name proposed here.

MALE (holotype). – **Head** (Fig. 2a). – Labium light ochreous, mandibles light blue at the base with red-testaceous tips. Light blue colour on most of the head completely covering genae, labrum, anteclypeus and base of the antennae. Blue area on the frons is going backwards to the base of lateral ocelli. Two large occipital blue spots roughly trapezoid-shaped with shorter sides turned outwards and backwards. Outer corners produced anteriorly as short spines along the eye edges. Blue transverse cross line between the occipital spots non-contacting their inner anterior corners. Black area on the head as follows: three spots with irregular shape and pointed forwards edges at the posterior edge of postclypeus with median spot continuing up the frons as a small triangle; entire proximal half of scape, almost whole pedicel (saved for light bluish anterior half and light testaceous shine at the posterior tip) and flagellum; roughly oval spot anteriorly of the median ocellus; base of the median ocellus in its proximal half; two semi-oval spots on the anterior bases of lateral ocelli; transverse bar behind lateral ocelli runs between the eyes with small tubercles towards the base of the antennae and embracing the proximal and inner bases of lateral ocelli; larger part of the back of the head saved for two longitudinal light bars running from

¹ Dates are given according to the original publication, however, all other records from Nuku'alofa come from February and Vava'u island group has been sampled in March.

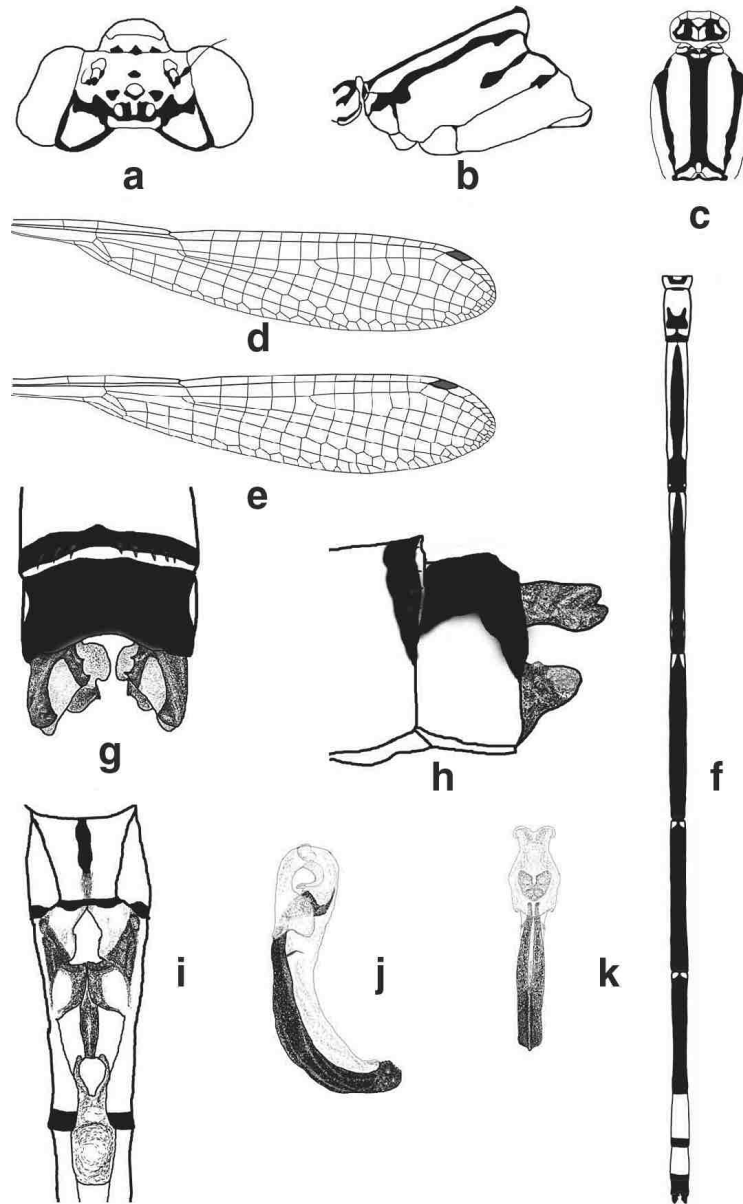


Fig. 2. *Pseudagrion microcephalum stainbergerorum* ssp. n., holotype male: (a) head, dorsal view; – (b) thorax, lateral view; – (c) same, dorsal view; – (d) forewing; – (e) hindwing; – (f) abdomen, dorsal view; – (g) anal appendages, dorsal view; – (h) same, lateral view; – (i) secondary genitalia, ventral view; – (j) penis, lateral view; – (k) same, ventral view.

the base of the mandibles back towards the outer posterior edge of blue occipital spots. Light brownish hairs at the dorsal edge of the mandible below the outer posterior corners of the labrum, on entire labrum, outer edges of anteclypeus, top of postclypeus, on occipital spots and blue bar between them. Paler hairs on the frons and epicranium. Small stiff spine-like hairs on the back of the head below the posterior end of occipital spots. Eyes light blue with light brownish bars running from anterior corners of the black transverse bar behind lateral ocelli towards back of the head.

T h o r a x (Figs 2b-c). – Prothorax: pronotum black divided medially with a dark line separating two blue spots with irregular rectangular shape; hind lobe of pronotum raised in a rounded margin; propleuron black in its upper part leaving for blue coloration towards the sternum, along the rim-like lateral expansions encompassing the whole prothorax and for two rectangular light spots laterally on each side. Synthorax: overall bright blue with black bars and lines developed as follows: posterior edges of the mesostigmal laminae and area between them; both sides of mid-dorsal carina (small scar-like light spot on the left hand side in dorsal view); black bar running alongside humeral suture entering anteriorly mesepimeron as going around and down the shoulders and continues in the mesinfraepisternum overarching its dorsal part; same bar in its posterior half raises in the mesepisternum with small extension at the last 1/8 down to mesepimeron; it becomes thinner posteriorly and joins the black line going along the posterior sclerites; club-shaped line on the posterior half of the first lateral suture; semicircular spot on the metepisternum at the posterior end of the second lateral suture with very weak expansion to metepimeron; small spot at the top anterior end of second lateral suture where it joins metinfraepisternum; weak line on the anterior end and ticker circular bar on the posterior edge of poststernum.

Legs: light bluish proximally becoming dull yellowish distally. Dark areas developed as follows: dorsally on all femora (saved for tiny obscured spots at the bases and tips) being black testaceous on fore legs and becoming lighter towards the hind legs with irregular edge lines; ventral longitudinal half of fore tibia; ventral 1/4 basal part and tip of middle and hind tibia; proximal and distal ends of all tarsal segments (where well developed – see below) with dark reddish colorations so are the tarsal claws except the black tips. Tarsal segments reduced to two and claws unequally developed (one large and second just half of its length) on fore right and middle left legs.

Wings (Figs 2d-e): Damaged in the holotype and redrawn from one male not included in the type series. Wing hyaline with completely black venation; pterostigma light brownish outlined with black veins thicker at their distal and posterior edge. In holotype forewings venation differ from Figure 6d with IR2 descending from 9th pncv leaving for three cells between origins of R3 and IR2 in forewing (R3 descending just before 6th pncv). Four cells present at Figure 6d as IR2 descending from 10th pncv. No difference in hindwings compared to Figure 2e.

Abdomen (Fig. 2f). – S1 blue with large rectangular black spot at the basal dorsum and circular lines running at the latero-posterior end of the segment becoming dark reddish at the ventral part. S2 blue with thin black transverse bar at the basal dorsum and U-shaped thick black mark joined with thin black line to the black posterior ring. S3-4 blue with spear-like black marks running anteriorly from a large posterior black area. S5-7 black on the dorsum and light on the ventral part. The latter is dull yellowish posteriorly and becoming bluish anteriorly as the blue continues on both sides up towards the dorsum, but does not join together because of the thin black line projecting from the dorsal black area to the anterior end of the segment. S8-9 blue with tick black transverse bars on the posterior dorsum running laterally down and ending 1/3 and 1/2 before the sternum for S8 and S9 respectively. S10 black on the dorsum and blue laterally.

Table II
Morphological comparison between *P. m. stainbergerorum*, *P. m. microcephalum*,

| Morphological feature | <i>m. stainbergerorum</i> | <i>m. microcephalum</i> | <i>pacificum</i> | <i>samoense</i> |
|----------------------------------|--|---|---|--|
| Head | | | | |
| spots on the postclypeus | separated | joined in a thick transverse bar | joined posteriorly | separated |
| black area behind lateral ocelli | thin with projections | thin with very small projections | interrupted behind the ocelli | excessive black area |
| blue occipital spots | large with projections | large with projections | large with projections | small without projections |
| Thorax | | | | |
| synthorax | black spot on the poststernum | no black spot on the poststernum | no black spot on the poststernum | no black spot on the poststernum |
| Abdomen | | | | |
| S2 | transverse bar on the basal dorsum; U-shaped mark joined to posterior ring | no transverse bar on the basal dorsum; U-shaped mark not joined to posterior ring | no transverse bar on the basal dorsum; U-shaped mark joined to posterior ring | black spot on the basal dorsum; U-shaped mark joined to posterior ring |
| S3-9 | spear-like marks on S3-4 | spear-like marks on S3-4 | no spear-like marks on S3-4 | no spear-like marks on S3-4 |
| S10 | black | black could be reduced | black | black |
| Anal appendages | | | | |
| superior | lower lobe longer | lower lobe longer | both lobes the same length | lower lobe longer |
| Secondary genitalia | black area around the hamules straight | black area around the hamules diffuses | black area around the hamules diffuses | black area around the hamules diffuses |

Black posterior spines on S7-9.

Anal appendages (Figs 2g-h): superior appendages dark reddish at the base to black at the tips; bifid in lateral view with lower lobe slightly longer. Lower lobe in dorsal view concave extending inwards and bearing two strong teeth. It is mostly light bluish-yellowish with inner margin deep dark red around the teeth. Inferior appendages bilobed in dorsal view with proximal lobe light blue and round edge, and distal lobe dull yellowish with dark inner tooth each. In lateral view they are deep dark red at the proximal two-thirds and light at the tips. Inferior appendages slightly surpass half of the length of the superior.

Secondary genitalia (Fig. 2i): apparent black areas around hamulus running anteriorly with straight line edges. Both areas form a superficial V-shape mark. Penis (Figs 2j-k): terminates with a trifid end with two lateral flaps extending down and forwards.

M e a s u r e m e n t s (mm). – Total length (without appendages) 34.1-36.1 (36.1 in the holotype); abdomen (without appendages) 27.5-29.6 (29.6 in holotype); Fw: length 19.0-20.3 (20.3 in holotype); Hw: length 18.1-19.2 (19.2 in holotype).

VARIATIONS IN PARATYPES. – Variations established in colour pattern of the head and wing venation only. In one specimen only the black spots (middle and right once) on the posterior edge of postclypeus joined with their anterior corners. All paratype males have black transverse bars behind lateral ocelli with projections reaching bases of the antennae. Other colour variations are age dependant with younger males having yellow outlines of the black bars alongside the dorsal carina and humeral suture and yellow longitudinal lines on both sides of black coloured dorsal carina. Also black area at the anterior end of second lateral suture lacks in one male. IR2 in Fw may descent from 8th to 11th pncv, but mainly from 9th or 10th pncv with mostly 4 (rarely 3) cells enclosed between IR2 and R3. These figures for Hw are as follows: IR2 descends at 8th to 10th pncv, but mainly from 8th or 9th pncv. Beginning of R3 is less variable. It is mainly just before or at 6th (rarely between 5th and 6th or at 5th) pncv in Fw and just before 4th or 5th pncv in Hw.

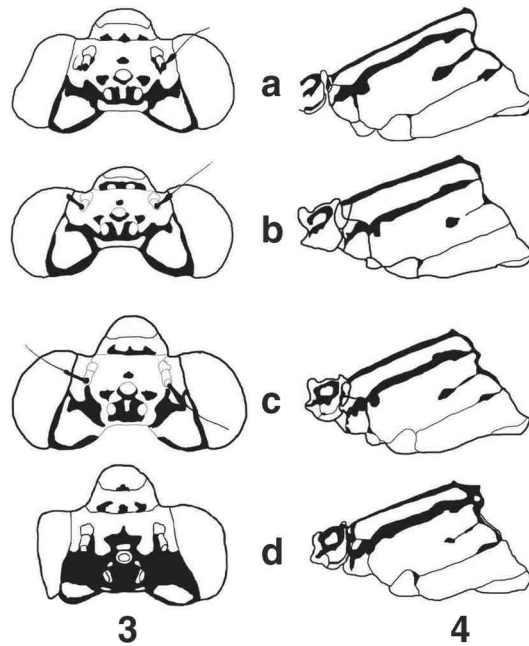
FEMALE and LARVA. – Unknown.

DIFFERENTIAL DIAGNOSIS. – The new subspecies is compared with three other species from the genus (Tab. II) found within the Pacific region: (1) *P. m. microcephalum* (Rambur, 1842), which is also widely distributed in India, SE Asia, Indonesia, New Guinea, Solomon Islands and Vanuatu (THEISCHINGER & HAWKING, 2006), (2) *P. pacificum* Tillyard, 1924 is endemic to Fiji (TILLYARD, 1924), and (3) *P. samoense* Fraser, 1925 to Samoa (FRASER, 1925). Note that the original spelling of the *P. samoensis* introduced by Fraser is incorrect and must be replaced by *P. samoense* (H. Fliedner, pers. comm.).

All three species highly resemble each other and the here proposed *P. microcephalum stainbergerorum*. The species separation could be a major point of contention in future research and therefore a short morphological analysis is suggested

here. The main diagnostic features are also represented in Table II. It must be emphasized that the following descriptions are based on a very limited number of specimens. One male *P. m. microcephalum* (Solomon Islands: Guadalcanal Honiara, Rove Cr. at Reservoir 13/24-II-1987, T. Donnelly leg.) and one male *P. pacificum* (Fiji: Viti Levu, Nandi District, stream near Namboutini, 01-VII-1972, T. Donnelly leg.) were studied personally. One male *P. samoense* (Western Samoa: Upolo, Lake Lanoto'o (2500'), 24-31-VII-1985, T. Donnelly leg.) was analyzed from high resolution pictures provided by P. Skelley (Florida State Collection of Arthropods) with facilitation of C. Cook.

Figure 3 displays the heads of all four taxa. Generally they share the same type of arrangement of the black areas. Variations are observed on: (a) the expansion of the black corners of the spots at the posterior edge of postclypeus: the three black spots do not join only in *samoense*; in *m. microcephalum* they form a thick transverse bar and in *pacificum* they are joined at their posterior corners, (b) black bar behind lateral ocelli: very small projections towards the bases of the antennae in *m. microcephalum* which lack in *pacificum* and in *pacificum* it is interrupted at the level of lateral ocelli; *samoense* has excessive black area which occupies nearly half of the epicranium, and (c) blue occipital spots: outer projections developed in *m. microcephalum* (having the largest) and *pacificum*, but absent in *samoense*, which has also the transverse bar interrupted and reduced to two small blue spots.



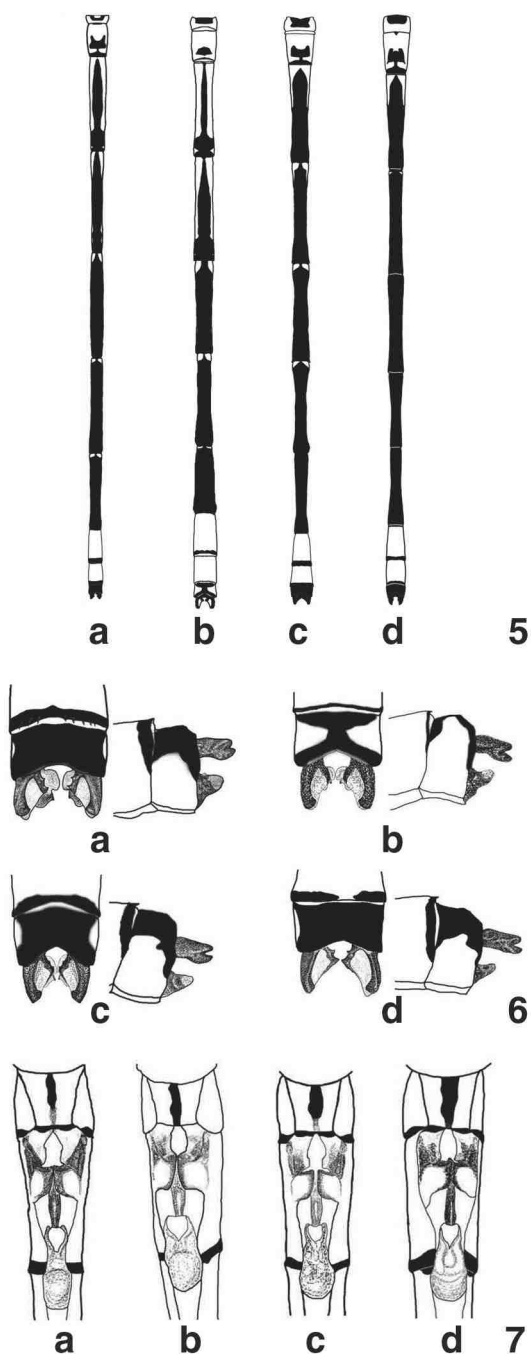
Figs 3-4. Comparison between the heads (dorsal view) and thoraxes (lateral view) of: (a) *P. m. microcephalum stainbergerorum* ssp. n.; - (b) *P. m. microcephalum*; - (c) *P. pacificum*; - (d) *P. samoense*.

The variations in the thorax are even less expressed (Fig. 4). No significant differences in the shape and colouration of the prothorax have been observed. Synthorax of the four taxa is also generally similar with the black markings developed at the same positions and being different only at the extend of the occupancy. Unlike the rest three species, *P. m. stainbergerorum* has black markings on post-sternum.

Variations in wings were

found to be of not significant use for species/subspecies differentiation. They vary among the studied taxa on the same manner as within the specimens of *microcephalum stainbergerorum* type series.

Abdomens in the four taxa are again very similar (Fig. 5) with major variations observed on the S2. Unlike *microcephalum stainbergerorum* other three taxa lack the transverse black bar at the basal dorsum with *samoense* having a small medial spot only. In *m. microcephalum* the large black spot does not have a U-shaped form and it is not joined to the black posterior ring. Spear-like black markings on S3-4 developed in *m. microcephalum* only. In *pacificum* and *samoense* those areas are thicker and the black occupies larger surfaces. S5-7 similar in *m. microcephalum* and with increased black areas in *pacificum* (no blue basal spots on S7) and *samoense* (completely black). S8-9 in all taxa are blue with black posterior rings slightly re-



Figs 5-7. Comparison between the abdomens (dorsal view), anal appendages (dorsal view) and the secondary genitalia of: (a) *P. microcephalum stainbergerorum* ssp. n.; - (b) *P. m. microcephalum*; - (c) *P. pacificum*; - (d) *P. samoense*.

duced in *m. microcephalum* only. Same species has largely reduction on black area on S10 too.

Anal appendages of all four taxa look very similar (Fig. 6). Superior are always bifid with the lower lobe longer than upper in all, but *pacificum* where both lobes are of the same length. In lateral view the bifurcation is due to a V-shaped notch not well developed in *pacificum* only where the lower lobe has straight site, but not oblique. In dorsal view the upper lobes are very similar in all four taxa. Also all have lower lobe concave terminating with two inner teeth. The latter are developed at the same positions in all taxa and differ in their exposition only. They are largest in *samoense* and *microcephalum stainbergerorum* with no possible distinction between them. Other two species have smaller teeth not visible in *m. microcephalum* on Figure 6 as they are pointed upwards in the studied specimen. Inferior appendages follow the general scheme of having a light tip in lateral view. No significant distinction could be proposed on this feature. In dorsal view *m. microcephalum* has much reduced appendages in size, but possible it is due to the preservation method as they look shrunk and concaved to a larger extent than what is supposed to be normal.

External part around the area of the secondary genitalia shows deviation in the new subspecies only (Fig. 7). The black pigmentation around the hamules have straight edges going oblique anteriorly, while other three taxa have the black area developed near the hamules, which diffuses anteriorly.

Penes have been investigated in all, but *samoense* (Fig. 8), which was studied by photos only. In all three taxa the penes have a common structure – they terminate with a trifid end with two lateral flaps expanding down and forwards. The latter in lateral view surpass the middle lobe in *m. microcephalum* and have the same length in other two taxa.

NOTES ON BIOLOGY AND ECOLOGY. – The new subspecies was found only between the prop roots of *Rhizophora* sp. (Fig. 9). Adults were lacking from the thick tree plantations and preferably moved around isolated plants (Fig. 10). All specimens were collected in one occasion only – during a rainy day where larger competitors of the space, like *Anax guttatus* and *Tholymis tillarga* were not active. Although completely wet (Fig. 11) they were still flying among the roots perch-

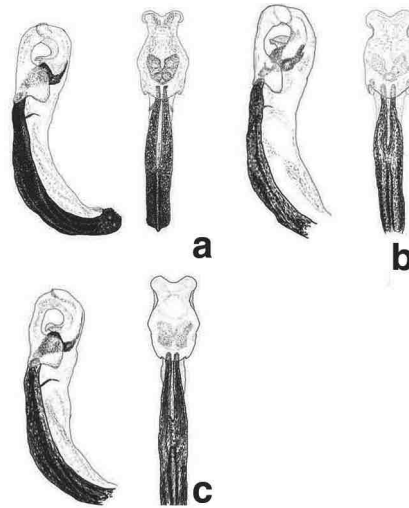


Fig. 8. Comparison between the penes (lateral and ventral view) of: (a) *P. microcephalum stainbergerorum* ssp. n.; – (b) *P. m. microcephalum*; – (c) *P. pacificum*; – (d) *P. samoense*.

ing directly on to them or at the edge of the leaves. Five specimens have been collected only, but many more individuals were seen active as well. The type locality was visited two more times, but not a single individual was encountered in spite of the nice sunny windless weather those days.

DISCUSSION

The small Odonata collection from the Kingdom of Tonga presented here raises important discussion points. Despite the short sampling period and regardless of the fact that dragonfly collection was not the main purpose of the visit, seven new species for the country, including one subspecies new to science, were recorded. It is believed that this contribution is small and that the odonate studies of the Kingdom of Tonga must still be considered in their initial stages.

The total number of 16 species so far known for the country seems rather small and could be a reflection not only of the insufficient sampling efforts, but also due



Figs 9-11. *P. microcephalum stainbergerorum* ssp. n., habitat and general appearance: (9) prop roots of *Rhizophora* sp., a favourite perching place; – (10) habitat; – (11) male active in a rainy day.

to shortage of suitable odonate habitats. The total surface area of the country is scattered among numerous islands with small sizes and great demands of surface waters. Running waters are almost completely lacking, as are the species associated with them. 'Eua Island is the only place with tropical rainforests, hills and streams, which support large dragonfly assemblages (J. Harding, pers. comm.). Given its great isolation from neighbouring countries that hold lotic biotopes (about 900 km from Samoa and 800 from Fiji) one may expect new species to be discovered from this island too.

Species of Odonata so far recorded from the Kingdom of Tonga are represented by a high number of invasive species (87.5%). All of them are widely distributed throughout the Pacific with *Ischnura heterosticta* and *Lathrecista asiatica* reaching their easternmost limit there. Species of *Hemicordulia* and *Tramea* need further taxonomic work within the Pacific. The problem with the former was presented briefly above. The proper identification of *Tramea* species, however, is always a great challenge even with preserved specimens. The records on *T. transmarina* reported here are based on two males only. Other data are on passing individuals only. The synonyms already introduced in the literature are largely due to the variations of the dark basal area of the hindwings. Tonga's specimens identified as *T. transmarina* were compared with another male from Fiji where Brauer's syntypes come from. *T. transmarina* is the only species from the genus known from Fiji. They all show great similarity in head and thorax pattern as well as hamules and anal appendages. The only deviation from the Fijian specimen was observed again in the wing spot. Males collected from the Kingdom of Tonga have the dark area constricted in the middle and diffused to an almost transparent section in one of them. Further, the dark area is shorter and neither entering the subdiscoidal cell distally of the cubito-anal cross-vein nor reaching the posterior wing edge as in the Fijian specimen. To avoid future confusions and additional invalid names, *T. transmarina* is preferred here for the Tongan specimens. However, it must be confirmed with a larger sampling size involving in-depth morphological, as well as DNA analysis, of the genus over the entire Pacific. Moreover, *T. limbata* is another species from the genus given for Tongan archipelago (FRASER, 1927). One must bear in mind that LIEFTINCK (1975) already included all old *T. limbata* records for New Caledonia to the new subspecies *T. transmarina intersecta* he introduced. He also concluded that "... other Oriental "forms" of the *limbata*-group having a more western distribution (i.e. *euryale* Selys and *propinqua* Lieft.), are subspecies of *transmarina*." Therefore it is likely that the Tongan *T. limbata* is another subspecies of *T. transmarina*.

The percentage of species with wide distribution within the Pacific is very high leaving only 12.5% endemic to the Kingdom of Tonga. It is a situation not usually observed in neighbouring island groups. Numerous endemic species have been described in the initial samplings carried out in New Caledonia (MONTROUZIER, 1865; SELYS, 1871, 1885), Fiji (SELYS, 1871, 1891) and Samoa

(BRAUER, 1867; FRASER, 1925, 1927). Again it could be attributed to the fact that no odonate collection is available from 'Eua Island, which is perhaps the best place for dragonflies within the country.

The percentage of the endemic taxa would be even lower if it was not for the newly proposed subspecies. *Pseudagrion* is known to consist of 145 species (SCHORR & PAULSON, 2011), two-thirds occurring in Africa and Madagascar (DIJKSTRA & CLAUSNITZER, 2006). It is evident from the descriptions given here that the *Pseudagrion* species inhabiting the Pacific islands share a number of common features. It is the combination of particular morphological traits (mainly color patterns) that retains their species-specific status at present. Both TILLYARD (1924) and FRASER (1925) recognized the close affiliation of the proposed by them *P. pacificum* and *P. samoense* to *P. australasiae* Selys, 1876. LIEFTINCK (1949) suggested that all Australian records of *australasiae* by Tillyard must be considered as *microcephalum* and possibly the same conclusion is valid for Fraser's records as both authors had worked closely and published together during the same period. They erected the two separate species largely based on observed color variations with little support of the anal appendages. TILLYARD (1924) pointed out at the shorter lower lobe of superior appendages and longer inferior appendages of *P. pacificum*. FRASER (1925) did not compare the appendages of *P. samoense* with that of *P. m. microcephalum*, but emphasized on the fact that "... superior anal appendages lacking an inner lobe." which is not correct.

The great morphological similarities and their contemporary distribution suggest that possibly all species are conspecific (POLHELMUS et al., 2000) with *P. pacificum* and *P. samoense* being close descendants of *P. m. microcephalum* (T. Donnelly, pers. comm.) The detailed morphological analysis provided above supports this view and perhaps subspecific status for all of them is the best solution for the moment. This suggestion is based on the fact that although quite variable in color pattern no significant morphological differences are observed in both anal appendages and penises. One must bear in mind that even greater color variability would be observed if *P. m. microcephalum* was studied within its entire area. Ignoring these variations, which could be driven by the geographical disjunction rather than actual speciation, no definite morphological features could be proposed for separation at species level.

However, further support from DNA analysis is imperative for the final decision upon their true taxonomic status because the slight variations in both anal appendages and penes combined with the great isolation by distance infer an incomplete lineage sorting. Such analysis may reveal another situation of the so called "hidden" or "cryptic" species which were proven to be case for another species rich odonate genus – *Trithemis*. DAMM & HADRY (2009) suggested *T. morrisoni* sp. nov. and *T. palustris* sp. nov. based on material considered to be *T. stictica* (Burmeister, 1839). Known diagnostic characters of the three species are color variation and small differentiation in the morphology of the penes, which

highly resembles the situation with the Pacific *Pseudagrion* taxa. However, DAMM & HADRYNS (2009) also stressed on the support achieved by the preliminary genetic analysis commented upon in details in DAMM et al. (2010).

The DNA analysis suggested here would reveal important information on the Pacific islands odonate biogeography and phylogeny if other species like *Pseudagrion palauense* Lieftinck, 1962 were included. It was not included in the morphological analysis above as is known to be endemic to the Palau which is further away from the Kingdom of Tonga. Moreover in spite of its close general appearance to *P. m. microcephalum*, the anal appendages of *P. palauense* are obviously different enough to be confused with any of the taxa discussed above. However, preliminary genetic studies cluster *P. palauense* with *P. pacificum* (JOOP, 2005), which is a fact that must be considered in future studies on the genus from the Pacific.

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**POPULATION STRUCTURE IN DRY AND RAINY SEASONS
IN *ERYTHRODIPLAX UMBRATA* (LINNAEUS)
(ODONATA: LIBELLULIDAE)**

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Mark-recapture studies in adult odon. have revealed that rainy periods have a negative impact on population size, recapture rate, survival probability and life expectancy. One reason for this is that rainy periods are usually associated with low temperatures which indirectly and directly affect individual condition. However, given that most studies have been carried out in temperate environments it remains to be seen whether such phenomenon occurs in other places, i.e. tropical environments. Here, this question is approached by marking-recapturing the tropical *E. umbrata*, in a field site in central Colombia. Two seasons of opposite rainfall patterns were compared: a rainy and a dry season. After checking for no marking effects, no difference was found in population size and recapture rate. However, animals from the dry season had a higher survival and life expectancy compared to animals from the rainy season. These apparently conflicting results, suggest differential effects of seasonality. A population compensation may be occurring in the rainy season (with more animals emerging at this time compared to the dry season) despite the negative effects on survival. Thus, the principle that rainy periods have a negative impact in tropical odon. ssp. seems supported.

INTRODUCTION

Adult odonates are useful study subjects for population structure research due to the following reasons: adults are site-faithful, relatively large for marking and

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detection, and fairly easy to catch (CORDERO RIVERA & STOKS, 2008). Due to this and among other issues, we have a good knowledge of how abiotic factors drive population size, survival probability and life expectancy. One such abiotic factor is rainy periods which are associated with decreases in population sizes and a reduction in survival and life expectancy (e.g. CORDERO RIVERA & STOKS, 2008). In temperate environments, in which most odonate population structure studies have been carried out, raining periods are linked with a number of proximate factors that negatively affect individuals and a whole population. Given that odonates are impeded to flight under raining periods, examples of such factors is that adults cannot fly to prey the small flying insect items they use, or die because of extremely low temperatures associated with rains over long time periods. However, how much we can generalize from studies carried out in temperate environments over tropical environments is debatable. Related to population structure studies, one simple reason is that in tropical places, raining periods are not necessarily linked to low temperatures. This means that raining periods should not necessarily lead to negative effects at the individual and population level. To our knowledge, this issue has not been explored in odonates.

In the present study we explored the question of whether reduction in odonate population attributes such as population size, survival probability and life expectancy, are associated with raining periods in a tropical environment by using a mark-recapture study. For this, we compared the above attributes over two periods that contrast in waterfall availability. We used a libellulid study subject, *Erythrodiplax umbrata*.

MATERIAL AND METHODS

STUDY SUBJECT AND AREA. – *E. umbrata* is a large dragonfly whose distribution goes from South United States to North Argentina. Both male and female appear in two morphs: one has a dark band on all wing pairs. Our study was carried out in a rice crop of 74 ha whose plants were 45 days-old, within which one transect (200 m) was established. The study site is located in the Pachaquiaro rice stripe in Puerto López municipality, which is located at 178 masl in the Colombian Meta department. Maximum annual temperature is 30.6°C, while the average temperature ranges between 24-28°C, and 77% of average relative humidity and 2700 mm of average precipitation. In general, the site has a monomodal rainfall, with a dry period that goes from December to February, and a rainy period that goes from March to November. Average temperatures in these two different seasons are as follows: 27.2°C for the dry season and 24.5°C for the rainy season.

COLLECTION AND MARKING. – Field work was carried out between June 21-24, 2010 and between May 2-6, 2011 (from now on, the rainy period), and between March 10-29, 2011 (from now on, the dry period), and from 09:00 to 17:00 h. Non-marked dragonflies were daily captured with aerial nets, and individually marked on any wing using three-digit numbers between 001 and 630 with a red, black, green or blue Sharpie® fine tip marker. After marking, a census was carried.

STATISTICAL ANALYSIS. – Prior to any analysis and as recommended by ANDERSON et al. (2011), we tested whether the probability of resighting was dependent on marking (either color-dependent or wing used for writing). This analysis was done to control for any biases in resighting probability in our subsequent analysis. For this, a contingency table (X^2 tests) was used comparing the resighting occurrence among different marking categories. Population size and survival probability

(*s*) were estimated using JOLLY (1965), SEBER (1965) and MANLY & PARR (1968) data analyses. Data variances of both seasons were compared using X^2 tests. The life expectancy (*le*) was calculated as is described by GARRISON & HAFERNIK (1981). Recapture rate was analyzed using X^2 tests with Statistica 8.0 software.

RESULTS

MARKING EFFECTS

Color used for marking was not associated with the probability of resighting (Tab. I; $X^2 = 7.13$; $p = 0.414$). Similarly, wing used for marking was not associated to probability of resighting (Tab. I; $X^2 = 4.26$; $p = 0.748$).

POPULATION SIZE, SURVIVAL, LIFE EXPECTANCY AND RECAPTURE RATE

Data of number of captured and recaptured animals appear in Table I. There was no difference in terms of recapture rate for both seasons ($X^2 = 5.60$, $p = 0.356$) and sex within each period ($X^2 = 2.04$, $p = 0.35$). Males from the dry season were less likely to be recaptured compared to males from the rainy season ($X^2 = 25.16$, $p < 0.01$). Females from both seasons were similarly likely to be recaptured ($X^2 = 21.03$, $p = 0.329$). Population size varied widely within each period, but no significant difference was detected when comparing both the dry and rainy season (Manly-Parr, $p = 0.49$; Jolly-Seber, $p = 0.36$). Survival (*s*) and life expectancy (*le*) for both sexes was higher in the dry season (0.9 and 9 days respectively) than in the rainy season (*s*: 0.84; *le*: 6 days). Within each sex and for both seasons, females had a higher survival (*s*: 0.92) and life expectancy (12 days) than males (*s*: 0.2; *le*: 0.62 days). Comparing both seasons and within sex, females had a survival and life expectancy of 0.90 and 9.94 days respectively for the dry season, and 0.85 and 6.33 days respectively for the rainy season. However and in the rainy season, survival and life expectancy for males was 0.24 and 0.71 days respectively. Calculations of survival and life expectancy for males in the dry season were not carried out given their low number of recaptures.

Table I

General data of marked and recaptured animals according to season and sex – [N = total number of marked individuals; – RC = total number of recaptured individuals; – RC% = relative number of recaptured individuals]

| Period | N Males | RC males | %RC males | N Females | RC Females | %RC females |
|--------|---------|----------|-----------|-----------|------------|-------------|
| Dry | 52 | 4 | 7,69% | 330 | 28 | 8,48% |
| Rain | 56 | 6 | 10,71% | 190 | 11 | 5,78% |
| Total | 108 | 10 | 18,40% | 524 | 39 | 14,26% |

DISCUSSION

Having discarded that our animals were not affected by marking, our results suggest that despite no changes in population sizes across seasons, there was a difference in survival and life expectancy. Unexpectedly, animals had higher values during the dry season compared to the rainy season. It is unlikely that these differences were caused by temperature-driven effects for several reasons since the difference between both seasons seems negligible (dry season: 27.2°C, rainy season: 24.5°C). Possible non-mutually excluding factors explaining biases in survival and life expectancy are: (a) that raining periods can impede flying and, consequently, feeding. This may be especially problematic for recently emerged animals who usually emerge with scarce nutritional reserves (in the form of fat reserves; MARDEN, 1989); – (b) that more water availability can allow for better conditions for parasite transmission to dragonfly hosts. It may be that parasites such as gregarines can increase in number so that odonates can get more parasitized by these parasites during raining periods. Gregarines are present in the odonate faeces which mosquitoes and other small flying insects, use as food (reviewed by FORBES & ROBB, 2008). These intermediate hosts are later consumed by odonate adults so that the gregarines are ingested and develop in the odonate gut. It may be that raining periods allow for such intermediate hosts to be more common so that the gregarine life cycle can replicate more frequently and thus more odonate adults become infected; – (c) more intense predation of odonate adults during the rainy season, by predators such as birds due to the breeding season of the latter (CORBET, 1999); and, – (d) anthropogenic factors such as use of pesticides during the rainy season (in fact, during our study and in this rainy season, fumigation was observed by the land owner; FP-R and NAC-S, pers. obs.).

Interestingly, despite survival and life expectancy differences, population size was similar for both seasons. This means that independently of what sources may be driving mortality in the rainy season, there may be conditions that favour population increases during this time. We are not aware of any odonate study that has documented a similar pattern. Possibly, at the larval stage and during the rainy season, conditions are more benign, thereby reducing mortality at this stage. During the larval stage, mortality in odonates is usually associated to two factors: predation and food (a third factor would be time constrain to complete development but this would usually apply for non-tropical species. It would be difficult to say which of these two factors may drive mortality in our study species.

Survival values in *E. umbrata* are higher than in libellulids and odonates in general (around 0.8 and 0.85 respectively), while life expectancy values are lower than in libellulids and odonates in general (around 9 and 25 days respectively; reviewed by CORDERO-RIVERA & STOKS, 2008). However, these comparisons have to

be taken with caution as many studies in other odonates did not mark-recapture long enough (as it is our case) to get reliable computations of survival and life expectancy values, and/or have been carried out in times when either time periods are too benign (which are unlikely to reflect the natural conditions odonates are regularly exposed to) (CORDERO-RIVERA & STOKS, 2008). Finally, we detected a sex-biased survival difference in which females seemed to have higher survival and life expectancy values than males. These results are opposite to other libellulids and odonates in general (reviewed CORDERO-RIVERA & STOKS, 2008). One reason for this is a longer maturation period for males that expose them to higher mortality (ANHOLT, 1997). One cause would be that males demanded more nutrients than females and, if active foraging is associated with higher vulnerability to predation, then males would survive less than females. These potential causes need further investigation.

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DIE LIBELLEN DER GERMANENGÖTTIN FRIGGA

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*... mit allem Fleiß viel Jahr über zusammengetragen und jetzt
den Gelehrten zur beliebigen Vermehrung und Verbesserung überlassen ...*

Johann Leonhard FRISCH, 1740,
Odonatologe, der zum allerersten Mal
das Wort „Libelle“ verwendete

THE DRAGONFLIES OF THE GERMANIC GODDESS FRIGGA – In 1919, the German author Hermann Löns published ‘*Wasserjungfern. Von Sommerboten und Sonnenkündern*’ (Voigtländer-Verlag, Leipzig), a collection of thirteen dragonfly stories written in a particular emotional style. Here Löns stated that in paganian Germanic times dragonflies had been consecrated to the goddess Frigga and that, therefore, early missionaries had damned dragonflies as diabolic, imposing on them the names ‘*Satansbolzen*’ and ‘*Teufelsnadel*’. The ‘*Wasserjungfern*’ were reprinted many times up to today and these statements have become widespread popular belief in Germany. Their diction being close to Nazi-terminology, Löns’s statements as to Frigga and the damnation of dragonflies were amended from the first edition following WW II but appeared again in all later editions. Here it is shown, by analyzing mythological and earliest clerical as well as ethnographic and old entomological literature, that dragonflies never have been consecrated to a Germanic goddess and that no clerical damnation ever took place.

ZWEI BEHAUPTUNGEN DES HERMANN LÖNS

Lange schon wird in der deutschen Populärliteratur kolportiert, Libellen seien Attribut einer germanischen Göttin gewesen. Verfolgt man die Spur dieses *statements* zurück, stößt man vor rund 100 Jahren auf Hermann Löns, der in seinen ‘*Wasserjungfern*’ (LÖNS, 1919) zum ersten Mal diese Verbindung zwischen Libellen und Germanengöttin behauptete, aber ohne seine Behauptung zu belegen. Als die Göttin nennt er Frigga, die *first lady* des Pantheons. Seither ist das in populärer Literatur sehr oft wiederholt worden, aber nie mit einem Beleg.

Häufig liest man im Zusammenhang hiermit, als einer heidnischen Göttin geweihte Wesen seien Libellen von karolingisch-fränkischen Christenmissionaren verteufelt und zu Satansbolzen und Teufelsnadeln umgetauft worden. Auch diese Behauptung einer Verteufelung, verkörpert in den beiden diabolischen Namen, findet sich erstmals in den „*Wasserjungfern*“ von Löns. Später werden in der Populärliteratur die Missionare zu der Lönsschen Verteufelung hinzugefügt und diese damit zeitlich präzisiert. Auch hierfür wird nie ein Beleg angeführt, so dass es scheint, als seien diese Feststellungen aus einem schon zur Zeit des Hermann Löns vorhandenen wohlbegründeten Allgemeinwissen geschöpft.

DIE ZENSIERTEN WASSERJUNGFERN

Vor ungefähr 35 Jahren nannte ich einem mir befreundeten Libellenkundler den Hermann Löns als Quelle für diese angebliche Verbindung zwischen Libellen und Germanengöttin, bekam aber umgehend die Nachricht, der Dichter sei wohl doch nicht der Urheber, man habe in den „*Wasserjungfern*“ vergeblich nachgesehen. Etwas verwundert – ich war mir sicher, bei Löns darauf gestoßen zu sein – nahm ich damals die „*Wasserjungfern*“ aus dem Regal, die zu jenem Zeitpunkt letzte Ausgabe von 1953, und fand darin nichts von Frigga. Selbstzweifel kamen auf, während ich zerstreut das brüchige zweite Exemplar meiner „*Wasserjungfern*“ nahm, die Erstausgabe von 1919, und nachdenklich in den ersten Seiten herumblätterte, als mir das Wort Frigga förmlich in die Augen sprang. In dem Moment hatte ich einen Fall von Zensur entdeckt. Diese Erstausgabe von 1919 hatte ich vor langer Zeit gekauft und gelesen. Sie und alle folgenden Ausgaben bis zum Zweiten Weltkrieg enthalten die Behauptung zur Frigga-Verbindung der Libellen und ihrer Verteufelung. Die später erworbene Ausgabe von 1953, die erste nach dem Krieg, hatte ich nicht mehr gelesen, sondern nur wegen ihrer Farbphotos mit den so falsch determinierten Libellen gelegentlich darin herumgeblättert. Ein Vergleich beider Ausgaben ergab damals: In der 1953er Ausgabe fehlt der gesamte Abschnitt, in dem Löns die Libellen als der germanischen „Sommergöttin Frigga“ verbunden und deshalb als später „verteufelt“ bezeichnet, „wie alles, was unseren Urahnen hold und heilig war“, einstmals, als nämlich „das deutsche Naturempfinden noch nicht mit asiatisch-romanischer Brähe übergossen war“ (Zitate aus LÖNS, 1919). Solche Formulierungen erschienen den beiden Verlagen, die 1953 je eine Einzelausgabe der „*Wasserjungfern*“ herausbrachten (LÖNS, 1953a, 1953b), offenbar noch als ideologisch anrüchiges Germanentum und verständlicherweise nicht druckbar. In beiden 1953er Ausgaben fehlt der betreffende Abschnitt zwischen dem letzten Satz auf Seite 13 und dem ersten Satz auf Seite 14. Der restliche Text ist identisch mit dem von 1919. Hermann Löns, der Libellenfreak, würde sich im Grabe umdrehen, wegen der eklatant falschen Artbestimmungen auf den Farbphotos und wohl auch wegen der Zensur.

Schon als ich die Lönsschen Behauptungen zum ersten Mal gelesen hatte, waren

sie mir kaum akzeptierbar erschienen, und vor rund 35 Jahren stimulierte mich die Entdeckung der Streichung des Frigga-Absatzes, die Quellen zu suchen, aus denen Löns seine Ansichten gewonnen haben mag.

QUELLENSUCHE UND IHR ERGEBNIS

Die Menge der insgesamt durchgesehenen Literatur kann hier nicht aufgeführt werden. Für in meinem Text allgemein angesprochene, aber nicht einzeln zitierte Literatur sei verwiesen auf die Bibliografien in den Sammelwerken von GRIMM (1878, 1899), GRÖNBECH (2002), GOLTHER (2004), SIMEK (2009), KRAMER (1486), HUMMEL (1787, 1791). Das Verzeichnis von SIMEK & PALS-SON (1987) enthält die gesamte altnordische Literatur.

Hermann Löns kann seine Behauptung von der Verbindung Frigga-Libellen entweder unmittelbar aus den germanischen Urtexten, aus im weitesten Sinn volkskundlicher Literatur oder aus älteren entomologischen Schriften entnommen haben. Angesichts seines detailliert bekannten Bildungsweges und Tätigkeitsspektrums (LÖNS, 1921; ANT, 1972; BECKMANN, 2006) erscheint es gesichert, dass er nur hochdeutsche Übersetzungen germanischer Texte nutzen konnte und nicht etwa Originale in altnordischer und altdeutscher Sprache. Also konnte sich die Quellensuche zunächst auf die wenigen bis zum Verfassen der „*Wasserjungfern*“ übersetzten germanischen Texte beschränken. Sie waren leicht ausfindig zu machen, ebenso die damals existierenden zusammenfassenden „Mythologien“ als Sekundärliteratur, wovon viele auf Grimms „*Mythologie*“ (GRIMM, 1878; mehrere Aufl. seit 1835) fußen, welche ihrerseits möglicherweise von Löns gelesen worden ist.

Durch Mängel einer Übersetzung kann man fehlgeleitet werden (Paradebeispiel sind die angeblichen Libellen im Gilgamesh-Epos), und um das zu vermeiden, bin ich in den sehr wenigen Fällen, wo in Übersetzungen Insektennamen auftauchen, gezielt in die alten Originaltexte gegangen, um die Übersetzung zu beurteilen.

Man könnte die auf Island und Grönland entstandenen Anteile der beiden Eddas, also der Prosa-Edda und der Lieder-Edda, sowie alle anderen isländischen und färöischen Texte wegen des Fehlens von Libellen im Entstehungsland eigentlich übergehen. In den noch in Norwegen und den norwegischen Kolonien in England wurzelnden älteren Anteilen der eddischen Texte könnten Libellen dagegen auftauchen.

Löns dürfte jedoch eher den südgermanischen Raum gemeint haben, wofür – wie weiter unten deutlich wird – auch seine Nennung der Göttin Frigga spricht. Für diesen Raum gibt es keine dort geschriebene Originalliteratur, die unmittelbar die Mythologie darlegt, wie etwa im Norden die beiden Eddas (NECKEL & KUHN, 1983) oder die *völuspa* und die *gylfaginning* des Snorri Sturluson (SIM-ROCK, 1888). Abgesehen von Details erachtet man die in nordischen Texten

geschilderte Götterkunde auch für Südgermanien als relevant. Von den frühen römischen Berichterstatern über die Mythologie Südgermaniens ist Tacitus mit seiner *Germania. De origine et situ germanorum* (MUCH et al., 1967) der wichtigste. Er verfällt aber der bekannten *interpretatio romana* (BATTAGLIA, 2001), die mancherlei Ausführungen des Römers nicht vorbehaltlos akzeptierbar macht. Mit der Missionierung verfasste die christliche Obrigkeit der bekehrten Heiden Südgermaniens Schriften wie z.B. den *Indiculus superstitionum et paganiarum*, das Sächsische Taufgelöbniß, das *liber decretorum* des Burchard von Worms und zahlreiche ähnliche Rechts- und Verhaltensvorschriften (zusammenfassend: die oben erwähnten Sammelwerke und GRIMM, 1899), woraus bisherige mythologische Vorstellungen und Gebräuche indirekt erschließbar sind. Mittelalterliche Glossarien und Wörterbücher wie z.B. VOCABULARIUS TEUTONICO-LATINUS (1482), sowie auch Runenwörterbücher (DIETRICH, 2004), bieten neben Übersetzungen von Stichworten aus der Mythologie in vielen Fällen erläuternde Ausführungen zu ihrem Inhalt. Als Quellen können auch die großartigen Lexika des 18. Jahrhunderts (z.B. ZEDLER, 1732-1750; ADELUNG, 1796) dienen, die im Detail ihrer Einträge wahre volkskundliche Fundgruben sind.

Nicht übergehen darf man die zahlreichen uralten zoologischen und teils entomologisch spezialisierten Schriften, angefangen bei ALDROVANDUS (1602) und SWAMMERDAM (1669), die fast immer auch Information über die sachlich-biologische hinaus liefern. Weitere werden hier nicht einzeln genannt, weil ihre Bekanntheit bei jedem Entomologen vorausgesetzt wird. Vor allem im Libellenschrifttum des Johann Leonhard FRISCH (1740) könnte man Hinweise vermuten, weil er nicht nur Entomologisches und Volkskundliches produzierte, sondern als slawischer Philologe geradezu berühmt und Privatlehrer des Leibniz war.

Löns hatte als Libellenliteratur „*Die Geradflügler Mitteleuropas*“ in der Auflage von 1907 (TÜMPEL, 1907) zur Verfügung, wie wir aus seiner Korrespondenz wissen (BECKMANN, 2006). Zu einer Verbindung zwischen Frigga/Freya und den Libellen finden sich in keiner Ausgabe der „*Geradflügler*“ irgendwelche Hinweise. Mit dem westfälischen Libellenkenner Hermann Julius Kolbe (später Professor in Berlin) pflegte Löns als Student an der Universität Münster engen Kontakt. Von Kolbe ist keine Bemerkung zur Libellenmythologie bekannt, weder in seinen Publikationen noch in den publizierten Protokollen seiner insektenkundlichen Vorträge vor der Zoologischen Sektion im Westfälischen Provinzial-Verein für Wissenschaft und Kunst (heutiger Naturwissenschaftlicher Verein) in Münster. Leicht konnte ich eruieren, welche entomologischen Publikationen Hermann Löns damals in der Bibliothek des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst in Münster vorfand: Aldrovandus, Burmeisters Handbuch, Gesner, Kirby & Spence, Lampert, Sulzer, Frisch sowie zahlreiche frühe Zeitschriften, darunter die komplette Stettiner Entomologische Zeitung, aus der Löns die Libellenaufsätze des Hermann August Hagen kannte und in der er sel-

ber publizierte.

Zusammengefasst ist das Ergebnis der Recherche: weder in nord- und südgermanischen Urtexten, noch in der erwähnten entomologischen und volkskundlichen Literatur gibt es einen Hinweis auf eine Verbindung zwischen Libellen und germanischen Gottheiten, nicht einmal bei GRIMM (1878), der wohl detailreichsten Darlegung germanischer Mythologie. Zweifellos habe ich nicht alles durchgesehen, was relevant sein könnte, in 35 Jahren aber doch so vieles ohne Bestätigung der Lönsschen Behauptungen, dass jetzt die folgende Stellungnahme berechtigt erscheint, die darlegen soll, warum ein negatives Ergebnis der Recherche zu erwarten war.

FRIGGA VERSUS FREYA

Anstatt der Lönsschen Frigga wird später sehr häufig die Göttin Freya genannt. Frigga alias Frigg alias Frija alias Fria alias Frea und andererseits Freya alias Freyja sind jedoch trotz oberflächlicher Namensähnlichkeit keineswegs identisch. Populäre deutsche Literatur – nicht die wissenschaftliche – versteht gleichwohl sehr oft unter allen Namen eine einzige Göttin. Schon GRIMM (1878) beklagte diese unverständliche Verwechslung. Zusätzlich zu den Grimmschen Hinweisen auf die Existenz zweier Göttinnen enthalten die beiden Eddas (GENZMER, 1984, für andere Übersetzungen siehe die oben genannten Sammelwerke) zahlreiche Belege. Nur zwei Beispiele: Der Bericht von der Verbrennung der Leiche des von seinem Bruder Hödur getöteten Gottes Baldur beschreibt die Ankunft illustrier Trauergäste: zunächst fährt das Ehepaar Odin-Frigga vor, später Freya in ihrer von Katzen gezogenen Karosse. Bei dem Trinkgelage des Meeressgottes Aegir für das Götterkollegium werden Frigga und Freya jede für sich vom Gott Loki angesprochen. Anders liegt der Fall der männlichen Hauptgottheit, die zwar zwei Namen trug, im Süden Wodan, im Norden Odin, die aber eindeutig dasselbe Individuum meinen.

Allerdings gab es unter den Germanen, die ja kein einheitliches Volk darstellten und deren Religion alles andere als inhaltlich und im Kultus einheitlich kodifiziert war (BÖNISCH, 1830; HERRMANN, 1898; MOTZ, 1992), regional und über die Jahrhunderte erheblich variierende Auffassungen der sterblichen und gelegentlich in ihrem Handeln geradezu über-anthropomorph einfältigen Götter. So hatte in Ost-Schweden und Island Freya zeitweise ein viel höheres Gewicht als Frigga, die Gattin des Oberstgottes Odin. Unzweifelhaft ist jedenfalls, dass Freya erst ziemlich spät und im Norden auftauchte, zusätzlich zu Frigga (SIMEK, 2009, S. 62). Freya ist also nicht ursprünglich südgermanisch, Frigga dagegen wohl. Träfe die Lönssche Behauptung der gezielten Libellenverteufelung bezüglich des Zeitraumes der in jüngerer Populärliteratur unter Hinzufügung der Missionare erwähnten karolingisch-fränkischen Epoche zu, wäre auch dadurch Freya zwangsläufig ausgeschlossen, weil sie in jener frühen Zeit noch nicht existierte. Auch der

moderne nordeuropäische Autor Peterson erwähnt für die Verbindung Göttin-Libellen die in seinem Raum bedeutsamer gewesene Freya (PETERSON, 2003). Vermutlich kannte er die These des Hermann Löns nicht original und orientierte sich an der überwiegenden Nennung von Freya in der deutschen Populärliteratur. Jedenfalls ist der Ersatz der Lönsschen Frigga durch die isländisch-nordische Freya nicht berechtigt. Es lässt sich sowieso für keine der beiden eine Verbindung zu Libellen nachweisen.

EINE GÖTTERWELT OHNE LIBELLEN

Den in nordgermanischen Schriften geschilderten Menschen, in deren Lebensinhalt unentwegtes Morden, Töten und Blutrache ja buchstäblich Tagesordnung waren (BÖLDL et al., 2011; GRÖNBECH, 2002; HERRMANN, 1898, 1903), und auch ihren überaus anthropomorphen Göttern waren Pferd, Stier, Bär, Wolf und Adler von Bedeutung, aber nicht unscheinbare Insekten. Entsprechend selten und nur beiläufig tauchen Insekten in den eddischen Texten auf, die im Norden bekanntlich extrem lästigen und damit sehr auffälligen Stechmücken nur ein einziges Mal. Zu erwähnen sind die Heidreksrätsel (Mistkäfer), das Sonnenlied (Fliege), ferner die Episode, dass der Gott Loki in Gestalt einer Fliege durch ein kleines Wandloch in Freyas verriegeltes Schlafzimmer eindringt, um deren Schmuck zu stehlen, wobei er sich überdies noch in einen Floh verwandelt, sowie die negative Rolle einer Stechmücke beim Schmieden von Thors Hammer durch das Zwergenbrüderpaar Sindri und Brok. In nordgermanischer Mythologie und Götterkunde findet man also von Libellen nicht die geringste Spur. Erwartungsgemäß fehlen Libellen auch in den zahlreichen bis in das dort noch heidnische 9. Jahrhundert zurückgehenden isländischen Sagas, die ja volkskundliche Quellenliteratur sind (jüngste, als vollständig angesehene Übersetzung: BÖLDL et al., 2011). In bildlichen Felsritzungen sind Frigga und Freya manchmal von Vögeln begleitet, aber von Insekten nicht die geringste Spur. Auch die vielen skandinavischen *flisor*, also die Runensteine, die schon Linné und nach ihm viele andere sorgfältig untersuchten (LINNAEUS, 1745), zeigen zwar gelegentlich Schlangen oder stilisierte Vogeldarstellungen, aber keine Insekten. Man fand vor allem in Dänemark große Mengen Brakteaten und medaillenartige *guldgubber* aus der Zeit 400 bis 700, die auch gravierte Tierdarstellungen tragen – doch keine Insekten (SIMEK, 2009).

Eher noch als in nordgermanischen Texten erwartet man Libellen also in den südgermanischen („deutschen“) Mythen. Die bereits oben erwähnten und weitere den südgermanischen Raum berührende sehr frühe Autoren wie etwa Paulus Diaconus (der als Erster überhaupt Freya/Frigga erwähnt; ABEL, 1849), Saxo Grammaticus, Adam von Bremen, sowie anonyme Texte, etwa die Merseburger Zaubersprüche, *Indiculus superstitionum et paganiarum* und weitere (siehe oben erwähnte Sammelwerke) liefern zu Insekten keinerlei Erkenntnisse. Libellen kom-

men auch im südgermanischen mythologierelevanten Schrifttum überhaupt nicht vor.

Aufgrund der mythologischen Urtexte und der volkskundlichen Literatur sind Frigga und Freya auch von NÄSSTRÖM (1995) und DAVIDSON (1998) sehr gründlich auf ihr Wesen, ihre Eigenschaften und Assoziationen analysiert worden – auch sie fanden von Libellen keinerlei Spur.

Im 18. und vor allem im 19. Jahrhundert waren in der bildenden Kunst germanisch-mythische Bildmotive beliebt und verbreitet. COTTERELL (2003) führt mit vielen Bildbeispielen eine lange Reihe der Maler auf, die sich in dieser Richtung hervorgetan haben. In ihren Gemälden tauchen selbstverständlich Freya mit ihren Katzen, Wodan/Odin mit seinen Raben und Wölfen, sowie Thor mit seinen Böcken auf, um nur diese Beispiele zu nennen, doch Insekten, Libellen gar, findet man nicht, obgleich in dieser Zeit kurz vor Löns den Mythologie-Malern die Verbindung Germanengöttin-Libellen gewiss ebenso gut bekannt gewesen wäre wie dem Löns, wenn sie denn jemals dokumentiert gewesen wäre.

SATANSBOLZEN UND TEUFELSNADEL – DIE FIKTION DER VERTEUFELUNG

Warum tauchen die beiden von Löns erwähnten und nach späterer Meinung angeblich von den Missionaren vergebenen Namen Satansbolzen und Teufelsnadel erst in junger Literatur auf? Diabolische Libellennamen, nämlich Teufelsbolzen und Teufelsreitpferd, sind erstmals 1793 nachweisbar, und zwar nur lexikalisch, aber nicht als im Volk bekannter Name (SCHÄFER, 1947, S. 84), ein doch überraschender Befund. Natürlich waren diese Namen auch vor der Aufnahme in ein Lexikon mehr oder weniger lange vorhanden. Der Lönssche Satansbolzen ist vor ihm überhaupt nicht nachweisbar und – wiederum überraschend – jedenfalls noch nicht zu Beginn des 20. Jahrhunderts als im Volk bekannter Name (SCHÄFER, 1947). Die Etymologie des Wortteiles -bolzen, früher -bolt und -boltz, als mit der Armbrust verschossenes kurzes und (libellen-)schnelles Geschoss im Unterschied zum Pfeil des Bogens dürfte Satansbolzen/Teufelsbolzen allerdings bis zur Entwicklung der Armbrustwaffe unwahrscheinlich machen. Nur etwa sieben mehr oder weniger diabolische Libellennamen (wenn man dialektische Varianten nicht getrennt von ihren hochdeutschen Namensformen zählt) findet man in der deutschen Volkskunde (SCHÄFER, 1947), eine neben den ungefähr 1650 von Schäfer ermittelten neutralen und „guten“ göttlichen Volksmundnamen verschwindende Minderheit mit außerdem geringer regionaler Verbreitung. Nach SCHÄFER (1947) war nämlich z.B. die Lönssche Teufelsnadel ursprünglich mit sehr wenigen Ausnahmen auf zwei ziemlich enge Gebiete Deutschlands beschränkt, nämlich Westfalen/Münsterland (wo Löns Schulzeit und Studium verbrachte) und Teile Südwestdeutschlands (wo Löns seit 1891 in Kaiserslautern als Journalist arbeitete), bis in die angrenzende Schweiz. Schon allein vor diesem

Hintergrund scheint mir die von Löns nur mit den Namen Teufelsnadel und Satansbolzen begründete Behauptung einer gezielten Verteufelung nicht haltbar.

Nach einer bisher nur ein einziges Mal in der kunstgeschichtlichen Literatur geäußerten, dort aber nicht begründeten Meinung (FLECHNER, 2008) soll bei der Christianisierung ja sogar der Hirschkäfer explizit zum Sinnbild des Teuflichen umgewertet worden sein. FLECHNER (2008) analysiert ein Stillleben von Jacob Marrell (1631-1681), das neben einer auf einem Tisch liegenden Tulpenblüte als einzige Insekten einen kleinen Bockkäfer vom *Leptura*-Typ und einen Schmetterling, dem *Vanessa*-Typ ähnelnd, zeigt. Den Bockkäfer beschreibt FLECHNER (2008) ausdrücklich als „links im Schatten krabbelt ein Hirschkäfer“, den Schmetterling als „Bärenspinner“ – man weiß sogleich, dass man die Kunsthistorikerin Nina Flechner kaum ernst zu nehmen braucht. Wollte man solchen modernen Darlegungen glauben, hätte es für die Missionare genug diabolische entomologische Substanz gegeben, die sie in ihren Schriften, wie vieles andere neuerdings Teufliche, hätten erwähnen können. Man findet jedoch in klerikalen Schriften wie *Indiculus superstitionum et paganiarum* und allen anderen vergleichbaren Texten (siehe oben genannte Sammelwerke), die alles nunmehr als heidnisch Verdammte aufzählen und bei Strafe mit dem Bann belegen, nicht einmal eine Andeutung von Insekten.

Ein weiteres Argument gegen die Verteufelungsthese könnte in den alten Wurzeln des neuhochdeutschen Begriffs Ungeziefer liegen. Germanische Ansicht war ja, wie bereits durch Tacitus zutreffend beschrieben, den Göttern seien neben den üblichen Menschenopfern nur bestimmte würdige Tiere zu opfern und zu widmen. Diese Tiere wurden mit den untergegangenen Begriffen *ziefer* und *geziefer* bezeichnet und waren eindeutig definiert, eine Kategorisierung, die sich übrigens noch 1486 im berühmten „Hexenhammer“ (KRAMER, 1486) findet, einer gewichtigen Quelle für frühe Volkskunde. Alles andere Tierische hieß *ungeziefer*, und neben beispielsweise Reptilien und Amphibien gehörten dazu Insekten. Also können Libellen, weil zweifellos *ungeziefer*, sowieso keiner Göttin geweiht gewesen sein, was eine Verteufelung erübrigte. Die Trennung von *geziefer* und *ungeziefer* war gewissermaßen taxonomisch neutral; *ungeziefer* hatte nicht die moderne negative Konnotation, schon gar nicht als Teufelszeug. Im germanischen Paganismus gab es ja keinen Teufel, nicht einmal andeutungsweise den Begriff einer im Jenseits strafwürdigen Sünde und folglich auch keine Hölle. Die germanische *hel* gleicht zunächst keineswegs der christlichen Hölle, sondern ist als Gegenstück zu *walhall* einfach der jenseitige Verbleib der nicht in heroischem Kampf auf der *walstatt* Gestorbenen (SCHÜTZE, 1750; SIMEK, 2009). (Allerdings muss man einräumen, dass in den Urtexten für *hel* nichts von den in *walhall* üblichen Trinkgelagen berichtet wird.)

Somit bestand also für Missionare überhaupt kein Anlass, Libellen und Hirschkäfer gezielt zu verteufeln.

Nun könnte eine Verteufelung der Libellen, wenn nicht bereits in missionari-

scher Frühzeit, dann doch in jener dunklen Phase des christlich gefestigten Mittelalters manifest geworden sein, die sogar Menschen verteufelte. Bislang vielleicht nur unterschwellig als teuflisch gewertete Libellen hätten doch, wie andere Tiere auch, zum Attribut der Hexen, dieser Teufelsweiber, avancieren können. Wenn Libellen schon Teufelpferde waren, warum ritten nicht auch des Teufels Hexen auf Libellen? In der bei KRAMER (1486) angeführten zahlreichen alten Anti-hexenliteratur finden sich nicht wenige Verweise auf Tiere, auch Insekten, aber nicht das Geringste zu Libellen.

Wenn ich also annehme, den Libellen sei keineswegs die von Löns behauptete gezielte Verteufelung widerfahren, weder durch Missionare noch später, so möchte ich als Begründung auch die wenig im Bewusstsein stehenden mittelalterlichen Prozesse der Kleriker gegen vermeintlich oder tatsächlich schädliche Insekten erwähnen. Schon der vom Dominikanermönch Heinrich Kramer verfasste „*Hexenhammer*“ (KRAMER, 1486) diskutierte und rechtfertigte Prozesse gegen Insekten. Eine ausführliche Anleitung dafür schrieb der Geistliche Felix HEMMERLIN (1582 und viele folgende Aufl.); es fehlen darin Libellen. BERKENHOFF (1937), EVANS (1987), CHÈNE (1995), SCHENKLING-PREVOT (1897) nennen zahlreiche detaillierte Belege für solche Prozesse, in denen die Kleriker Gott um Vollstreckung der Todesurteile baten – man hatte ja noch kein DDT. Belege für Prozesse gegen Libellen gibt es nicht. Dabei wären Strafprozesse auch gegen Libellen durchaus denkbar gewesen, denn gerade diese neuerdings teuflischen und stechenden, im Mittelalter sogar oft in gefährlichen Massenschwärmen auftretenden Untiere musste man doch einfach, so wie Maikäfer auch, durch kirchlichen Richterspruch oder Exorzismus bannen! Doch nichts davon.

Übrigens vermissen wir bis heute die Behauptung einer missionarischen Verteufelung der realiter gewissen Heidengöttern geweiht gewesenen Tiere, also Odins Raben (ZERLING & BAUER, 2001), die allen zu christianisierenden Germanen ganz gewiss aus eigener Anschauung vertrauter waren als ausgerechnet die im Waldland Germanien, der *regio silvis horrida* des Tacitus, vermutlich nicht häufig zu treffenden Libellen, ferner die Katzen der Freya und die Keiler ihres Bruders Freyr – um nur diese drei zu nennen. Die gelegentlich zu sehende Verbindung von Katzen und Hexen taucht erstmals in der Malerei des Hochmittelalters auf und bleibt selten (BÖLDL, 2011; DAVIDSON, 1988).

DES TEUFELS ODER GOTTES PFERD?

Ausgerechnet im Bereich der Freya-Mythologie, in Schweden, war vor Jahrhunderten der volkstümliche Libellenname „Gottespferd“ so gebräuchlich, dass selbst Linné ihn in seinen Schriften mehrfach benutzte, etwa in seiner „*Tal om märkvärdigheter uti insecterna*“ (Rede von den Merkwürdigkeiten der Insekten) (LINNÉ, 1939). Ausgehend von der „merkwürdigen“ Paarung befasst er sich detailliert mit Libellen, dabei weder Göttinnen-Verbindung noch Verteufelung

erwähnd, bei anderen Insekten aber durchaus auf Volksglauben oder Mythologie eingehend. Davon hätte er bei seinem mehrjährigen Hollandaufenthalt (von dort Reisen nach Frankreich und Deutschland) und seinem intensiven Kontakt mit holländischer, französischer und deutscher Kultur gewiss erfahren, wenn es in der damaligen Folklore tradiert worden wären. Vielmehr lernte er in Holland/Frankreich/Deutschland die tatsächlich uralten zärtlichen Libellennamen juffertjes/demoiselles/Jungfern kennen und setzte später deren lateinische Übersetzung *puella* und *virgo* als wissenschaftliche Artnamen fest. Folgt man SWAMMERDAM (1669), gab es damals im Niederländischen keine diabolischen Libellennamen.

Natürlich meint Linnés „Gottespferd“ (dieser Name sowie „Himmelspferd“ früher auch in Deutschland üblich; SCHÄFER, 1947) mit seinem maskulinen Wortteil *gud* (weiblich wäre *gudinna*) den maskulin-christlichen Gott. Neben Linnés „Gottespferd“ darf man das schon vor rund 150 Jahren nachweisbare dänische *fandens ridehest* nicht übersehen, heute bekannt aus dem Titel eines modernen Libellenbuches für Kinder (RIGGERT & SCHERFIG, 1977) und immer als Teufelsreitpferd übersetzt. In Wirklichkeit ist der *fand* des alten dänischen Volksglaubens, wurzelnd in der heidnischen Mythologie, jedoch ein harmloser kleiner Troll (dänisch = *trolde*), der mit seiner Familie im Wald wohnt und im Sonnenschein gerne auf einem *guldsmed* reitet – um auch den gebräuchlichen nicht diabolischen dänischen Libellennamen zu nennen.

Es gibt mehrere Fälle, in denen der durchaus aufgeklärte (aber vielleicht aus Opportunismus sich über die Maße bibeltreu und gottesfürchtig gebende) Linné sich scharf gegen beim dummen *plebs* verbreitete göttliche oder diabolische Deutung von Naturalien und Naturereignissen oder sich gegen die neunköpfigen Hydren (wie er sie in Hamburg sah) in Naturalienkabinetten wendet, schon als 25jähriger in seiner „*Lappländischen Reise*“ und mehrmals später (LINNÉ, 1951, 1964). Selbstverständlich wusste er, aus welchen Tierteilen die gefälschten Drachen vieler Raritätenkammern bestanden (SEIPEL, 2006). In solchen Zusammenhängen hätte er sich durchaus auch gegen die angebliche frühe Verteufelung der Libellen wenden können.

LIBELLEN DOCH CHRISTLICH-GÖTTLICH?

Warum findet man in keiner der mittelalterlichen Emblematasammlungen (sehr viele Titel bei VIGNAU-WILBERG, 1986/87; HENKEL & SCHÖNE, 1967) mit ihrem religiös-diktatorischen und moralisierenden Anspruch reichlich Tierisches, aber nichts Negatives über Libellen? Als neuerdings teuflische Wesen wären Libellen nach meiner Ansicht nicht in den vielen Stundenbüchern, Breviarien, bebilderten Gebetbüchern und in ausgemalten Bibeln aus der Zeit von 1000 bis 1500 so häufig und schön abgebildet worden, nicht nur in dem einen bereits in der Libellenliteratur bekannten Beispiel der Gutenbergbibel (RUDOLPH,

1991), weiteres prominentes Beispiel sind die Dürer- und Hoefnagel-Libellen im Gebetbuch Kaiser Maximilians. Das lässt einen die Meinung solcher Kunsthistoriker verstehen (DITTRICH & DITTRICH, 2005; ZERLING, 2012), welche die zahlreichen Libellenabbildungen in frühen religiösen Büchern und vor allem später in Stilleben entsprechend dem Symbolismus jener Zeit als Hinweis auf die Metamorphose des Menschen aus dem jammervollen Erdenleben in eine geläuterte himmlische Existenz deuten. Gleiches gilt nach akzeptierter allgemeiner Auffassung erst recht für die Schmetterlinge in den Stilleben. Diese Identität von menschlicher Seele und Schmetterling soll ja auf klassisch-griechische Meinung zurückgehen (ROHDE, 1890; WILAMOWITZ-MÖLLENDORFF, 1959).

Libelle und Schmetterling im Mittelalter und in der Renaissance also keineswegs mit teuflischem Charakter, sondern Metaphern der guten Seele, die den physischen Körper verlässt wie das fliegende Stadium des Insekts die leer und leblos zurückbleibende Larven- oder Puppenhülle.

Die vielen Libellenfreunden bekannten Hoefnagelschen „*Archetypa*“, vom Vater Georg (auch Joris genannt) gemalt und vom Sohn Jakob in Kupfer gestochen und publiziert (HOEFNAGEL, 1592; VIGNAU-WILBERG, 1994), könnten mit ihren sehr vielen Libellendarstellungen und moralisierenden Sinnsprüchen etwas für unser Thema liefern, doch es fehlt jeglicher diabolische Akzent. Einfach nur naturalistisch schöne Libellen findet man auch bei dem westfälischen Maler Ludger tom Ring (LORENZ, 1996), der ein ganzes Menschenleben früher als Hoefnagel in jener hexenbesessenen Zeit arbeitete. Längst vorher, nicht erst bei den Libellen des Albrecht Dürer, der tom Rings, der Hoefnagels, des Georg Flegel und vieler anderer Libellenmaler, die hier nicht aufgezählt werden können, bildet einzig verherrlichende Ästhetik die Berechtigung für bildliche Darstellung der Libellen. Die im Wortsinn schönsten Beispiele: die nicht in den „*Archetypa*“ publizierten farbigen Libellenbilder des Georg Hoefnagel, einige davon in rezenten Büchern erscheinend (z.B. ALBUS, 2002), über allem aber seine herrliche *Brachytron* in den „*Mira calligraphiae monumenta*“ (BOCSKAY & HOEFNAGEL, 1562). Nirgendwo in der bildenden Kunst existieren Libellendarstellungen in auch nur angedeutet diabolischem Bildkontext. Es sei noch einmal betont: gerade in jener Phase des Hexenwahns und klerikaler Verfolgung gewisser Insekten gab es gleichzeitig wunderschöne Abbildungen von Libellen, aber nicht die geringste Verteufelung, eher wurden sie in die Nähe des Göttlichen gerückt.

Als Untermauerung dieser positiven Deutung der Libellen und Schmetterlinge auf Stilleben speziell im Human-Metamorphose-Sinne sind mir zwei alte Literaturstellen bekannt: Die erste gibt es bei dem Hamburger Physikotheologen und Dichter Barthold Brockes (1680-1747), der Libellen als geradezu göttliche Wesen verherrlicht und in einem seiner Gedichte den Vergleich Seele-Schmetterling behandelt (BROCKES, 1744; WEIDNER, 1967; KLESSMANN, 2003). Dass Maria Sibylla Merian gerade dieses Gedicht als Vorwort zu ihrem auch Schmetterlinge enthaltenden „Blumenbuch“ benutzte, unterstreicht die weite Verbreitung des

Werks des Brockes mit seiner überaus positiven Libellensicht. Eine zweite Stelle findet sich bei der Nonne Teresa von Jesus im fünften Kapitel ihrer *Las Moradas del castillo interior* (TERESA VON JESUS, 1577), wo ein Satz die Seele mit einem Schmetterling vergleicht (LORENZ, 1984). Religionsspezialisten mögen weitere Belege für diese Annahme der Kunsthistoriker kennen. Aber von Libellen bei Teresa keine Spur.

Hierher gehört auch der Theologe Friedrich Christian Lesser, zeitgleich mit Barthold Brockes, aber noch erheblich weiter gehend als dieser. Lesser leitet nämlich unmittelbar aus der Existenz der Libellen die Existenz Gottes beweisend ab (LESSER, 1738). Bemerkenswert ist übrigens die hervorragende Kenntnis des Theologen Lesser von der Biologie der Libellen. Man könnte erwarten, dass solche Autoren auf frühere Verteufelung der Libellen hinweisen und sie als unsinnig bezeichnen, aber es gibt auch in solchen Büchern keinerlei Andeutungen dazu.

Es gibt eine Reihe sehr früher Theologen und Theologinnen, die zugleich Naturkundler waren, sowie Naturkundler, die mythisch beeinflusst waren, etwa PARACELSUS (1590), COMENIUS (1658), KONRAD VON MEGENBERG (1482), Albertus Magnus und andere (siehe oben genannte Sammelwerke). Darunter der Gewichtige dürfte der etwa 1000 Jahre lang bis in Linné's Zeit maßgebliche Bischof Isidor de Sevilla sein, der zwar in Südwesteuropa arbeitete, die heute gewöhnlich als Enzyklopaedie bezeichneten erstaunlich stoffreichen Bände seines Werkes *„Etymologiarum sive originum libri XX“* berücksichtigen aber Tiere und Volksglauben anderer Regionen. Linné hat zumindest die biologischen Anteile dieser Enzyklopaedie studiert, die er mehrfach zitiert, und daraus den ihm zugeschriebenen berühmten Satz *nomina si nescis perit et cognitio rerum* „entliehen“, der also nicht annähernd ein genuiner Gedanke Linnés ist. Kein einziger dieser Männer gibt etwas Negatives über Libellen kund.

Um auch eine Dame zu nennen: Die Äbtissin Hildegard von Bingen erörtert Mystik und sogar Volksnamen von Insekten in ihren *„Subtilitatum diversarum naturarum creaturarum libri IX“* (GEISENHEYNER, 1911). In der frühen Zeitphase um 1150, in der sie schrieb, und so volksnah wie gerade sie als Ärztin der Armen war, hätte sie von heidnisch-göttlicher Verbindung der Libellen und christlicher Verteufelung noch wissen müssen. Die Missionierung durch zunächst wenige mönchische Prediger kann ja nur sehr langsam vorangegangen sein. Es ist kaum anzunehmen, dass diese Einzelkämpfer fähig waren, eine verwurzelte heidnische Ansicht wie die Weihe der Libellen an Frigga in kurzer Zeit und großräumig so restlos auszurotten, dass sie in alter Literatur nicht die geringste Spur hinterließ. Bekanntlich sind überraschend viel paganische Kenntnis und vor allem Brauchtum bis in das Mittelalter und darüber hinaus erhalten geblieben (SIMEK, 2009; viele Beispiele: HERRMANN, 1903), im Einzelfall sogar explizite Verehrung bestimmter Gottheiten. Libellenkennern ist der Name Nehalennia vertraut: eine bereits Tacitus bekannte Göttin Westgermaniens, die nachweislich noch im 16. Jahrhundert unter Seemännern und Kaufleuten verehrt wurde (LO-

HENSTEIN, 1690).

Wir erfahren aber auch von Hildegard von Bingen kein negatives Wort über Libellen, auch nichts zu deren heidnisch-göttlicher Verbindung. Sie preist einfach alle Lebewesen als göttliche Kreaturen.

EINE SCHLUSSFOLGERUNG

Eine Rechtfertigung der beiden Behauptungen des Hermann Löns lässt sich in mythologischer, volkskundlicher und entomologischer Literatur nicht finden. Wie also mag Löns zu der Verbindung Frigga-Libellen und der resultierenden Verteufelung gekommen sein?

Löns war einerseits Entomologe mit ganz besonderer Zuneigung zu den Libellen, die er immer wieder auch außerhalb der „*Wasserjungfern*“ in seinen emotionalen Naturschilderungen erwähnt. Daneben war er geprägt durch seine äußerst markante völkisch-germanophile Einstellung. Hinreichend bekannt ist seine fundamentale Abneigung gegen die katholisch-karolingischen Franken als missionarische „Sachsenschlächter“ (Zitat Löns), die mehrfach in seinem Werk erkennbar wird, gipfeln in seiner Erzählung „*Die rote Beeke*“ (GRIEBEL, 1934; DELMANN, 1965; DUPKE, 1993). Angesichts aller dargelegten Aspekte erscheint mir nur eine Annahme möglich: er hat die Verbindung Libellen-Frigga und die dezidierte Verteufelung in schriftstellerischer Imagination erfunden. Löns war in den Jahrzehnten nach seinem frühen Tod außerordentlich populär. Sogar noch zum gegenwärtigen Zeitpunkt werden zahlreiche seiner Werke von mehreren Verlagen gedruckt. Allein seine „*Wasserjungfern*“ haben in rund 90 Jahren 23 Auflagen als Einzelausgabe erlebt, die mir unmittelbar bekannt sind, und vielleicht sogar mehr. Dazu kommen die vielen Drucke der „*Wasserjungfern*“ in Gesamtausgaben der Lönsschen Schriften. Nachdem mir damals die Zensur in der ersten Nachkriegsausgabe von 1953 aufgefallen war, erschienen später in mindestens drei Verlagen weitere Ausgaben (Weltbild Verlag 1985; Nymphenburger Verlag 1986; Loensia Verlag 2006, hierin neben den „*Wasserjungfern*“ auch seine weiteren Libellengeschichten, in der Bibliografie: LÖNS, 2006), und zwar alle mit dem unzensurierten Vorkriegstext. Nun war die „asiatisch-romanische Brühe“ (LÖNS 1919) wieder druckbar. Die außerordentlich vielen Auflagen der „*Wasserjungfern*“ bis in die aktuelle Gegenwart bezeugen, dass sie häufig genug gelesen wurden, um die Behauptungen von den Frigga-Libellen und ihrer Verteufelung so oft auch in andere populäre Literatur zu übernehmen, bis sie sich als vermeintlich berechtigtes und gesichertes Allgemeinwissen festsetzen konnten.

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WATER MITE PARASITES (HYDRACHNIDIA) OF ODONATES FROM THE NATURE RESERVE “JEZIORO SZARE”, NORTHWESTERN POLAND

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The relationships between larvae of *Arrenurus* s. str. and their odon. hosts from Lake Szare are described. A total of 173 water mite larvae of *Arrenurus affinis/neumanilvietsi*, *A. bicuspidator*, *A. cuspidator*, *A. cuspidifer*, *A. tricuspikator*, *A. robustus* and *Piona longipalpis* was collected. Of these, 151 were found on adult odon., 9 on odon. larvae and 13 on exuviae. Parasitic mite larvae were found on odon. adults but only phoretic mite larvae were found on the larvae and exuviae. The occurrence of parasites was most frequently and most numerous recorded on the thoracic segments of their hosts.

INTRODUCTION

Larvae of almost all the water mite species parasitize aquatic insects and are carried to new water bodies by the adult insects (MITCHELL, 1959, 1969; BOHONAK et al., 2004; BAKER et al., 2006). The colonization of new areas in this way is likely to increase now because of more frequent migrations of Mediterranean species (BUCZYŃSKI et al., 2010; ZAWAL, 2010; ŻURAWLEW et al., 2010). In the case of mites parasitizing odonates, the lifespan of a mite is divided into the aquatic, pre-parasitic (phoretic) phase on odonate larvae (ZAWAL, 2005, 2006a, 2006b) and the terrestrial/aerial parasitic phase on adult odonates. Species of the subgenus *Arrenurus* s. str. parasitize the larvae and imagines of odonates (ÅBRO, 1999; BAKER et al., 1991; CASSAGNE-MÉJEAN, 1966; MÜNCHBERG, 1936; MITCHELL, 1959, 1969; SMITH, 1978; STECHMANN, 1976/77, 1978; ZAWAL, 2004, 2005, 2006a, 2006b). Up to now the host species of the dif-

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Table II
Distribution of water mite larvae on various body parts of odonate adults

| Position of attachment | prothorax | mesothorax | metathorax | 6th abd. segment |
|------------------------------|-------------|-------------|-------------|------------------|
| Host species | N (average) | N (average) | N (average) | N (average) |
| <i>Enallagma cyathigerum</i> | 7(2,3) | 54(2,6) | 21(2,6) | 1 |
| <i>Pyrrosoma nymphula</i> | 2 | 4 | 3 | |
| <i>Erythromma najas</i> | | 19(9,5) | 5(2,5) | |

RESULTS

Of 14 species of odonate adults only three were infested by water mite larvae of the genus *Arrenurus* (Tab. I). One of them, *Enallagma cyathigerum* (Charp.) was the most heavily parasitised species with 69.7% of the adult dragonflies serving as hosts for mite larvae. In contrast 5.5% of *Pyrrosoma nymphula* (Sulz.) and 1.8% of *Erythromma najas* (Hans.) adults were parasitised. The prevalence of parasitism of all water mite species on these hosts was: *E. najas* 42.9%, *E. cyathigerum* 35.5% and *P. nymphula* 16.7%.

E. cyathigerum was infested by five species of *Arrenurus* s. str.; *E. najas* by two species; and *P. nymphula* by one species. Species of the *Arrenurus affinis*-complex and *A. bicuspidator* differ in the prevalence and intensity of infestation; the former mostly occurs on *E. cyathigerum* and the latter on *E. najas* (Tab. I). The occurrence of these two most numerous species of parasites was most frequent and most numerous on the thorax of the hosts, particularly on the metathorax (Tabs II, III).

Four water mite species from two genera were observed on five of 21 host species of odonate larvae. The numbers of all mite species were very low, and the high rate of infestation apparently depends on the small numbers of hosts caught (Tab. IV). Water mite larvae were found on necks, legs and under wing buds (Tab. III).

Larvae of *Arrenurus affinis*-complex were recorded only on two exuviae of *Leucorrhinia albifrons* (Tab. IV); in both cases the parasites were found under wing buds.

The size of water mite larvae ranged from 196 to 560 μm . Most of the *Arrenurus* larvae studied were of relatively large size, except for *A. robustus*. Those of *Piona longopalpis* were of intermediate size (Tab. V). The infested odonates were collected in July and August. In these months the water mite larvae ranged widely in size. In the case of *Arrenurus affinis*-complex and *A. bicuspidator*, larvae of small size were prevalent while in *A. cuspidator* the small and the large larvae occurred in similar numbers (Fig. 1).

DISCUSSION

Of eight *Arrenurus* s. str. species (*A. affinis*, *A. bruzelii*, *A. claviger*, *A. cuspidator*, *A. maculator*, *A. neumani*-complex, *A. postulator*, *A. tetracyphus*) occurring in Lake Szare (ZAWAL, 2007a) only three (*A. affinis*, *A. cuspidator*, *A. neumani*-complex) were found in the form of parasitic larvae (Tab. I). The larvae of the other species were not found, presumably because they were very rare in the lake. *A. affinis* and *A. neumani* larvae cannot be morphologically differentiated and are regarded as a complex species *A. affinisneumani*vietsi (ZAWAL, 2008a). In the material investigated this was the most numerous parasitic species while *A. neumani*-complex was the most abundantly occurring *Arrenurus* s. str. species in the lake. *A. bicuspidator* was not found at all in the water mite adult fauna of Lake Szare (ZAWAL, 2007a). Its high numbers as a parasite were probably due to the migration of the infected hosts from the nearby Lake Chlewo, where this species occurred very abundantly. The species prefers small permanent reservoirs and phytolittoral of lakes (BIESIADKA, 1972; KOWALIK, 1973, 1984) and avoids acidic peat-bogs (KOWALIK, 1996; CICHOCKA, 1998). Hence it most probably does not find suitable conditions for full development in Lake Szare, which is characterized by a very low pH and unusually poor phytolittoral (ZAWAL & STEPIEŃ, 2007). The other species, both in the form of imagines and parasitic larvae, were not frequent and hence the diversity of the species composition of the parasitic larvae and adult forms was regarded as incidental and strongly depends on the sp.

Three zygopteran species found over Lake Szare are among the most frequently and most numerous infested by water mite larvae, and the extent of their infestation reported in earlier papers was: *Enallagma cyathigerum* 27.8%-56.5%, *Pyrrhosoma nymphula* 25.0% and *Erythromma najas* 33.3%. Like the intensity of infestation, the extents in the present study are within the ranges reported by ZAWAL (2004, 2006a).

The host species recorded here have a much wider list of parasites: the litera-

Table III
Distribution of particular parasite species on various body parts of hosts: (A) parasite/host (prevalence), (B) intensity (average)

| Parasite species | prothorax | | mesothorax | | metathorax | | 6th abd. segment | | neck - larva | | legs - larva | | under wing buds - larva | |
|--|-----------|----------|-------------|-----------|------------|----------|------------------|-----------|--------------|---|--------------|---|-------------------------|-----------|
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| <i>Arrenurus affinisneumani</i> vietsi | 8/3(21,4) | 2-4(2,6) | 38/11(78,6) | 1-10(3,5) | 12/5(35,7) | 1-5(2,4) | | | | | 13/2(100) | 2 | 13/1(100) | 1-12(6,5) |
| <i>Arrenurus bicuspidator</i> | 1/1(7,1) | 1 | 33/11(78,6) | 1-9(3,3) | 7/4(28,6) | 1-4(1,8) | | | | | | | | |
| <i>Arrenurus tricuspidator</i> | | | 1/1(100) | 1 | | | | | | | | | | |
| <i>Arrenurus cuspidator</i> | | | | | 6/1(100) | | 1/1(100) | 14/1(100) | 4 | | | | 1/1(100) | 1 |
| <i>Arrenurus cuspidifer</i> | | | | | 4/1(100) | 4 | | | | | | | | |
| <i>Arrenurus robustus</i> | | | | | | | | | | | | | 1/1(100) | 1 |
| <i>Arrenurus</i> sp. | | | 2/1(100) | 1 | | | | | | | | | | |
| <i>Piona longipalpis</i> | | | | | | | | | | | 1/1(100) | 1 | | |

ture gives a total number of nine *Arrenurus* s. str. species parasitizing the three dragonfly species (DAVIDS, 1997; BAKER et al., 2007). The parasitism of *A. cuspidator* and *A. cuspidifer* on *E. cyathigerum* and of *A. affinis*-complex on *E. najas* is recorded here for the first time. In the latter case the occurrence of *A. affinis* was noted previously while *A. neumani*-complex was not (DAVIDS, 1997).

Of the described parasitic species the most difficult task is to determine the list of hosts of the members of the *A. affinis*-complex, which includes three species with undistinguishable larvae whose identification is only possible after rearing the adults in the laboratory. The current literature gives five host species for *A. affinis* (*Coenagrion puella*, *C. pulchellum*, *Erythromma najas*, *Pyrrhosoma nymphula*, *Enallagma cyathigerum*) and three for *A. neumanilaffinis/vietsi*-complex (*Lestes sponsa*, *E. cyathigerum*, *P. nymphula*); thus two host species (*E. cyathigerum*, *P. nymphula*) are common for these parasites (DAVIDS, 1997). Both *Arrenurus affinis* and *A. neumani* are considered acidophilous species, and in waters characterized by low pH, the former is definitely less numerous than the latter (CICHOCKA, 1998). Seemingly, a wider distribution of *A. affinis* is due to a larger number of host species, which enables *A. affinis* to penetrate a wider spectrum of environments. The fact of specific host species are parasitized helps to understand the distribution of *A. neumani*. Its preference for acidic waters is connected with some factor associated with lowered pH, while its preference for open bodies of water is due to the ecology of its hosts, which are associated with the littoral zone inhabited by floating plants or plants characterized by a vertical structure: *Lestes sponsa* (SCHORR, 1990).

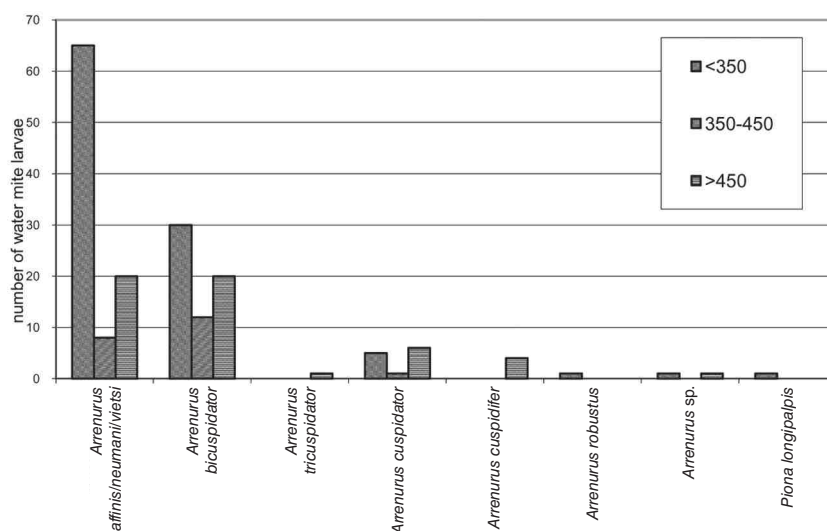


Fig. 1. Number of water mite larvae in particular intervals of body size.

For the other species of parasites the lists of host species are: seven (*Coenagrion hastulatum*, *C. puella*, *C. pulchellum*, *Enallagma cyathigerum*, *Pyrrhosoma nymphula*, *Erythromma najas*, *Ischnura elegans*) for *Arrenurus bicuspidator*; eight (*Platycnemis latipes*, *P. pennipes*, *Coenagrion pulchellum*, *Enallagma cyathigerum*, *Erythromma lindenii*, *E. najas*, *Ischnura elegans*, *Lestes sponsa*) for *A. tricuspikator*; six (*Coenagrion hastulatum*, *C. puella*, *C. pulchellum*, *Enallagma cyathigerum*, *Erythromma najas*, *Ischnura elegans*) for *A. cuspidator* and three (*Enallagma cyathigerum*, *Ischnura elegans*, *Lestes dryas*) for *A. cuspidifer* (DAVIDS, 1997; BAKER et al., 2007).

The prevalence and intensity of infestation of *Enallagma cyathigerum* (Tab. I) is similar to the data obtained by ZAWAL (2006a) with the reservation that the finding of parasitic species from two lakes (*Arrenurus affinis*-complex: Lake Szare; *A. bicuspidator*: Lake Chlewo) on this host shows the occurrence of a metapopulation of the host composed of two populations developing in these lakes. In the case of the two remaining host species the comparison is not possible because of the small number of individuals caught. In comparison with the literature data, where the parasites were found on the thoraxes and abdomens of hosts (ZAWAL, 2004, 2006a), water mite larvae collected for this study occurred almost only on the thoracic segments (Tab. II). It is probably due to a wider spectrum of parasitic species occurring on *Enallagma cyathigerum*, *Pyrrhosoma nymphula* and *Erythromma najas* in comparison with data given in the present work (DAVIDS, 1997). Absence of data in the literature renders it impossible to specify the preferences of *A. affinis/neumanilvietsi* (Tab. III) for particular regions of the host's body. As for *A. bicuspidator*, it seems to be a species preferring to attach itself to the mesothorax and metathorax of the host, while *A. cuspidator* has been found both on the thorax and on the abdomen of its hosts (Tab. III) (BAKER et al., 2006, 2007). On the larvae and exuviae of odonates only unengorged water mite larvae were found. They were loosely attached to the host and hence could be regard-

Table IV
Infestation of odonate larvae and exuviae by water mite larvae: (A) number of hosts (%), (B) intensity (mites/host)

| Host species | <i>Arrenurus affinis/neumanilvietsi</i> | | <i>A. cuspidator</i> | | <i>A. robustus</i> | | <i>Piona longipalpis</i> | |
|---|---|-----------|----------------------|---|--------------------|---|--------------------------|---|
| | A | B | A | B | A | B | A | B |
| <i>Enallagma cyathigerum</i> | | | 1(14,3) | 1 | | | | |
| <i>Aeshna cyanea</i> | | | 1(16,7) | 4 | | | | |
| <i>Somatochlora metallica</i> | 1(33,3) | 2 | | | | | 1(33,3) | 1 |
| <i>Sympetrum vulgatum</i> | | | | | 1(100) | 1 | | |
| <i>Leucorrhinia albifrons</i> - exuviae | 2(5,9) | 1-12(6,5) | | | | | | |

ed as phoretic larvae. As only individual specimens (Tab. IV) of the parasites have been found, their permanent presence on hosts mentioned in this study still requires confirmation, especially in the case of the *Piona longipalpis* larvae (Tab. IV), which parasitizes chironomids (KOUWETS & DAVIDS, 1984).

The smallest dimensions of parasitic water mite larvae recorded here (Tab. V) agree with the size of newly hatched larvae (ZAWAL, 2006b, 2006c, 2006d, 2007b, 2007c) while in most cases the largest dimensions agree with the maximum size recorded by Baker and coworkers (BAKER et al., 2007). The exception is the *A. affinis*-complex whose maximum dimensions were 644 μm according to Baker et al. Adult individuals of these species attain two or three times greater dimensions (VIETS, 1936) suggesting that, in contrast to *Hydrachna* and *Eylais* whose body increases chiefly occur at the stage of parasitic larva (DAVIDS, 1973; CICHOCKA, 1995; ZAWAL, 2002, 2003), a great part of body size increase occurs at the stage of the deutonymph.

The occurrence of both small and large water mite larvae shows a prolonged period of oviposition by these species (Fig. 1) and at the same time the recorded cases of parasitism late in the year. Earlier literature data showed the period of May-July as that of the most intense parasitism (ZAWAL, 2004) suggest the possibility of a shifting the time of oviposition depending on local environmental conditions (Lake Szare is surrounded by a forest and hence its waters warm slowly). The occurrence of small and large larvae at the same time on one host results from varied growth rates, while the infestation occurs only once, i.e. at the moment when the adult odonate emerges from the larva. Since small and large larvae were found next to each other, differences in body size were not due to the trophic variation in attachment sites but probably to competition for food or a place. The question arises whether the small larvae die because sufficient amounts of food were not accessible or maybe they remain longer on the host and, after the detachment of large larvae (the transformation into deutonymphs), obtain a freer access to its body, thus increasing their body size and detaching from the host during later ovipositions. If this is the case the period of emergence of adult forms of the genus *Arrenurus* s. str. would be considerably lengthened.

Table V
Body size (μm) of water mite larvae

| Parasite species | Size |
|--|---------|
| <i>Arrenurus affinis</i> / <i>neumanilvietsi</i> | 210-560 |
| <i>A. bicuspidator</i> | 220-556 |
| <i>A. tricuspikator</i> | 560 |
| <i>A. cuspidator</i> | 370-530 |
| <i>A. cuspidifer</i> | 500-524 |
| <i>A. robustus</i> | 196 |
| <i>A. sp.</i> | 244-558 |
| <i>Piona longipalpis</i> | 308 |

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SHORT COMMUNICATIONS

**DESCRIPTION OF THE LAST INSTAR LARVA
OF *BRACHYDIPLAX FARINOSA* KRÜGER
FROM BORNEO
(ANISOPTERA: LIBELLULIDAE)**

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A ♂ final instar larva from Sarawak is described and illustrated, and compared with that of *Brachydiplax chalybea flavovittata* Ris, using also notes and illustrations of congeners gleaned from literature.

INTRODUCTION

Two members of the genus *Brachydiplax* Brauer, 1868 are found in Borneo. *B. farinosa* is small sized (hw 22-23 mm), it occurs in East Asia/East Indies (DAVIES & TOBIN, 1985) and described as widespread in the Oriental region (ORR, 2003). In Borneo and Brunei it is known from forested swamps, whereas *B. chalybea* is more commonly found in degraded habitats (ORR, 2003).

METHODS AND TERMINOLOGY

A final instar larva was collected from a rainforest pool at Mount Mulu National Park, Sarawak, 9-X-2009.

The exuviae was cleaned and then illustrated using a flatbed scanner, stereo microscope and micrometric eye piece, the specimen being laid out, but not flattened and the labium was extended in situ for dorsal viewing.

A *Brachydiplax chalybea flavovittata* exuviae (Japan) was used for comparison. Illustrations of related species were also used as listed below in the Comparative Material section.

BRACHYDIPLAX FARINOSA KRÜGER

Figures 1-3

Material. – 1 ♂ exuviae, BORNEO (Sarawak): Gunung Mulu National Park, larva collected 9-X-2009, emerged 17-X-2009.

HABITUS (Fig. 1). – Total length 16 mm. Antennae (Fig. 2) 7-segmented, ratios segments 1-7: 1,8: 1,0: 1,4: 1,3: 1,4: 1,9: 1,9. The scape, pedicel and basal $\frac{3}{4}$ of segment 6 are dark (the latter more strikingly so).

HEAD. – Labrum clear, except for a small dark spot on the baso-lateral area and bearing a row of fine hairs on the distal margin. Clypeus unmarked, both these areas are transparent, the mandibles being visible beneath. The anterior shelf is slightly swollen, bearing small spots, some with fine setae connected. The distal margin is gently convex. The position of the ocelli is marked by a small tuft of hairs at their bases, otherwise they are rather indistinct. Eyes are distinctively shaped (Fig. 1) being narrow sagittally, with the basolateral margin slightly produced rearwards, but not sharply angled as in *Macrodiplax/Hydrobasileus*. Postocular lobes widely rounded with a scattering of long setae near the rear margin. On either side of the central suture and close to the eyes there is a noticeable tuft of hairs.

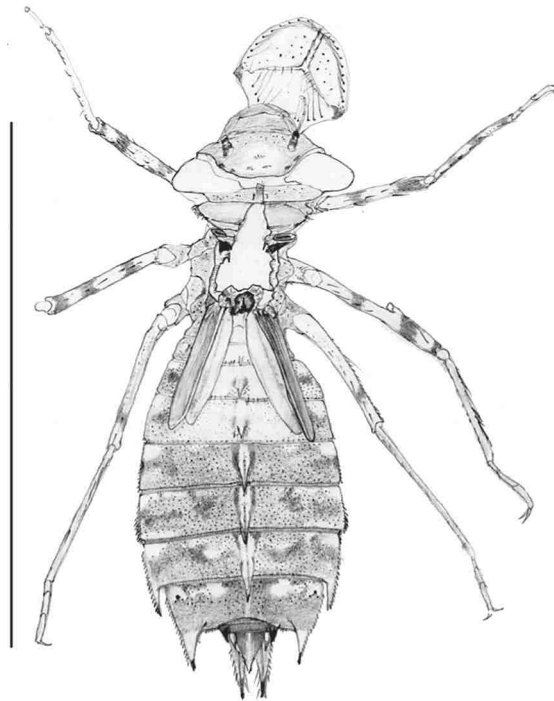


Fig. 1. *Brachydiplax farinosa*, male exuviae: habitus [bar 16 mm].

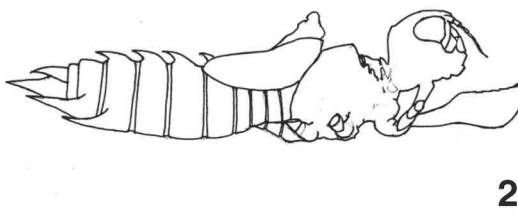
Labium (Fig. 3). – The prementum has 11 setae on either side. The outermost is shorter but together with the next six is long enough to protrude well over the distal margin of the labium, their lengths gradually shorten but the last 4 setae are noticeably shorter. The distal margin angulate with a short seta set on the ligula and with 3 short setae on the right hand side, but sockets for 5 setae vis-

ible on the left side. The labial palps have 9 long setae on the left palpus and 9 long setae plus one shorter finer basal seta on the right palpus. The distal margin of the palps has 6 lobes each bearing one long and two shorter setae. The inner margin has up to 13 long and short setae on the right hand palp and 8 surviving on the left hand palp.

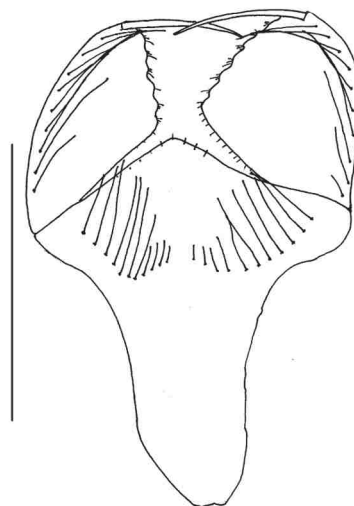
THORAX (Fig. 1). — The pronotum of the prothorax is ellipsoidal with a thickened basal rim which has a row of setae on its outer edge. The lateral lobes are pale with dark spotting. The inner wing cases reach $\frac{1}{2}$ way down segment 5, the outer pair reaching the base of segment 6.

L e g s are long with a mixture of both fine, long and also shorter setae distributed on the femora and tibia. Hind legs when fully expanded reach to the tips of the spines on segment 9, but not to the end of the paraprocts. Viewed ventrally there are small scattered setae between the 2nd and 3rd pair of legs and also on the bases of all legs.

ABDOMEN (Fig. 1). — This is light brown overall and covered with spots which are seen to be the bases for short adpressed setae. Some pale areas are smooth, whilst other darker areas are less spotted. The transparency of the cuticle shows the darker patches underneath which may be internal or ventral processes rather than dorsal markings. In ventral view spines are present on the distal margins of segments 7-9, whilst there is an isolated central row on segment 10. A few long, fine setae are present on segments 9 & 10. The ventral surface of all segments is covered with small adpressed setae, which appear less noticeable than on the dorsal surface. Segment 9 has a pair of pale spots surrounded by a dark margin halfway between the dorsum and lateral margins.



2



3

Figs 2-3. *Brachydiplax farinosa*, male larva: (2) lateral view showing shape of dorsal spines [bar 16 mm]; — (3) labium, dorsal view [bar 5 mm].

Table I
Differences among the *Brachydiplax* larvae

| Species | Source | Labial setae | | Abdominal spines | | Body length mm |
|-----------------------------|---------------------|--------------|--------|------------------|-------------|----------------|
| | | mental | palpal | dorsal | lateral | |
| <i>B. chalybea</i> | S.Z. LIN (unpubl.) | 15 | 12 | 4-8 | 9< epiproct | 17.7 est |
| <i>B. chalybea</i> | NEEDHAM (1930) | 15 | 11 | | | 20 abd 13 |
| <i>B.c. flavovittata</i> ** | exuviae Japan | 13-14 | 11 | 4-8 | 9< epiproct | 19 |
| <i>B. sp.</i> | DE FONSEKA (2000) | 14 | 12 | 4-8 | 9< epiproct | 15-16 |
| <i>B. denticauda</i> | THEISCHINGER (2007) | 12-13 | 10 | 4-8 | 9< epiproct | 16 |
| <i>B. sp.+</i> | exuviae Langkawi | 13 | 10 | 4-8 | 9< epiproct | 17 |
| <i>B. farinosa</i> | exuviae Sarawak | 11 | 9 | 3-8 | 9= epiproct | 16 |

** also ISHIDA (1996)

Dorsal spines are present on segments 3-8. Those on 3-5 are erect and curved, those on 6-8 are flattened, longer and overlap the succeeding segments. Viewed dorsally the pale central area on segment 9 gives the illusion of a spine, but the area is only slightly carinated. Lateral spines on segments 8 & 9 are long and pointed, the ratio of the length of segment 9 to spine 8 and spine 9 = 1,0: 1,2: 1,5. The margins of segments 7, 8 & 9 bear short, stout spines which increase in size distally on each segment.

The anal appendages (Fig. 1) are protruberant, ratios of epiproct to cerci and paraprocts = 3,0: 1,3: 5:0.

The ratio of male projection to epiproct = 2,0: 3:0, the spines on segment 9 reach to the end of the epiproct. The long paraprocts bear a mix of longer setae and stout spines, all appendages are sharply pointed and have slightly darker tips.

COMPARATIVE MATERIAL. — Illustrations unless otherwise stated: *Brachythemis chalybea* NEEDHAM (1930), LIN (unpubl.); *B. chalybea flavovittata* ISHIDA (1996), plus exuviae; *Brachythemis sp.* DE FONSEKA (2000); *B. denticaudata* THEISCHINGER (2007, 2009), THEISCHINGER & HAWKING (2006).

DISCUSSION

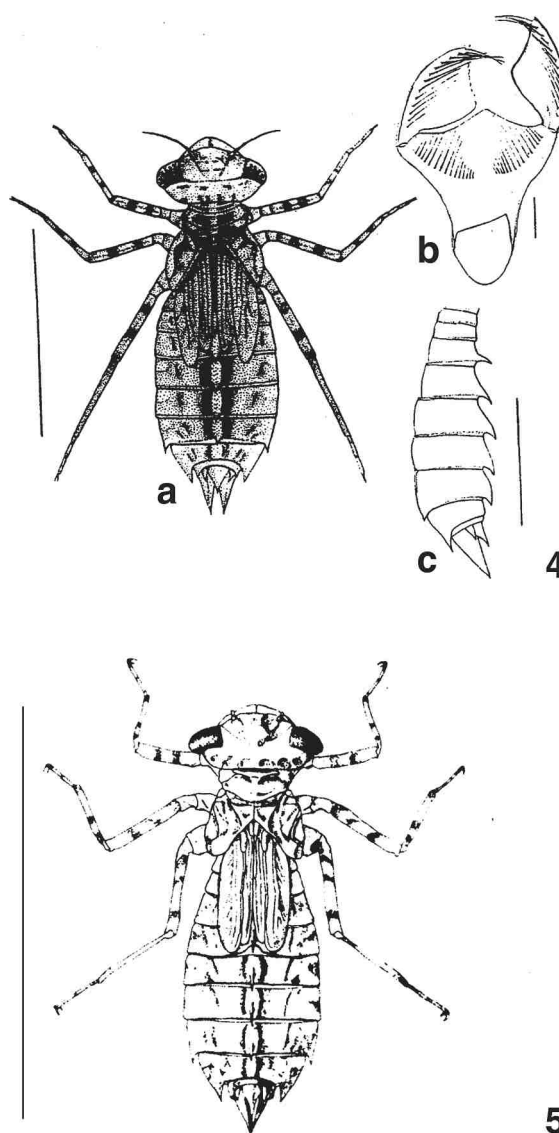
Illustrations of other species of the genus show similarities with regard to general body form and markings, shape of eyes, dorsal and lateral spine distribu-

tion and ratios of anal appendages. NEEDHAM (1930) also mentions the dark markings on basal and subapical segments.

The differences between *B. farinosa* and other members of the genus (where recorded) are shown in Table I. *B. farinosa* appears to differ in having longer lateral spines on segment 9 and a dorsal spine on segment 3. *B. chalybea* can be separated by the above, plus overall larger size and the greater number of setae on the prementum and labial palps.

Quoted diagnostic differences have been used where possible, in other cases obvious features have been inferred from clear diagrams e.g. scale lines in S.Z. LIN (unpubl.). Where diagrams are unclear such inferences have been avoided.

An exuviae of the genus previously ascribed by me to *B. chalybea* shows characteristics of *B. farinosa*, but has extra mental setae, however such variations are common and show that on their own these features should not be relied on, also that a range of determined specimens would be more desirable.



Figs 4-5. Larval habitus: (4) *Brachydiplax chalybea* [bars: A 10 mm, B 0.1 mm, C 0.5 mm]; - (5) *B. c. flavovittata* [bar 19 mm].

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**DREPANOSTICTA SIMUNI SPEC. NOV. FROM BORNEO,
WITH NOTES ON RELATED SPECIES
(ZYGOPTERA: PLATYSTICTIDAE)**

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The new sp. is described from Gunung Mulu National Park in Sarawak, Malaysian Borneo and compared with its closest congeners, *Drepanosticta barbatula* Lieftinck and *D. drusilla* Lieftinck, which are also refigured. New distribution records for the latter 2 spp. are documented.

INTRODUCTION

The Platystictidae, once considered to be a small family in the Zygoptera, are now known to be very diverse on the islands of south-east Asia (e.g. VAN TOL, 2000, 2005, 2007a, 2007b; DOW, 2010; VILLANUEVA et al., 2011; VILLANUEVA & SCHORR, 2011), but many species remain very poorly known. In some cases this lack of data is simply the result of a lack of expert sampling in the area in which a species is found, but in other cases it appears to be linked to the secretive habits of the species concerned and, possibly, genuine rarity.

LIEFTINCK (1940) described *Drepanosticta barbatula* from a single male collected in east Kalimantan, a distinctive species bearing a row of long setae on the superior anal appendages. In 2005 a male *Drepanosticta* with very similar anal appendages and general appearance was collected at Gunung Mulu National Park, Sarawak and was initially identified (DOW & REELS, 2008) as *D. barbatula* on the basis of Lieftinck's description and illustrations. Direct comparison of this specimen with the type of *D. barbatula* has revealed that it is a distinct species; it is described here as *D. simuni* sp. nov. Earlier LIEFTINCK (1934) had described *D. drusilla* from a single male from north-west Kalimantan. Examination of the anal

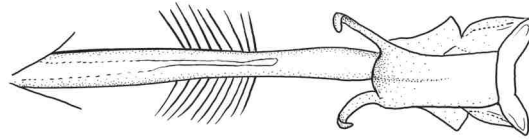


Fig. 1. Penis of *Drepanosticta simuni* sp. n., holotype male.

appendages of *D. drusilla* reveals a close similarity with those of *D. barbatula* and *D. simuni*; however the superior anal appendages of *D. drusilla* lack a distinct row of long setae. All of these species appear to be either very secretive in their behaviour, and/or genuinely scarce.

D. barbatula was only known from the holotype for 65 years, but a second specimen from Sabah was collected in 2005. Similarly the only definite records of *D. drusilla* were of the type series collected in 1932, but two additional specimens of *D. drusilla*, from west Sarawak, are now available.

DREPANOSTICTA BARBATULA LIEFTINCK, 1940

Figures 2, 5, 8, 10, 13

Drepanosticta barbatula: LIEFTINCK, 1940: 351-353, fig. 6; – LIEFTINCK, 1954: 33; – LIEFTINCK, 1971: 77; – ORR, 2003: 38; – VAN TOL, 1992: 48.

Material. – **Holotype** ♂: (Jan van Tol number 3023), Indonesia, Kalimantan Timur, Sangkulirang, “Bataui Besi”, leg. M.E. Walsh, VI-1937. – **Other material**: ♂, Malaysia, Sabah, Mount Kinabalu National Park, Poring Hot Springs, stream in Bamboo Garden, leg. unknown, 1-V-2005, in RMNH.

REMARKS. – The male from Poring Hot Springs agrees well with the holotype of *D. barbatula* except in small details of colouration, and in size: abdomen plus appendages 42mm (48mm in the holotype), hindwing 22.5mm (24.5mm in the holotype). A pair of distinct but irregular basal pits are present on the dorsum of S10 (Fig. 10); these were not mentioned in the original description of *D. barbatula* but are also present on the holotype. Long setae are present on the genital valves of both specimens available.

DREPANOSTICTA DRUSILLA LIEFTINCK, 1934

Figures 3, 6, 11, 14

Drepanosticta drusilla: LIEFTINCK, 1934: 474-476, figs 4-5; – LIEFTINCK, 1954: 33; – LIEFTINCK, 1971: 85; – ORR, 2003: 38; – VAN TOL, 1992: 87.

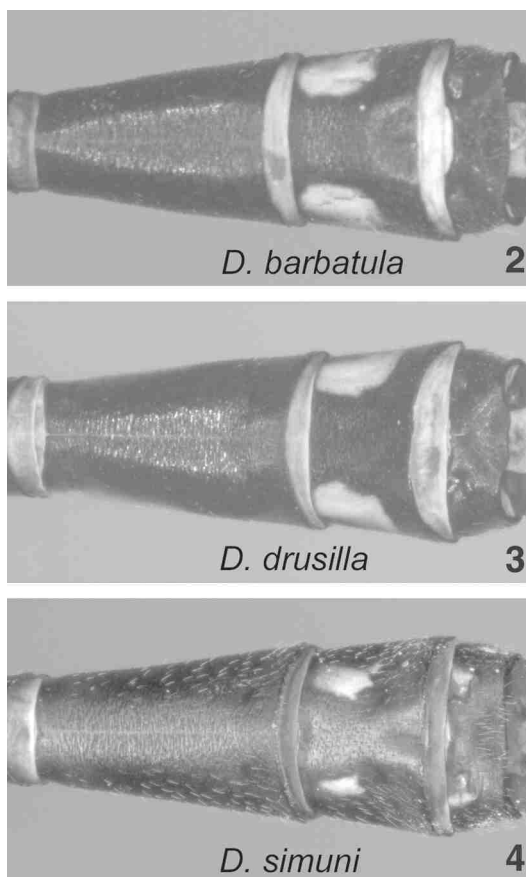
Drepanosticta barbatula: DOW, 2004: 4, photographic record; – ORR, 2004: 376, photographic record.

Drepanosticta? barbatula: DOW & REELS, 2010: 15, photographic record.

Material. – **Holotype** ♂: (Jan van Tol number 3032), Indonesia, Kalimantan Barat, Singkawang, Bengkayang, 30-VIII-1932, leg. L.C. de Ruiter. – **Other material**: ♂ (SAR06_PST17), Malaysia, Sarawak, Kuching Division, Lundu district, foot of Gunung Pueh, perched ca 3m above trail pool, leg. R.A. Dow, 28-I-2006; ♂ (SAR09_10_PST413, teneral), Malaysia, Sarawak, Kuching Divi-

sion, Kubah National Park, Matang Wildlife Centre, in forest at mouth of tributary of Sungai Rayu, leg. R.A. Dow, 4-VI-2010.

REMARKS. — The photographic record made by the first author at Kubah National Park (DOW, 2004; DOW & REELS, 2010; ORR, 2004) and originally thought to be *D. barbatula* is almost certainly actually *D. drusilla*; the teneral male from 2010 was captured very close to the spot where the photograph was taken. The two species are very similar in size and appearance. In both of the recent specimens from Sarawak there are a few long setae in the position where *D. barbatula* and *D. simuni* have a row of long setae. Distinct basal pits are present on the dorsum of S10 (Fig. 11), as in *D. barbatula* and *D. simuni*. Long setae are present on the genital valves. The mature male from Gunung Pueh has an abdomen length plus appendages of ca 45.5mm, Hw 22mm; this is within the range stated for the males from the type series (LIEFTINCK, 1934: 475).



Figs 2-4. Markings of male terminal abdominal segments, dorsal view: (2) *Drepanosticta barbatula*, Poring Hot springs; — (3) *D. drusilla*, Gunung Pueh; — (4) *D. simuni* sp. n., holotype.

DREPANOSTICTA SIMUNI SP. NOV.

Figures 1, 4, 7, 9, 12, 15

Drepanosticta barbatula: DOW & REELS (2008: 3, record Gunung Mulu National Park).

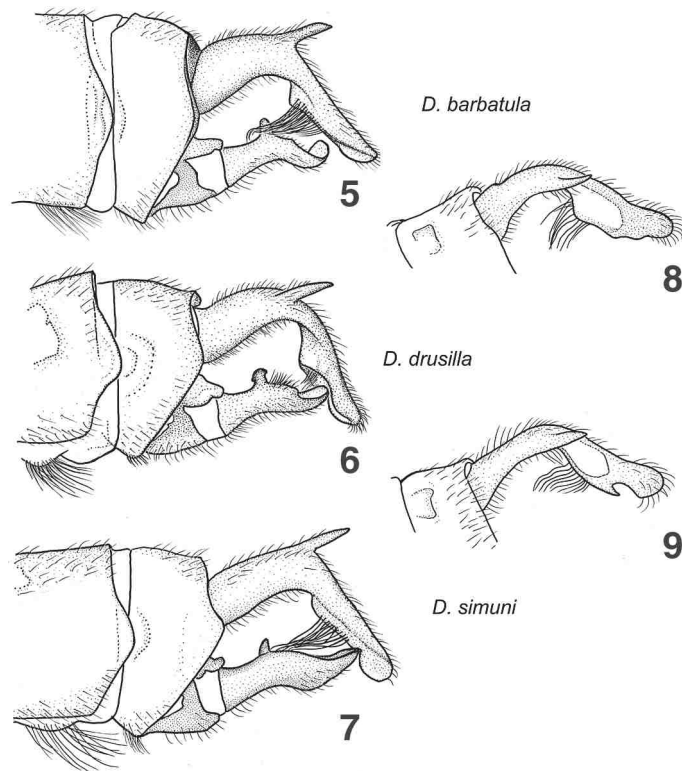
Material. — **Holotype** ♂: (SAR05_PST1), Malaysia, Sarawak, Miri division, Gunung Mulu National Park, foot of Gunung Mulu, perched trailside near junction of Summit Trail with old trail to the Sarawak Chamber, leg. J. Simun, 24-IV-2005.

E t y m o l o g y. — Simuni, a noun in the genitive case. Named for Jeffry Simun, who collected the holotype, a member of the staff at Gunung Mulu National Park and friend of the first author.

DIAGNOSIS. — A long bodied platystictid, readily distinguished from all other members of the family except *D. barbatula* by the combination of size, lack of pale antehumeral markings and presence of a row of long setae arising directly from the underside of the apical half of the superior anal appendage. Distinguished from *D. barbatula* by the deep cleft in the tip of the superior anal appendage, and the more slender internal spine on the inferior anal appendage.

MALE. — **H e a d.** — Labium pale. Basal 3/4 of labrum blue, black along outer margin. Anteclypeus blue, postclypeus shining black. Mandible bases blue in corner beside clypeus, black below. Vertex and frons bronzy black, occiput shining black. Transverse occipital carina with lateral extremities rounded. Ocelli whitish. Antenna mostly brownish, flagella missing.

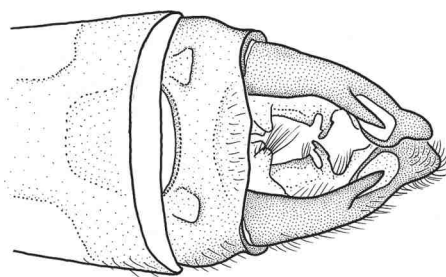
T h o r a x. — Prothorax, largely pale yellowish white except propleuron, which has extensive dorso-posterior black marking, and the central third of the posteri-



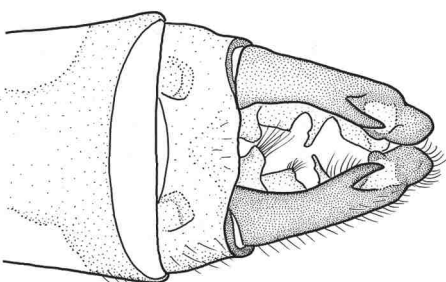
Figs 5-9. Male anal appendages, lateral view: (5) *Drepanosticta barbatula*, Poring Hot springs; — (6) *D. drusilla*, Gunung Pueh; — (7) *D. simuni* sp. n., holotype. — Male anal appendages, dorsal-interior view: (8) *D. barbatula* holotype; — (9) *D. simuni* sp. n., holotype.

or pronotal lobe which is black. Posterior pronotal lobe of simple crescent shape. Synthorax: Mesepisternum and mesepimeron bronzy black. Antealar triangles black near apex, pale towards wing bases. Metepisternum largely occupied by a yellowish band running its entire length, bronzy black below this. Metepimeron mostly yellowish, with a black area below the metapleural suture. Venter of synthorax pale. Legs: each with coxa and trochanter cream, femur cream with a dark stripe along extensor surface, black above joint. Tibia black immediately below femur, then mostly brown, darker on flexor surface, tarsus brown. Wings: 13 Px in Fw, 12 Px in Hw. Anal crossing branched in all wings. R_4 arising distal to subnodus in IR_3 joined to it by a short stalk. Pterostigma an elongate trapezium with costal side shorter than anal side, and proximal side slightly shorter than distal side, dark brown with narrow white border, covering slightly more than one underlying cell.

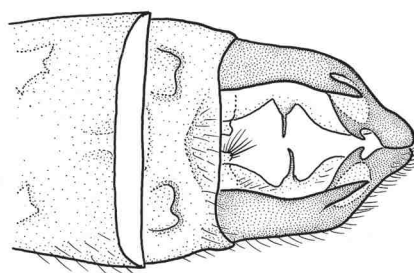
A b d o m e n. — Largely brown. S1 yellowish cream laterally, brownish dorsally, this darker near basally but with a small central basal yellowish mark, cream to sides. S3-7 brown with a pale basal annulus, becoming broader and more diffuse on successive segments. S8 very dark brown and black above, pale brown at sides. S9 black with a pair of dorsal basal yellow spots (Fig. 4). S10 black, with

*D. barbatula*

10

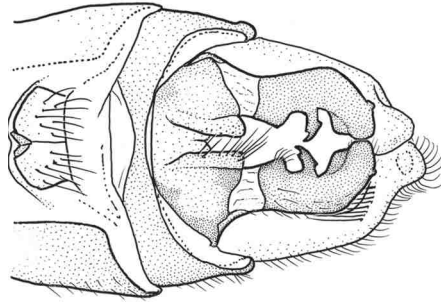
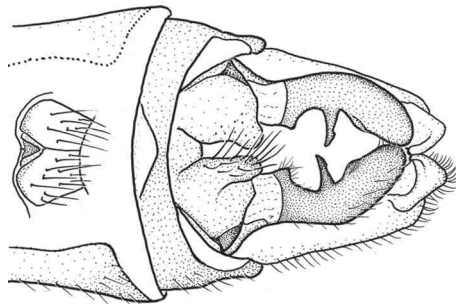
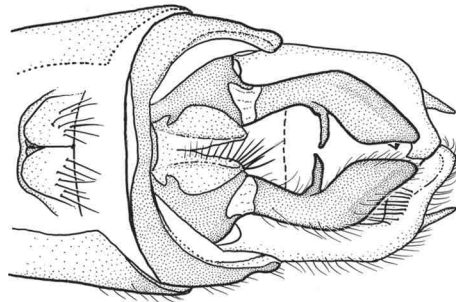
*D. drusilla*

11

*D. simuni*

12

Figs 10-12. Male anal appendages, dorsal view: (10) *Drepanosticta barbatula*, Poring Hot springs; — (11) *D. drusilla*, Gunung Pueh; — (12) *D. simuni* sp. n., holotype.

*D. barbatula**D. drusilla**D. simuni*

Figs 13-15. Male anal appendages, ventral view: (13) *Drepagnosticta barbatula*, Poring Hot springs; - (14) *D. drusilla*, Gunung Pueh; - (15) *D. simuni* sp. n., holotype.

a pair of deep widely separated dorsal basal pits (Figs 4, 12). Long setae are present on the genital valves. Anal appendages (Figs 7, 9, 12, 15) brown, inferiors paler than superiors, especially basally. Superior appendage ca twice the length of S10, directed upwards from base, then abruptly downwards at ca half length, the two sections at slightly more than a right angle to each other, the apical section slimmer than the basal one in lateral view (Fig. 7). A long spine originates from the inner margin of the upper surface of the superior anal appendage at the down-turn. Row of long beard-like setae arising from the underside of the superior appendage (Fig. 7). Tip of superior appendage deeply cleft interiorly, most visible in internal-oblique dorsal view (Fig. 9), between the spine and the base of the cleft lies a pale, weakly sclerotised, hollowed area. Inferior anal appendages as shown in Figures 7 and 15, articulated at base then narrowing to a stalk bearing a long, thin, internally directed spine arising from the inner dorsal surface at ca midpoint of appendage, expanded terminally into a dorsally hollowed foliate structure. Penis (Fig. 1): of typical form for the family (see illustrations in VAN

13

14

15

TOL, 2009), with a row of setae centrally on either side of the shaft and a very slight convexity between the arms of the terminal segment.

M E A S U R E M E N T S (mm). — Abdomen without caudal appendages ca 45.5, superior appendage just over 1, Hw 23.

R E M A R K S. — *D. simuni* is very similar to *D. barbatula*, but differs significantly in the structure of the terminal part of the superior anal appendages and in the inferior anal appendages. In the inferior anal appendages of *D. simuni* not only is the terminal part a different shape from that of *D. barbatula*, but the inner margin of the appendage runs smoothly from the articulation to the spine (Fig. 15), whereas in *D. barbatula* (and *D. drusilla*) the inner margin runs inwards then contracts sharply shortly after the articulation, making a sharp corner (Figs 13, 14)

DISCUSSION

The row of long setae on the superior anal appendages of *D. barbatula* and *D. simuni* is superficially similar to the dense tuft of setae occurring on the superior appendages of *D. hamadryas* Laidlaw, 1931 and its allies from Peninsular Malaysia. LIEFTINCK (1940) noted this similarity, but, correctly in our view, did not propose a particularly close relationship between *D. barbatula* and the mainland species. In *D. barbatula* and *D. simuni* the setae arise as a relatively long row on the lower surface of the superior appendages, whereas in *D. hamadryas* and its allies they arise as a concentrated bunch from a small stalk-like protuberance. There are also significant differences in the structure of the inferior appendages between *D. barbatula* and *D. simuni* on the one hand and *D. hamadryas* and allies on the other. As already noted, *D. drusilla* is extremely similar in structure and coloration to *D. barbatula*, with the most significant difference being the lack of the row of long setae on the superior appendages; however as noted above, in the specimens from Sarawak a few long setae are present in the same position. The two species can be further differentiated by the shorter distance between the sharp corner on the inner margin of the inferior anal appendage and the base of the spine in *D. barbatula* (Figs 13, 14), the more strongly inward turned and less smoothly shaped terminal part of the inferior anal appendage and the colour of the middle pronotal lobe: entirely pale in *D. drusilla* but with a dark central mark in *D. barbatula*. All of these species share well defined, deep basal dorsal pits on S10 of the abdomen: depressions are present in this position in all species of the Platystictidae that have been checked for this character by the first author, but vary considerably in depth and size; in many cases they are very shallow and poorly defined and easily overlooked. They also all share long setae on the genital valves, a character not typically present in the old world Platystictidae. Clearly *D. drusilla* falls within the same group as *D. barbatula* and *D. simuni*.

There are also number of similarities between *D. barbatula*, *D. drusilla* and *D. simuni* and two other species from south-east Asia: *D. attala* Lieftinck, 1934 from

Borneo (LIEFTINCK, 1934) and *D. lestoides* (Brauer, 1868), originally described from Mindanao in the Philippines but now known to have a wider distribution within the Philippines (VAN TOL, 2005). The anal appendages of *D. attala* differ in that the dorsal spine of the superior anal appendages is more inwardly directed, so that it is only just visible in typical lateral view (LIEFTINCK, 1934: fig. 2). The anal appendages of *D. attala* are extremely similar in structure to *D. lestoides*, with the inferior anal appendages of both of the same general form as those of *D. barbatula* etc. *D. attala* and *D. lestoides* also share the same form of penis as *D. barbatula* etc. The pits on the dorsum of S10 do not appear to be as well defined in *D. lestoides* as in *D. barbatula* etc.; they are very poorly defined in *D. attala*. However both *D. attala* and *D. lestoides* bear long setae on the genital valves. All five species are here considered likely to form a monophyletic group. The habitat in which the holotype of *D. barbatula* was collected was not recorded. However the specimen from Poring Hot Springs was apparently collected at a small stream. The holotype of *D. simuni* was collected trailside in mixed dipterocarp forest. There was a variety of streams, from tiny trickles to a large torrential stream, in the vicinity. LIEFTINCK (1934: 474) records "forest-brook" as the habitat of the two males from the type series of *D. drusilla*. This information is not on the labels of the type series and must presumably have come from the collector. It is not possible to know if the specimens were actually collected at the brook or merely somewhere in its vicinity. The mature male *D. drusilla* from Gunung Pueh was collected away from running water, but the teneral male from the Matang Wildlife Centre was collected at the confluence of a small closed canopy forest stream with its much larger parent stream. On several occasions the first author has observed platystictids likely to be *D. drusilla* in forest away from any stream at the Matang Wildlife Centre. It is difficult to draw firm conclusions on the habitat requirements of these species, but they probably breed in small forest streams and are either very scarce or, more likely, are secretive in their habits and only spend short periods at accessible heights at the breeding habitat. It is worth noting that *D. attala* appears to spend much of its time perched sufficiently high in the forest to be effectively undetectable. It has been observed ovipositing into leaf ribs high above swift running sections of larger forest streams than are typical of the habitats of most Platystictidae (R.A. Dow unpublished).

ACKNOWLEDGEMENTS

We are grateful to the Sarawak Forest Department and Sarawak Forestry Corporation for granting permission for the first author to collect Odonata in Sarawak. The first author owes many thanks to all the staff at Gunung Mulu National Park, but especially to JEFFRY SIMUN for his assistance and friendship.

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- VILLANUEVA, R.J.T. & M. SCHORR, 2011. Two new damselfly species from Polillo Island, Philippines (Odonata: Platystictidae). *Zootaxa*, 3017: 46-50.

ODONATOLOGICAL ABSTRACTS

2004

- (19008) DOGAN BORA, N. & A. GÜL, 2004. Feeding biology of *Silurus glanis* (L., 1758) living in Hirfanli Dam Lake. *Turk. J. Vet. Anim. Sci.* 28: 471-479. (With Turk. s.). – (Dept Biol. Educ., Gazi Fac. Aduc., Gazi Univ., TR-06500 Teknik Okullar, Ankara). In a tab., the total weight and percentage occurrence of Odon. in the stomachs of the fish individuals are shown according to seasons.
- (19009) FENOGLIO, S., T. BO, G. GALLINA & M. CUCCO, 2004. Vertical distribution in the water column of drifting stream macroinvertebrates. *J. Freshw. Ecol.* 19(3): 485-492. – (First Author: Dept Adv. Sci. & Technol., Eastern Piedmont Univ., via Cavour 84, I-15100 Alessandria). From the Ebro river (NE Italy) *Calopteryx* sp., *Boyeria irene* and *Onychogomphus* sp. are reported. For the latter, relative abundance at different depths is stated.
- (19010) HAMPE, A., 2004. Odonate communities of the Barbate river: glacial relicts and oriental colonizers. *Revta Soc. gaditana Hist. nat.* 4: 205-214. (Span., with Engl. s.). – (Depto Biol. Vegetal. & Ecol., Univ. Sevilla, Apdt 1090, ES-41080 Sevilla). The odon. of the upper and middle reaches of the Rio Barbate, Cadiz (Spain) are surveyed and their flight phenology, larval development and biogeographic origin are compared. Semivoltine spp. occur only in the upper reach, whereas spp. with 2 or more generations per yr form an important fraction in the middle reach. These are mostly libellulids that have probably colonized southern Spain from the E Mediterranean basin after the Pleistocene glaciations. In contrast, the spp. of the upper reach have been most probably present in the area during a longer time and are (at least) glacial relicts.
- (19011) HUNGER, H., 2004. *Naturschutzorientierte, GIS-gestützte Untersuchungen zur Bestandsituation der Libellenarten Coenagrion mercuriale, Leucorrhinia pectoralis und Ophiogomphus cecilia (Anhang II FFH-Richtlinie) in Baden-Württemberg*. Diss. Dr rer. nat., Hochschule Vechta. iv + 229 pp., 3 App. excl. (With Engl. s.). – (Author: August-Ganther-Str. 16, D-79117 Freiburg). On the current conditions and trends of all known populations of the 3 spp. in Baden-Württemberg (SW Germany). Vector- and raster-based GIS methods play an important role in the analysis of the data. A synoptic discussion of the results leads to concrete recommendations for action plans for protection of these spp.
- (19012) RODRIGUES, D.J., M. UETANABARO & C.P.A. PRADO, 2004. Seasonal and ontogenetic variation in diet composition of *Leptodactylus pedicpinus* (Anura, Leptodactylidae) in the southern Pantanal, Brazil. *Revta esp. Herpetol.* 18: 19-28. (With Span. s.). – (Depto Biol., Univ. Fed. Mato Grosso do Sul, C.P. 549, BR-79070-900 Campo Grande, MS). Odon. larvae were found in the stomachs of the frog in wet season only, in the frequency of 0.41%.
- (19013) TROCKUR, B., 2004. *Untersuchungen zur Habitatwahl von Epitheca bimaculata Charpentier, 1825*. Diss. Dr Naturw., Hochschule Vechta. 291 pp. (With Engl. s.). – (Author: Schulstr. 4, D-66636 Tholey-Scheuern). The work focusses on the habitat selection of *E. bimaculata*. Important aspects of the chapter dealing

with the faunistical-ecological and phenological data base are: comparison of the study sites in the “Central Valley of the River Saar” (esp. bayous, ponds) and the biosphere reserve “Schorfheide-Chorin” (small lakes), increase in the amount of newly detected occurrences in both study regions owing to an optimised and intensified search strategy, characteristics as a typical spring species (start of emergence in the first half of May) with a short emergence period and a flight period until the end of June/beginning of July, and relations between emergence and flight period and weather characteristics. The females select submersed habitat elements near the water surface in the open water of the breeding sites (floating leaf of plants such as *Nuphar lutea*, large areas with submersed plants, e.g. *Myriophyllum* spp., *Ceratophyllum* spp. and *Elodea canadensis*, reeds standing in the water, or woody debris) for the deposition of the egg strings containing more than 1,000 eggs. The analysis of the oviposition sites shows marked differences between the stem habitats. In several cases a repeated neighbouring, thus double concentrated oviposition took place and frequently it was observed on the edges of submersed vegetation just below the water surface. These parts of the water bodies used as oviposition sites are also primary triggers of habitat selection for mature males, because in most cases these males ready for reproduction use the same habitat elements for orientation within the territories, which are sometimes continuously occupied for several hours. Perching behaviour and thus habitat selection of the males can be influenced by strong wind, shadow by groves at the shoreline, or the presence of other dragonflies which occupy perching sites in a similar way and are dominant over *Epitheca*. The lack of an exact congruence of perching and oviposition sites is discussed as well as the potential correlation between differences in niche specialisation between younger and older larvae. Also, the frequently observed orientation of territorial males towards the edges of submersed vegetation is discussed. The behaviour in larval stages 1-3 is, above all, characterized by the selection of submersed, vertical habitat elements located near the water surface. Some weeks older larval stages switch to a predominantly or at least partially benthic and night-active life style. Special interest was paid to the documentation and analysis of emergence sites, and on habitat selection of the F-0 larvae, as indicated by the sites where the exuviae were found. For this purpose, quantitative, spatially precise documenta-

tion data taken over many years at the biggest population in the “Saarland”, the analysis of accumulations of exuviae (amount and extent), correlations between the finding sites of the exuviae and various habitat elements (positive correlation with *Nuphar lutea*) and the depth of the water bodies (negative to the maximal depth), and changes over the course of the six intensive study years are used. In addition to the comparison with other stem habitats, emergence substrates, distance from the shoreline and height of the emergence sites are treated. The duration of the larval period of usually two or three years was deduced from the analysis of potential sibling pools, the characteristics of pools of exuviae found within very short distance of each other, and the often both highly stenotope and synchronized behaviour of the emergent F-0 larvae are taken into account as well. In a comprehensive, synecological synopsis, different hypotheses about the ecological requirements of the species are developed and discussed. In this context, the population ecological view of the known occurrences in reference to the mobility and dispersal ability is taken into consideration. Aspects of stenotopy and synchronisation are evaluated and compared with other species. The observed behaviour and the habitat selection are related to the visually identifiable habitat factors. The role of potentially effective ultimate factors in the water body is discussed. The availability of vertical habitat element near the surface and the ecological conditions in the fish-dominated biocoenosis are found to be the most important factors. The negative biotopes and the observed effects of changes or systematic manipulations of the habitat configuration at some occurrences are included into these considerations. The special role of fish and the ecological adaptation of the *Epitheca* larvae to the fish-dominated biotope, the ecological comparison and the syntopy with *Leucorrhinia caudalis* and *Cordulia aenea* are discussed in the context of the synecological demands of the species. Subsequently, a new classification, exceeding the common classification of the occurrences in stem-, secondary- and male-habitats, is proposed, and the different metapopulation levels and a promising search strategy are discussed. In a separate chapter about aspects of nature conservation, the current classification in the Red List of Germany (“endangered”), the proposal to include the species in a nation-wide monitoring programme, the high diversity of dragonflies at the *Epitheca* waters, the function as an indicator species, the coexistence with other species, threat factors and

components of the management of the species and a protection concept are treated.

- (19014) VAN GOSSUM, H., T. ADRIAENS, H. DUMONT & R. STOKS, 2004. Sex- and morph-specific predation risk: colour or behaviour dependency? *Eur. J. Ent.* 101: 373-377. – (First Author: Evol. Biol. Gr., Dept Biol., Univ. Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen).

The coexistence of discrete morphs within a species, with one morph more conspicuous than the others is often thought to result from both sexual selection and predation. In many Zygoptera, sexual dimorphism occurs jointly with multiple ♀ colour morphs. Typically, one morph is coloured like the ♂ (andromorph), while the other/s is/are not (gynomorph/s). The mechanisms contributing to the maintenance of such ♀ polymorphism in Zygoptera remain poorly understood, especially the role of predation. The detectability of 2 different ♀ colour morphs in *Enallagma cyathigerum* was tested, using human observers as model predators; andromorphs were detected more frequently than gynomorphs. Field data on mortality of ♂♂ and the 2 different ♀ morphs due to predation or drowning were also collected, and these observations support morph-specific mortality. In natural populations predation risk was higher in ♂♂ than in ♀♀; gynomorphs, however, were more prone to predation than andromorphs. Differences in behaviour between morphs, rather than colour, may explain this result.

- (19015) VERDONSCHOT, P.F.M. & R.C. NIJBOER, 2004. [*Macrofauna and vegetation of the brooks in the Netherlands*]. Alterra, Wageningen. 325 pp. [*Alterra Rep. 756*]. (Dutch). – (Publishers & Authors: P.O. Box 47, NL-6700 AA Wageningen). The eco-typological network for the brooks in the Netherlands is described. In the analysis of the macroinvertebrate data the odon. are species-wise considered.

2005

- (19016) LANDMANN, A., 2005. Rote Listen und Föderalismus im deutschsprachigen Raum: Entwicklung, Bestand, fachliche und praktische Probleme. *NatSchutz biol. Vielfalt* 18: 167-185. (With Engl. s.). – (Karl-Kopfererstr. 3, A-6020 Innsbruck). More than 2000 Red Lists (RL) have been published in German-speaking countries during the last 30 yr.

Many of these RL only refer to political subunits (federal countries, provinces, districts, cities) and often to only small areas. After giving a general review of numbers and history of such regional-level RL (RRL) in Switzerland, Austria, Germany, Liechtenstein and the South Tyrol (Alto Adige, Italy), the paper mainly deals with specific scientific problems of RRL which tend to increase with decreasing reference areas (e.g. problems connected with metapopulation biology, biogeography) and with tendencies reducing the practicability of RRL for nature conservation activities (e.g. inflation with insufficiently known invertebrate taxa or with biological units below species level). For several scientific and practical reasons, in many cases the IUCN-guidelines for RL at regional-levels are not adequately applicable for RRL at small scales. As such, RRL are mostly dedicated to serve as instruments for regional nature conservation, different and more region-specific criteria and threat descriptors might be more useful than for national and international RL. Moreover, it is doubtful if the comparability between RRL is improved by simply adopting standardised criteria and categories.

- (19017) LEIPELT, K.G., 2005. Behavioural differences in response to current: implications for the longitudinal distribution of stream odonates. *Arch. Hydrobiol.* 163(1): 81-100. – (Inst. Geoökol., Techn. Univ. Braunschweig, Langer Kamp 19/C, D-38106 Braunschweig).

Different longitudinal distribution patterns occur in closely related running water spp. However, the mechanisms that underlie this phenomenon are poorly studied. In European Cordulegaster, 2 different longitudinal distribution patterns occur: spp. like *C. bidentata* and *C. insignis* are limited to springs and springbrooks, whereas those like *C. boltonii* and *C. picta* are less restricted and occur from springs to larger streams and rivulets. Here, experiments in artificial streams were carried out to reveal differences in larval response to current between spp. of the 2 types. Larval *C. bidentata* and *C. insignis* showed a higher proneness to drift compared to *C. boltonii* and *C. picta*. Furthermore, *C. bidentata* and *C. insignis* avoided renewed drifting after a forced drift event less effectively and, exposed to strong current, travelled longer distances. It is concluded that the behavioural traits in *C. bidentata* and *C. insignis* are less effective to withstand strong hydraulic stress, which restricts their distribution to habitats with low discharge and current velocity, i.e. to springs and springbrooks.

- (19018) NAGY, B., A. SZÉKELY & N. SZÁLLASSY, 2005. Site fidelity and fluctuating asymmetry in males of *Libellula fulva* (Odonata: Libellulidae). *Entomol. rom.* 10: 59-64. (With Roman. s.). – (First Author: Dept Hydrobiol., Univ. Debrecen, Egyetem tér 1, H-4032 Debrecen).
The study was conducted at a small, canalized creek in E Hungary. The site fidelity was studied with the Localisation Index (LI) and Site Fidelity Index (SFI). In ♂♂ that simultaneously defended 3 territories the SFI was high, while the LI was highest in the ♂♂ that protected a single area. There was no correlation between ♂ site fidelity and the measure of wing asymmetry during the first yr of the study, but in the second yr a significant correlation was found in the case of ♂♂ that defended a single territory. There was no correlation between body size and SFI.
- (19019) PÁEZ, A.K., D.F. STOTZ & J.M. SHOPLAND, 2005. Cuba: Peninsula de Zapata. *Rapid Biol. Invent.*, Chicago 7: 1-150. – (c/o Envir. & Conserv. Program, Field Mus., 1400 South Lake Shore Dr., Chicago, IL 60605-2496, USA).
Cuba is home to 81 odon. spp., none of which is endemic. As the largest wetland in the Antilles, Zapata is of great importance for odon. conservation. It is estimated that ca 50 spp. probably occur there. During the present survey (8-15 Sept. 2002), 18 spp. were recorded and they are listed here.
- (19020) PRUNIER, F., 2005. Sex ratio and biometry of three dragonflies from populations in Sierra Morena: *Anax imperator*, *Boyeria irene*, *Cordulegaster boltonii immaculifrons* (Insecta: Odonata). *Boln Soc. andaluza Ent.* 13: 67-71. (Span., with Engl. s.). – (Author's postal address not stated).
The ♀♀ were prevailing. Sex ratios in the 3 spp. were 1.1, 1.2 and 1.2 respectively; – Spain
- (19021) SCHAPPERT, P., 2005. A new species of damselfly for the Lost Pines. *Lost Pines Nature Notes* 13: 1 pp. – (Author's address unknown).
Hetaerina titia is recorded for the first time from Bastrop co., Texas (USA).
- (19022) VAN DUINEN, G.-J., A. DEES & H. ESSELINK, 2005. *Baseline survey of aquatic invertebrates in the wetland restoration area of Raessaare bog*. PIN/MATRA project "Integrated wetland and forest management of the transborder area of North Livonia", Bargerveen Foundation", Univ. Nijmegen. 17 pp. – (Dept Anim. Ecol, Radboud Univ., P.O. Box 9010, NL-6500 GL Nijmegen).
10 odon. spp. (larvae) are listed from the bog and the reference sites in Nigula, Valgeraba and Punaraba (N Livonia, Estonia).
- (19023) VAN GOSSUM, H., R. STOKS & L. DE BRUYN, 2005. Lifetime fitness components in female colour morphs of a damselfly: density- or frequency-dependent selection? *Biol. J. Linn. Soc.* 86: 515-523. – (First Author: Evol. Biol. Gr., Dept Biol., Univ. Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen).
In many Zygoptera mature ♀♀ exhibit colour polymorphism: one ♀ morph resembles the conspecific ♂ (androchrome) while the others do not (gynochromes). Hypotheses for the maintenance of such polymorphisms differ mainly as to whether they are based on density- and/or frequency-dependent selection and on the nature of the frequency dependence. Lifetime fitness data (individual lifespan, number of copulations and number of ovipositions) for ♀ morphs of *Ischnura elegans* were collected from 15 insectaries differing in population parameters (density, sex ratio and ratio of andro- to gynochromes). Both density and frequency affected a specific set of the studied fitness components. Morph frequency influenced lifespan, sex ratio influenced the number of copulations, and density affected lifespan and the number of ovipositions. Clearly, discrepancies among studies may be generated if the studied fitness components differ. The final fitness estimate, the number of ovipositions, was only influenced by density, thereby not supporting frequency-based hypotheses. Contrary to expectation under the current density-based hypothesis, androchromes compared to gynochromes had a lower number of ovipositions at high density. The results are discussed in the light of mechanisms maintaining the ♀ polymorphism.
- (19024) VERBERK, W.C.E.P., H.H. VAN KLEEF, M. DIJKMAN, P. VAN HOEK, P. SPIERENBURG & H. ESSELINK, 2005. Seasonal changes on two different spatial scales: response of aquatic invertebrates to water body and microhabitat. *Insect Sci.* 12: 263-280. – (First Author: Dept Anim. Ecol. & Ecophysiol., Radboud Univ., Nijmegen, The Netherlands).
The study was conducted at 3 water bodies located in Korenburgerveen, The Netherlands. 14 identified odon. spp. are listed. Their respective locomotion and

mobility and the season, water type and microhabitat of their occurrence are stated.

- (19025) XU, Q.-h., 2005. A new species of the genus *Aciagrion* Selys from Fujian, China (Odonata: Coenagrionidae). *Ent. J. East China* 14(4): 301-302. (Chin., with Engl. s.). – (Dept Biol. & Envir. Engin., Zhangzhou City Univ., 10 Xi-Yang Ping Rd, Zhangzhou, Fujian-363000, China).
A. huaanensis sp. n. is described and illustrated. Holotype ♀: Huaan co., Fujian, China, 22-IX-2005; deposited in Zhangzhou Educ. Coll., Zhangzhou, China.

2006

- (19026) BECHLY, G., 2006. New results about the arthropod fauna from the Lower Cretaceous Crato formation of Brazil. *Abstr. Pap. Philadelphia annu. Meet. geol. Soc. Am.*, abstract 154-12. – (Staat. Mus. Naturk., Rosenstein 1, D-70191 Stuttgart).
 Has a reference to the newly discovered fossil “Anisozygoptera”.
- (19027) BOGDANOVIĆ, T., 2006. *Ecology, morphology and cytogenetics of genus Lindenia (Insecta, Odonata, Gomphidae) in Croatia*. PhD thesis, Univ. Zagreb. viii+193 pp. (Croat., with Engl. s.). – (Author: Dept Biol., Strossmayer Univ., Trg Ljudevita Gaja 6, HR-31000 Osijek, Croatia).
L. tetraphylla is a widespread sp. in S Croatia, and *L. naranta* sp. n. is described here. Holotype ♂, allotype ♀: Croatia, southern Dalmatia, Neretva river mouth, Desansko Lake, 16-V-2002; deposited in Dept Biol., Strossmayer Univ., Osijek, Croatia. The morphology, biology, ecology and cytotaxonomy of the 2 spp. are described in much detail. Their karyotypes appear similar: $2n\delta = 22+X$, $n\delta = 11+X$; $X0/XX$; no *m*.
- (19028) BRAUNE, E., 2006. *Spatially explicit models for interacting populations in a changing landscape: a case study on Namibian dragonflies (Odonata)*. Diss. Dr rer. nat., Techn. Univ. Braunschweig. vi + 134 pp., App. excl. – (Author's current address unknown).
 A model system is developed, which allows the modelling of the responses of the 3 major anisopteran groups (*Paragomphus genei*, *Crocothemis erythraea*, *Pantala flavescens*) in arid Namibia under current and future climatic conditions. It can be used as a tool for the assessment of odon. biodiversity and

may help to identify and emphasize valuable regions for freshwater conservation management.

- (19029) CHANDRA, G., S.N. CHATTERJEE & A. GHOSH, 2006. Role of dragonfly (*Brachytron pratense*) nymph as a biocontrol agent of larval mosquitoes. *Buletin Penelitian Kesehatan / Bull. Health Stud. Indonesia* 34(4): 147-151. – (Mosquito Res. Un., Dept Zool., Burdwan Univ., W Bengal, India).
 The monotypic *Brachytron* is restricted to the W Palaearctic; the correct identity of the sp. actually used in this study cannot be ascertained.
- (19030) DE VRIES, H.H. & V. MENSING, 2006. *Kansen voor groene glazenmaker in Noord Brabant. – [The opportunities for Aeshna viridis in the province of Noord Brabant, The Netherlands]*. De Vlinderstichting, Wageningen (VS2006.007). 23 pp. (Dutch). – (Publishers: P.O. Box 506, NL-6700 AM Wageningen).
 The potential habitats in the province are surveyed. The adequate *Stratiotes aloides* habitats are located particularly in the Langstraat, nr Ravenstein and at Moerdijk.
- (19031) DJERNAES, M. & J. DAMGAARD, 2006. Exon-intron structure, paralogy and sequenced regions of elongation factor-1 alpha in Hexapoda. *Arthrop. Syst. Phylog.* 64(1): 45-52. – (Biol. Inst., Zool. Mus., Univ. Copenhagen, Copenhagen, Denmark).
 Elongation factor-1 alpha is widely used and shows a promise for phylogenetic studies of Hexapoda. However, paralogous copies and the presence of introns pose problems. Here, exon-intron structure, presence of paralogous copies and the number and extent of sequenced regions are surveyed in all hexapod orders (incl. Odon.) and a phylogenetic tree based on intron positions is constructed.
- (19032) EASON, P.K. & P.V. SWITZER, 2006. Spatial learning in dragonflies. *Int. J. comp. Psychol.* 19(3): 268-281. – (First Author: Dept Biol., Univ. Louisville, KY 40292, USA).
 Spatial learning is evident in dragonflies on a variety of spatial scales. Mature dragonflies must be able to locate a variety of features in the habitat that are critical to survival and reproduction, including sites for breeding, foraging, roosting, and thermoregulating. In many spp., these sites do not coincide in space. Because individuals may repeatedly use particular sites for different activities, they must learn both

the locations of these sites and routes among them. Further evidence of spatial memory in dragonflies is provided by their site specificity on a finer scale. Breeding ♂♂, for example, often are faithful not only to a particular area, but to a specific territory site within that area. ♂♂ appear to become faithful to a territory site through localization, a process during which they explore the site and develop a spatial map of the location of the territory and its resources. ♂♂ also respond to their interactions with other individuals, adjusting both their choice of territories and their space use within their territories to reflect those interactions. In *Perithemis tenera*, ♂♂ are not faithful to territories on which they have lost a fight with another ♂; in contrast ♂♂ are more likely to be faithful to territories on which they successfully mated than to territories on which they obtained no matings. Similarly, while on territories, ♂ *Perithemis* adjust their position in response to negative and positive interactions. They move away from the side of the territory from which neighbours most frequently intruded, and they move toward locations from which they pursued a ♀. Territorial *Perithemis* thus modify their space use at both the territory and within-territory spatial scale in response to their social environment. Their responses are consistent with the hypothesis that they learn from their positive and negative experiences and adjust their future space use accordingly. Further study of spatial learning in dragonflies would greatly enhance studies of dragonfly behaviour and ecology, and help us understand learning in general.

- (19033) FERREIRA, S., J.M. GROSSO-SILVA & P. SOUSA, 2006. Miscellaneous records of dragonflies (Odonata) from continental Portugal, 2. *Boln Soc. ent. aragon.* 38: 321-323. (With Span. s.). — (First Author: Cent. Invest. Biodiv., Univ. Porto, Campus Agrário de Vairão, PT-4485-661 Vairão). Records of 34 spp. — (For pt 1, see OA 15856).
- (19034) HARTMANN, A., 2006. *Key to Odonata (dragonflies and damselflies) of the Hindu Kush-Himalayan region*. Regional Capacity Building Workshop on the Macroinvertebrate Taxonomy and Systematics for Evaluating the Ecological Status of Rivers in the Hindu Kush-Himalayan (HKH) Region, Kathmandu Univ., Dhulikhel. 13 pp. — (c/o Dr O. Moog, Dept Water, Atmosphere & Environment, Inst. Hydrobiol. & Aquat. Ecosyst. Mngmt, Univ. Bodenkultur, Feistmantelstr. 4, A-1180 Wien).
- An illustrated key to the families and genera of larvae.
- (19035) HICKS, B.J., H.J. BANNON & R.D.S. WELLS, 2006. Fish and macroinvertebrates in lowland drainage canals with and without grass carp. *J. aquat. Plant Mngmt* 44: 89-98. — (First Author: Cent. Biodiv. & Ecol. Res., Dept Biol. Sci., Sch. Sci & Engin., Univ. Waikato, P.B. 3105, Hamilton, NZ). The introduction of diploid grass carp (*Ctenopharyngodon idella*) to a lowland Waikato drainage canal, NW of Huntly, North Island (New Zealand), resulted in its removal of aquatic macrophytes and had a profound impact on the occurrence and abundance of *Xanthocnemis zealandica* larvae.
- (19036) KAISER, M., 2006. Bemerkenswerte faunistische Beobachtungen in der Lippeau nördlich von Bentfeld, Kreis Paderborn (Nordrhein-Westfalen) (Insecta: Odonata, Saltatoria, Coleoptera, Lepidoptera). *Mitt. ArbGem. westfäl. Ent.* 22(1): 7-18. — (Elise-Rüdiger Weg 1, D-48147 Münster). Out of the 23 odon. spp. recorded in the Lippeau (N of Bentfeld, Paderborn distr., North Rhine-Westphalia, Germany), but not listed, the occurrence of *Calopteryx virgo*, *Sympetma fusca*, *Aeshna isosceles* and *Gomphus vulgatissimus* is outlined in detail.
- (19037) KALKA, M. & E.K.V. KALKO, 2006. Gleaning bats as underestimated predators of herbivorous insects: diet of *Micronycteris microtis* (Phyllostomidae) in Panama. *J. trop. Ecol.* 22: 1-10. — (Second Author: Dept Experimental Ecol., Univ. Ulm, Albert-Einstein-Allee 11, D-14195 Ulm). The small, insectivorous gleaning bat shows high site fidelity in the use of night roosts for prey consumption. Its diet was studied (1-31 March) at Barro Colorado Island by means of all-night infrared videotaping at the feeding roost (located ca 2 m from the forest edge) and the subsequent analysis of remains in the faecal pellets. After Lepidoptera (caterpillars), Orthoptera and Coleoptera, the Anisoptera were among the most important diet items (10.3% of the consumed biomass). Despite the bat's small body mass, the relatively heavy loads of large insects did not negatively affect its flight performance.
- (19038) LI, K., W. ZHOU, Y. YANG & X.-f. PAN, 2006. Sexual dimorphism and feeding habits in *Rana pleuraden*. *J. Swest Forest. Coll.* 26(1): 47-51. (Chin., with Engl. s.). — (Dept Conserv. Biol., Southwest

- Forestry Coll., Kunming, Yunnan-650224, China). The contents of 223 ♂ and 235 ♀ stomachs were analysed (May-Oct.). There was no significant difference in the diet between the sexes, but (very few) odon. were found in ♀ frogs only.
- (19039) LUCK, J., 2006. Dragonflies and damselflies, Sussex 2006. *Adastra /Annu. Rev. Wildl. Recording Sussex 2006*: 18-19. – (4 Mill View, Ringmer, East Sussex, BN8 5EP, UK).
Highlights among the spp. recorded in 2006; – Sussex, UK.
- (19040) POBOLJŠAJ, K., D. ERJAVEC, M. GOVEDIČ, M. KOTARAC, J.K. VEENVLIET, P. PRESETNIK, A. ŠALAMUN, B. TRČAK & A. VREZEC, 2006. *Presoja spremenljivosti vplivov D[ržavnega] L[okacijskega] N[ačrta] za zagotavljanje poplavne varnosti v Spodnji Savinjski dolini na varovana območja (zavarovana in Nature območja) ...* – [Assesment of changeability of the State Location Plan impacts for assurance of inundation security in the Lower Savinjska valley (the protected and Natura areas) ...] CKFF, Miklavž-na-Dravskem-polju. 123 pp. (Slovene). – (CKFF, Klunova 3, SI-1000 Ljubljana).
Includes a list of 21 odon. spp. recorded from the Vrbje fishpond near Žalec, Slovenia.
- (19041) SEMWAL, N. & P. AKOLKAR, 2006. Water quality assessment of sacred Himalayan rivers of Uttaranchal. *Current Sci.* 91(4): 486-496. – (Central Pollution Control Bd, Parivesh Bhawan, East Arjun Nagar, Delhi-110012, India).
The study deals with water quality assessment of rivers in Uttaranchal (India), in view of their religious importance and ecological sustainability. Euphaeidae, Gomphidae and Libellulidae are reported from the clean water stretch of the Nagon Gadhera (downstream, Dharasu) and from the moderately polluted Kali (Naya Basti, downstream Dharchula, Pithoragarh distr.).
- (19042) SERRANO-MENESES, M.A., 2006. *Sexual size dimorphism in damselflies, dragonflies and birds: function and development*. Thesis Doctor Philosophy, Dept Biol. & Biochem., Univ. Bath. 34 p. [not paged]. – (Author's current address unknown).
Sexual selection, via mating competition and/or ♂ display agility correlates with sexual size dimorphism (SSD) in Zygoptera, seabirds and bustards (Otididae). The interdisciplinary and taxon-diverse approach in the study of SSD revealed patterns of SSD and macroecological trends that are likely to be caused by variation in the selection pressure acting on adults and on the development of ♂♂ and ♀♀.
- (19043) TAKAHARA, T., Y. KOHMATSU, A. MARUYAMA & R. YAMAOKA, 2006. Specific behavioral responses of *Hyla japonica* tadpoles to chemical cues released by two predator species. *Curr. Herpetol.* 25(2): 65-70. – (First Author: Grad. Sch. Sci. & Technol., Kyoto Inst. Technol., Sakyo, Kyoto, 606-8585, JA).
Tadpoles exposed to the predator chemical cues exhibited similar reduction in activity level. In the presence of the fish (*Gnathopogon elongatus*) they spent more time in the bottom water layer compared to controls, but did not change their microhabitat choice in the presence of *Anax parthenope julius* larvae chemical cues. (See also OA 17418).
- (19044) VELASCO, J., A. MILLÁN, J. HERNÁNDEZ, C. GUTIÉRREZ, P. ABELLÁN, D. SÁNCHEZ & M. RUIZ, 2006. Response of biotic communities to salinity changes in a Mediterranean hypersaline stream. *Saline Systems* 2006: 15 pp.; – DOI: 10.1186/1746.1448-2-12 – (First Author: Dept Ecol. & Hydrol., Univ. Murcia, ES-31100 Murcia).
The Rambla Salada is a naturally hypersaline stream (close to 100 g/L⁻¹) in the sedimentary Fortuna basin of the Segura river (SW Iberian Peninsula). Its salinity is principally due to the Miocene gypsiferous marls in the basin. In consequence of the 1979 Tajo-Segura diversion, there has been an increase in the input of freshwater and the salinity has fallen to a mean of 35.5 g/L⁻¹. The dilution of the salinity (3.5-6.8 g/L⁻¹) allowed colonisation of the low salinity tolerant *Anax* sp.

2010

- (19045) ALKER, P., 2010. Red wing venation in darters. *Atropos* 40: 49-51. – (63 Lodge Rd, Orrell, Wigan, Lancashire, WN5 7AT, UK).
On the venation in *Sympetrum fonscolombii*, *S. sanguineum* and *S. striolatum*. The degree to which *S. striolatum* can have extensive red veins is not adequately covered in the keys.
- (19046) ANDRELIČ, A., 2010. *Popis in primerjava favnih kačjih pastirjev (Odonata) v okolici Renč (sev-*

- erna Primorska*). – [Inventarisation of dragonflies (*Odonata*) in the Renče area, northern Littoral, Slovenia]. Paper on the subject “Animal Ecology”, Univ. Ljubljana. 15 pp. (Slovene). – (Author’s address unknown).
24 spp. from Renče and Volčja Draga, based on literature and original work.
- (19047) ARTNAK, M., 2010. Paritveni ples modrih bleščavcev. – [Courtship display in *Calopteryx virgo*]. *Gea*, Ljubljana 20(1): 16-19. (Slovene). – (Author’s address unknown).
A commented photographic account.
- (19048) BEDJANIČ, M., 2010. *Seznam vrst kačjih pastirjev (Insecta: Odonata) Pohorja z odonatološko bibliografijo*. – [The *Odonata* list of Pohorje, with bibliography]. Projekt NATREG, Gradivo za Zavod RS za varstvo narave, Ljubljana. 9 pp. (Slovene). – (Author: Kolodvorska 21/B, SI-2310 Slovenska Bistrica).
A list of 36 spp., with annotations on their legal protection status; – Slovenia.
- (19049) DAVIES, P.J., I.A. WRIGHT, S.J. FINDLAY, O.J. JONASSON & S. BURGIN, 2010. Impact of urban development on aquatic macroinvertebrates in south eastern Australia: degradation of in-stream habitats and comparison with non-urban streams. *Aquat. Ecol.* 44: 685-700. – (Second Author: Coll. Health & Sci., Univ. Western Sydney, Locked Bag 1797, South Penrith Distrib. Cent.-1797, AU).
It includes a comparison in the mean frequency of the collection of 6 odon. fam. from streams in urban and non-urban-impacted, adjacent, naturally vegetated catchments in N Sydney (Australia). The study reveals that urban streams are significantly impaired.
- (19050) DE PAULA-LIMA, J.E., D. RÖDDER & M. SOLE, 2010. Diet of two sympatric Phyllomedusa (*Anura: Hylidae*) species from a cacao plantation in southern Bahia, Brazil. *NWest. J. Zool.* 6(1): 13-24. – (Third Author: Depto Ciênc. Biol., Univ. Estad. Santa Cruz, Rodovia Ilhéus Itabuna, km 16, BR-45650-000 Ilhéus, Bahia).
Some odon. were reported in the Phyllomedusa rohdei diet by R.L. Teixeira & D. Vrcibradic (2007, *Herpetol. Rev.* 38: 69-70), but none were detected during the present study on *P. burmeisteri* and *P. rohdei*, although the examined frogs were collected from low shrubs near ponds.
- (19051) DE SOUZA, N.S.D. & R.L. FERREIRA-KEPPLER, 2010. Conteúdo do trato digestivo de imaturo de *Odonata* (Insecta) de poças da Reserva Forestal Adolpho Ducke, Manaus, AM. *19. Jorn. Iniciação cient. PIBIC INPA-CNPq/FAPEAM*, 3 pp. (Port.). – (Authors’ postal addresses not stated).
The food remains in digestive tract of the larvae of 4 odon. fam. from 4 ponds in the Reserve (Amazonas, Brazil) are listed.
- (19052) DOW, R.A., C.Y. CHOONG & Y.F. NG, 2010. A review of the genus *Amphicnemis* in Peninsular Malaysia and Singapore, with descriptions of two new species (*Odonata: Zygoptera: Coenagrionidae*). *Zootaxa* 2605: 45-55. – (First Author: Naturalis, P.O. Box 9517, NL-2300 RA Leiden).
The *Amphicnemis* spp. occurring in this region are reviewed and 2 new spp. are described, viz.: *A. bebar* sp. n. (holotype ♂: Malaysia, Pahang, upstream on Sg Bebar, 23-IX-2009) and *A. hoisen* sp. n. (holotype ♂: same locality, 22-IX-2009). The types are deposited in RMNH, Leiden. From Peninsular Malaysia and Singapore are now known 4 spp.; keys to both sexes of these are provided. *A. ecornuta* is recorded from Borneo for the first time. A summary of the distributions of the named *Sundaland Amphicnemis* spp. is given; 12 of these are known from Borneo.
- (19053) DOW, R.A., C.Y. CHOONG & Y.F. NG, 2010. *Elatoneura mauros* sp. nov. (*Odonata: Zygoptera: Protoneuridae*). *Zootaxa* 2502: 65-68. – (First Author: Naturalis, P.O. Box 9517, NL-2300 RA Leiden).
The new sp. is described and illustrated. Holotype ♂: Malaysia, Sarawak, Lanjak Entimau Wildlife Sanctuary, Sungai Begua, 18-VI-2008; deposited in RMNH, Leiden. Currently, 6 *Elatoneura* spp. are known from Sundaland and a key to these is provided.
- (19054) FERRARI, M.C.O., B.D. WISENDEN & D.P. CHIVERS, 2010. Chemical ecology of predator-prey interactions in aquatic ecosystems: a review and prospectus. *Can. J. Zool.* 88: 698-724. (With Fr. s.). – (First Author: Dept Biol., Univ. Saskatchewan, 112 Science Pl., Saskatoon, SK, S7N 5E2, CA).
A review paper, with a summary of the studies on conspecific alarm cues, diet cues and learned predator recognition via alarm cues, published since 1998, incl. the reference to *Enallagma antennatum* larvae. See M.C. McBean et al., 2005, *Odonatologica* 34:

- 155-164, and L. Mortensen & J.M.I. Richardson, 2008, *J. Insect. Behav.* 21: 285-295.
- (19055) FLENNER, I., O. RICHTER & F. SUHLING, 2010. Rising temperature and development in dragonfly populations at different latitudes. *Freshw. Biol.* 55: 397-410. – (First Author: Ecol. & Envir. Sci., Halmstad Univ., P.O. Box 823, SE-30118 Halmstad).
For modelling the future ecological responses to climate change, data on individual spp. and on variation within and between populations from different latitudes are required. Here, life cycle regulation and growth responses to temperature are examined in Mediterranean and temperate populations of *Orthetrum cancellatum*. In an experiment, offspring from individual ♀♀ from different parts of the range were kept separately to elucidate differences between families. The experiment was run outdoors at 52°N at a natural photoperiod for almost a year. 4 temperature regimes were used, viz. ambient (i.e. following local air temperature) and ambient temperature increased by 2, 4 and 6°C, to mimic future temperature rise. A mathematical model was used to categorise the type of seasonal regulation and estimate parameters of the temperature response curve. Growth rate varied significantly with temperature sum, survival and geographic origin, as well as with family. Offspring of all ♀♀ from the temperate part of the range had a life cycle with a 12 h day-length threshold necessary to induce diapause (i.e. diapause was induced once day length fell below 12 h). By contrast, Mediterranean families had a 10 h threshold or had an unregulated life cycle allowing winter growth. The temperature response did not significantly differ between populations, but varied between families with a greater variation in the optimum temperature for growth in the Mediterranean population. The variation in seasonal regulation leads to a diversity in voltinism patterns within spp. ranging from bivoltine to semivoltine along a latitudinal gradient. Given that the type of seasonal regulation is genetically fixed, rising temperatures will not allow faster than univoltine development in temperate populations. The consequences of these results are discussed in the light of rising temperature in central Europe.
- (19056) GOVEDIČ, M., 2010. *Okoljsko poročilo (zvezek 2: Narava) za občinski podrobni prostorski načrt za center za ravnanje z odpadki Nova Gorica*. – [Environment report (No. 2: Nature) on the municipal detailed location scheme for a garbage treatment centre of Nova Gorica]. CKFF Miklavž-na-Dravskem-polju. 135 pp. (Slovene). – (Author: CKFF, Klučnova 3, SI-1000 Ljubljana).
The information on the local odon. fauna appears on pp. 49-53, with emphasis on *Cordulegaster heros*. A list of conservationally important spp. recorded in 2009, with annotations on their legal protection status is also included; – Nova Gorica area; W Slovenia.
- (19057) GROS, P., 2010. Die Libellenfauna des Madlinger Moores (Gemeindegebiet Radstadt, Salzburg): erster inneralpiner Nachweis der Grossen Moosjungfer *Leucorrhinia pectoralis* (Charpentier, 1825) aus dem Bundesland Salzburg und erste Meldung der Glänzenden Binsenjungfer *Lestes dryas* Kirby, 1890 aus dem Ennstal, Österreich (Odonata). *Mitt. Haus Natur*, Salzburg 18: 29-34. (With Engl. s.). – (Haus der Natur, Museumsplatz 5, A-5020 Salzburg).
29 spp. are listed from the Enns river valley of Salzburg (Austria). *L. dryas* and *L. pectoralis* are recorded from this area for the first time.
- (19058) KISELYOVA, G.A., G.A. PROKOPOV & V.N. RAZUMEIKO, 2010. The condition of macrozoobenthos of the mountain streams of Crimea. *Nauk. zap. ternop. nac. pedagog. Inst. (Biol.)* 43(2): 245-248. (Russ., with Engl. s.). – (Tavrda Natn. Vernadsky Univ., Vernadskogo 4, UKR-Simferopol-95007, AR Krym).
An account of the characteristics of the Crimea rivers is provided (the Ukraine) and the anthropogenic impact is analysed. *Platycnemis pennipes*, *Calopteryx splendens taurica*, *Gomphus vulgatissimus* and *Onychogomphus forcipatus* are listed.
- (19059) KRAKOWSKA, K. & J. KRAKOWSKI, 2010. *Trzy stawy: przewodnik po przyrodniczej ścieżce dydaktycznej w Gminie Żmigród*. – [Three fish ponds: a guide for the educational path in the community of Żmigród]. Fundacja EkoRozwoju, Wrocław. 57 pp. (Pol.). – (Publishers: Białoskórnicza 26, PO-50-134 Wrocław).
The locality is situated ca 60 km N of Wrocław (Poland). 6 odon. spp. encountered along the path are listed.
- (19060) MOLLOV, I., P. BOYADZHIEV & A. DONEV, 2010. Trophic role of the marsh frog *Pelophylax*

- lax ridibundus* (Pallas, 1771) (Amphibia, Anura) in the aquatic ecosystems. *Bulg. J. agricult. Sci.* 16(3): 298-306. – (First Author: Dept Ecol. & Envir. Conserv., Fac. Biol., Univ. Plovdiv, BG-4000 Plovdiv). *P. ridibundus* is an opportunistic predator, consuming any animal (mostly insects) that is within its reach and has a suitable size. In the Maritsa floodplain, Plovdiv distr. (S Bulgaria), the adult Zygoptera, Anisoptera and odon. larvae were found to represent, respectively 1.77, 0.52 and 0.07% of its food items.
- (19061) ORR, A.G. & V.J. KALKMAN, 2010. *Arrhenocnemis parvibullis* sp. nov. (Odonata: Platycnemididae), a new calicnemiine damselfly from Papua New Guinea, with a description of the female of *A. amphidactylis* Lieftinck, 1949. *Aust. Entomologist* 37(4): 137-146. – (First Author: Griffith Sch. Environment, Griffith Univ., Nathan, Qld 4111, AU). The new sp. is described, illustrated, and its habits and habitat are discussed. Holotype ♂: Papua New Guinea, Western prov., Muller Range Expedition, Camp 1 (Gugusu), alt. 515 m, 4/11-IX-2009. *A. amphidactylis* ♀ is described for the first time.
- (19062) OUTOMURO, D., 2010. Latitudinal morphological patterns in Iberian *Calopteryx* Leach, 1815 (Odonata, Calopterygidae) populations: possible environmental and evolutionary factors. *Boln Asoc. esp. Ent.* 33(3/4): 299-319. (Span., with Engl. s.). – (Depto Biol. Organismos & Sistemas, Univ. Oviedo, ES-33071 Oviedo). The morphological clines related to latitudinal or altitudinal gradients, generally caused by natural selection, can be modified by sexual selection, particularly when it plays a major role in inter-population divergence. *C. virgo meridionalis* and *C. xanthostoma* were studied at 3 different latitudes in the Iberian peninsula. Latitudinal patterns in size and secondary sexual traits were recorded. A modified converse Bergmann rule explains size patterns. Patterns in secondary sexual traits are better explained by a balance between sexual selection processes within and between the 2 spp. These processes are influenced by latitudinal differences in relative abundance, in the sense that the most abundant sp. displaces the traits of the other sp. because of sexual interferences in order to reduce reproductive effort costs between the spp. Differences in relative abundance are supported by the distribution frequencies of both spp. in the Iberian peninsula. The third Iberian sp. (*C. haemorrhoidalis*) might cause a reinforcement polymorphism in one of the spp. studied.
- (19063) OUTOMURO, D., F.J. OCHARAN, F. HERRERO & G. PEREZ-ANDUEZA, 2010. First record of *Oxygastra curtisii* (Dale, 1834) in Avila province (central Spain). *Boln Soc. ent. aragon.* 46: 615-616. (Span., with Engl. s.). – (First Author: Depto Biol. Organismos & Sistemas, Univ. Oviedo, ES-33071 Oviedo). A ♂ is reported from Coto de Pesca Hoyocasero del no Alberche (alt. 1205 m), 17-VII-2009. This is the highest known locality of this sp. in the Iberian peninsula. Its Iberian distribution is briefly discussed.
- (19064) SADEGHI, S., T. KYNDI & H.J. DUMONT, 2010. Genetic diversity, population structure and taxonomy of *Calopteryx splendens* (Odonata: Calopterygidae): an AFLP analysis. *Eur. J. Ent.* 107: 137-146. – (Last Author: Dept Biol., Univ. Gent. Ledeganckstraat 35, B-9000 Gent). *C. splendens* is a widely distributed Palaearctic sp. with a remarkably uniform morphology. Variation in the size and shape of the pigmented spot on the wing is the main diagnostic character used to discriminate subspecies across its huge geographic range. Here, AFLP analysis was used to assess the genetic structure and diversity of nine populations representing 3 putative subspecies and evaluate the pigment spot as a taxonomic marker. Genetic diversity was high, with the number of polymorphic loci per population ranging from 141 to 280 out of a total of 333 variable sites (42.3-84.1%) and Nei's gene diversity from 0.160 to 0.283 (overall 0.299). Overall population genetic differentiation ($F_{ST} = 0,2766$) suggests limited gene flow and adaptation to local environments. Restricted gene flow and genetic differentiation among populations are supported by significant F_{ST} estimates. High levels of gene flow ($N_m > 1$) were only recorded among three Asian populations (Russia – Kazakhstan – Turkey). The patterns of genotypic diversity suggest that a given wing spot size and shape may arise from the hybridization of a limited number, possibly not more than four, ancestral gene pools in different ways and at different times. Clearly, the sample analyzed was not sufficient to capture all of the complex history of *C. splendens*, but sufficient to indicate the taxa *ancilla*, *waterstoni* and *orientalis* possibly represent three of the four ancestral gene pools, and originated in western Asia. The origin of the fourth, *xanthostoma*, is the western Mediterranean.

- (19065) SATHE, T.V. & A.R. BHUSNAR, 2010. Biodiversity of mosquito-feeding dragonflies (order Odonata) from Kolhapur district including Western Ghats. *Biol. Forum* 2(2): 38-41. – (Dept Zool., Shivaji Univ., Kolhapur, MS, India).
A list of 43 anisopteran spp., along with the names of mosquito genera on which each of them was observed feeding.
- (19066) SATO, T. & N. TSURUSAKI, 2010. Preliminary report of insect fauna occurring in the Tottori Sand Dunes. *Bull. Tottori pref. Mus.* 47: 45-81. (Jap., with Engl. s.). – (First Author: Suzukake-dai 1-38-306, Sanda city, Hyogo, 669-1322, JA).
Lists 38 odon. spp.; – Japan.
- (19067) SZEKERES, J. & B. CSÁNYI, 2010. Seasonal investigations on the macroinvertebrate fauna of the stream Burnót-patak. *Acta biol. debrecina Oecol. Hung.* 21: 189-196. (Hung., with Engl. s.). – (VI-TUKI Envir. & Water Mngmt Res Inst., Kvassay Jenő ut. 1, HU-1095 Budapest).
The teneral corduliids and *Libellula fulva* are recorded from the stream, a tributary of the Balaton lake (Hungary).
- (19068) TERZANI, F., F. CIANFERONI, G. MAZZA & F. ZINETTI, 2010. Ricerche odonatologiche in Toscana, 12: Lago di Montieri, provincia di Grosseto (Odonata). *Onychium* 8: 3-5. (With Engl. s.). – (Mus. Stor. Nat. "La Specola", Univ. Firenze, Via Romana 17, I-50125 Firenze).
From the Montieri lake, Tuscany (Italy), 10 spp. are brought on record. Of particular interest is a *Lestes parvidens* (♂) × *L. viridis* (♀) tandem.
- (19069) VASIL'KOVSKAYA, O.B., L.M. ZUB, N.M. BARSHCHEVSKAYA & M.M. VOVCHENKO, 2010. Some features of current hydrobiological features of the Berda river. *Nauk. zap. ternop. nac. ped. Univ.* (Biol.) 2010(2) [43]: 54-58. (Ukr., with Engl. & Russ. s's). – Shmal'gauzen Inst. Zool., Ukr. Acad. Sci., Hmel'nic'kogo 15, UKR-01601 Kiev).
Platycnemis pennipes is listed from the Berda estuary (Ukraine).
- (19070) VERMA, A.K. & D.N. SAKSENA, 2010. Impact of pollution on sewage collecting river Kalpi (Morar) Gwalior (M.P.) with special reference to water quality and macrozoobenthic fauna. *Asia J. exp. biol. Sci.* 1(1): 155-161. – (Limnol. Res. Unit, Aquat. Biol. Lab., SOS in Zool., Jiwaji Univ., Gwalior-474011, M.P., India).
4 odon. spp. are reported from the non-polluted section of the river, 3 and 4 spp. from the less polluted sampling stations, but *Brachythemis contaminata* occurred only at the highly polluted sites. The mean values of various physico-chemical parameters are provided for all sampling stations. At the B. contaminata sites, a higher ammonia concentration was measured, which is in agreement with the earlier observations, where this sp. was reported to be restricted to organically polluted lotic waters.
- (19071) VERNOUX, J., D.-y. HUANG, E.A. JARZEMBOWSKI & A. NEL, 2010. The Proterogomphidae: a worldwide Mesozoic family of gomphid dragonflies (Odonata: Anisoptera: Gomphidae). *Cretaceous Res.* 31: 94-100. – (First Author: 23 rue de Bruxelles, F-69100 Villeurbanne).
Lingomphus magnificus gen. n., sp. n. and *Cordulagomphus europaeus* sp. n. are described and illustrated from, respectively, Early Cretaceous Yixian Formation of Beipiao, Liaoning prov. (China) and the Early Cretaceous Upper Weald Clay of Auclay Brickworks, Surrey (UK). The Proterogomphidae has a known distribution very similar to those of several other Lower Cretaceous insect groups in Asia, Europe and S America, showing that the distribution of the climates and land masses at that time was not a "serious" impediment to these organisms.
- (19072) VINKO, D., 2010. *Inventarizacija kačjih pastirjev (Odonata) in dvoživk (Amphibia) na območju Zaloškega bajerja (Vipavska dolina)*. – [*Odonata and Amphibia inventarisation in the area of Zalošče pond, Vipava valley*]. Vinko, Mengeš. 4 pp. (Slovene). – (Slovenska 14, SI-1234 Mengeš).
Annotated list of 19 odon. spp. recorded from 5 localities in the Dornberk-Zalošče area, W Slovenia.
- (19073) VON HOLDT, E., 2010. Entomologische Besonderheiten des Jahres 2009. *Info hamover. Vogel-schutzver.* 2010 (1): 3-6. – (Offensteinstr. 13, D-30451 Hannover).
The oviposition of *Leucorrhina caudalis* is reported from Herrenhäuser Gärten, Hannover (Germany), 30-VI-2009.

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- (19074) ARENHOVEL, C., E. JAHN, L.C. MAUL &

- W. ZIMMERMANN, 2011. *Die Fauna Weimars und seiner Umgebung*. Weimarer Schriften 66, Stadtmus. Weimar, Weimar. 332 pp., 2 maps excl. Paperback (13.0 × 20.5 cm). ISBN 978-3-910053, 49-1. – (Publishers: Karl-Liebknecht-Str. 5-9, D-99425 Weimar). An overview of and considerations on the vertebrate fauna and on that of Mollusca, Lepidoptera, Odonata (pp. 173-182; 38 spp.), Ephemeroptera, Trichoptera, Plecoptera, Orthoptera, Hymenoptera and Coleoptera of the city of Weimar area, Germany.
- (19075) BAE, Y.J., 2011. *Insect fauna of Korea* 4(1): *Damselflies*. Natn. Inst. Biol. Resour., Incheon. vi: 70 pp. ISBN 9788994555423-96470. – (Publishers: Envir. Res. Complex, Gyeongsea-dong, Seo-gun, Incheon 404-708, Korea).
A monographic treatment: 39 spp., with keys to the families and genera.
- (19076) BEDJANIČ, M., 2011. *Coenagrion hastulatum* (Charpentier, 1825), new for the dragonfly fauna of Bosnia and Herzegovina (Odonata: Coenagrionidae). *Natura Sloveniae* 13(2): 31-36. (With Slovene s.). – (Kolodvorska 21/B, SI-2310 Slovenska Bistrica). 3 ♂ are reported from the Bare lakes (alt. 1490 and 1550 m; 26-VI-2011) in the Sutjeska National Park (SE Bosnia & Herzegovina). The occurrence of *C. hastulatum* on the southern border of its European range is outlined and discussed. A list of 22 other odon. spp. sighted in the area is appended.
- (19077) BRIED, J.T., F. D'AMICO & M.J. SAMWAYS, 2011. A critique of the dragonfly delusion hypothesis: why sampling exuviae does not avoid bias. *Insect Conserv. Diver.* 2011: 5 pp.; – DOI: 10.1111/j.172-4598.2011.00171.x – (First Author: Albany Pine Bush Preserve Commission, 195 New Karner Rd, Albany, NY 12205-4605, USA).
A recent study comparing adult and exuvial odon. richness concluded that adult surveys overestimate the number of spp. reproducing successfully. The authors called this phenomenon the “dragonfly delusion” and recommended that only exuviae be used for biomonitoring and habitat quality assessment. However, they drew this conclusion from limited surveys and detection-naïve analysis and failed to acknowledge that exuvial richness is typically biased low. Here, the exuvial bias is quantified using 2 related metrics: (1) species detectability from concurrent adult and exuvial surveys and (2) estimated exuvial species richness at a site based on imperfect detectability and the regional pool (cumulative total across study sites) of exuvial species observed. Using concurrent adult and exuvial data from lakes in SW France, it was found that detectability was generally lower in 1-h exuvial searches than in 20-min adult searches and that exuvial surveys may lead to strong negative bias in richness estimation. This suggests the alleged delusion of adult surveys was exaggerated. Controlling for species detection probability is crucial in making unbiased inferences on how many odon. spp. occupy a site and, by extension, comparing adult and exuvial species richness. Exuviae sampling avoids positive bias, not bias in general, and requires either relatively intensive search effort, statistical accounting of false species absences, or acceptance of negatively biased richness.
- (19078) BUDEN, D.W., 2011. The Odonata of Fais island and Ulithi and Woleai atolls, Yap state, Western Caroline Islands, Federated States of Micronesia. *Micronesica* 41(2): 215-222. – (Div. Nat. Sci. & Mathem., Coll. Micronesia, P.O.Box 159, Kolonia, Pohnpei, FSM).
A commented list of 10 spp., incl. 3 easternmost records for the Caroline Isls. Breeding on one or more of the islands is confirmed for 7 spp.
- (19079) COUTEYEN, S. & M. PAPAŽIAN, 2011. Contribution à la connaissance des odonates de l'île de la Réunion, 10: *Zyxomma petiolatum* Rambur, 1842, une espèce nouvelle pour l'île (Odonata, Libellulidae). *Entomologiste* 67(1): 21-23. (With Engl. s.). – (Second Author: La Constellation, bât. A, 72 av. des Caillols, F-13012 Marseille).
The discovery of a *Z. petiolatum* population (X/XI-2010) in the island of the Réunion is brought on record and discussed.
- (19080) DAS, S.K., S.D. ROUT & H.K. SAHU, 2011. Odonates of North Orissa University Campus and adjoining areas, Orissa. *Newsl. Invert. Conserv. Inform. Network Sth Asia* 2011(18): 21-23. – (PG Dept Wildl. & Conserv. Biol., N Orissa Univ., Sri Ramchandra Vihar, Takatpur, Baripada, Orissa-757003, India).
A commented list of 29 spp; – Orissa, India.
- (19081) DOW, R.A., 2011. *Mortonagrion indraneil* spec. nov. from Borneo, and a redescription of *M. arthuri* Fraser (Odonata: Zygoptera: Coenagrionidae). *Zootaxa* 3093: 35-46. – (Naturalis, P.O. Box

- 9517, NL-2300 RA Leiden).
The new sp. is described and illustrated from Sarawak (Malaysian Borneo). Holotype ♂: Malaysia, Sarawak, Samarahan division, Kota Samarahan area, 24-I-2006; deposited in RMNH, Leiden. Records of *M. amoena* Ris from Borneo in fact refer to *M. indraneil*; there is no evidence that *M. amoena* occurs in Borneo. Relationships between *Argiocnemis*, *Agriocnemis* and *Mortonagrion* are discussed.
- (19082) DOW, R.A. & G.T. REELS, 2011. *Coeliccia southwelli* sp. nov. (Odonata: Zygoptera: Platycnemididae) from Mount Dulit, Sarawak. *Zootaxa* 2832: 63-68. — (Second Author: C-6-26, Fairview Park, Yuen Long, N.T., Hong Kong, China).
The new sp. is described and illustrated. Holotype ♂: Sarawak, Kapit div., SW face of Mt Dulit, alt. ca 1095 m; deposited in RMNH, Leiden. This is the sixth sp. in the borneensis-group described from Borneo. New material of other spp. of this group is brought on record as well.
- (19083) GÓMEZ-ANAYA, J.A., R. NOVELO-GUTIÉRREZ & W.B. CAMPBELL, 2011. Diversity and distribution of Odonata (Insecta) larvae along an altitudinal gradient in Coalcomán mountains, Michoacán, Mexico. *J. trop. Biol.* 59(4): 1559-1577. — (Second Author: Inst. Ecol. A.C., Carretera Antigua a Coatepec 351, El Haya, MX-91070 Xalapa, Veracruz).
The diversity of odon. larval assemblages is evaluated and related to local habitat variables. A total of 75 spp. are recorded.
- (19084) HUTCHINGS, G. & D. HALSTEAD, 2011. *Dragonflies and damselflies in the hand: an identification guide to boreal forest Odonata in Saskatchewan and adjacent regions*. Nature Saskatchewan Special Publ. 29. 158 pp. Price: CAN \$ 24.95 net. — (Available from Nature Saskatchewan, 206-1860 Lome St., Regina, SK, S4S 2L7, CA).
Not available for abstracting; description based on a book review by P. Taylor, in *Nature Manitoba News* 3(6): 8-9; 2011. — The book's scope is the western boreal forest, covering parts of the 3 prairie provinces (Canada). The region is home to 49 spp., plus a number of what the Authors call "fringe spp.", i.e. mostly those with more southerly or easterly ranges that peter out at the edge of the boreal forest. The book includes about 200 photographs and over 40 pp. of drawings and keys. Each sp. is briefly described, with a statement on the preferred habitat, and information on its abundance, distribution and behaviour.
- (19085) [KIAUTA, B.] GANTAR, K., 2011. *Zasilni pristanki*. — [Provisional landing]. Slovenska matica, Ljubljana. 264 pp., hard cover (24.5 × 16.5 cm). ISBN 978-961-213-213-2. Price: euro 24.90 net. (Slovene). — (Author: Rusjanov trg 6, SI-1000 Ljubljana; — Publishers: Kongresni trg 8, SI-1000 Ljubljana).
Includes a biographic note on B. Kiauta, with a reference to his early dragonfly work in the 1950s and on his odon. collection of that time.
- (19086) MUZÓN, J. & F. LOZANO, 2011. Description of the final instar larva of *Progomphus joergenseni* Ris (Eiprocta: Gomphidae). *Zootaxa* 2762: 56-60. (With Span. s.). — (Inst. Limnol. C.C. 712, AR-1900 La Plata).
The larva is described and illustrated from Rio Negro prov., N Patagonia (Argentina). Antenal, leg and paraproct morphology suggest a close relationship with the spp. included in the pygmaeus-group.
- (19087) NEISS, U.G., G.L. FIORENTIN & J. DE MARMELS, 2011. The larva of *Allopodagrion brachyurum* De Marmels, 2001 (Odonata: Zygoptera: Megapodagrionidae) from southern Brazil. *Zootaxa* 2836: 44-50. — (Last Author: Mus. Inst. Zool. Agric., Fac. Agron., Univ. Central Venezuela, Apdo 4579, Maracay 2101-A, Venezuela).
This is the first known larva of the genus. The description and illustrations are based on exuviae of reared larvae, collected from the upper course of the Rio dos Sinos, Rio Grande do Sul. It can be distinguished from all other neotropical megapodagrionid larvae by the presence of a well-developed obtuse tubercle in sub-vertical orientation on each side of occiput, 2 blunt tubercles on top of the head, and caudal gills thin, stiff, triquetral and as long as body.
- (19088) NGIAM, R.W.J. & G.W.H. DAVISON, 2011. A checklist of dragonflies in Singapore parks (Odonata: Anisoptera, Zygoptera). *Nature Singapore* 4: 349-353. — (Natn. Biodiv. Cent., Natn. Parks Board, 1 Cluny Rd, Singapore-259569).
A commented list of 51 spp. recorded from the 19 parks surveyed, accounting for 42% of the spp. known at present from Singapore. Of these, 10 spp. are considered Critically Endangered, showing that urban parks play a very important role in the odon. conservation in Singapore.

- (19089) PAPAŽIAN, M., 2011. Compte rendu d'expéditions sur le mont Nimba (Afrique occidentale): additive à la faune odonatologique et description de la femelle de *Paragomphus kiautai* Legrand, 1992 (Odonata). *Bull. Soc. ent. Fr.* 116(2): 169-176. (With Engl. s.). – (Le Constellation, bât. A, 72 av. des Caillols, F-13012 Marseille).
A commented list is presented of the 47 spp. recorded during 2 surveys (Guinea, Liberia). *Heliaeschna fuliginosa*, *H. ugandica*, *Sleuthemis diplacoides*, *Tramea basilaris* and *Oxythemis phoenicosceles* are new for the local fauna. The ♀ allotype of *P. kiautai* is described and illustrated from Mt Nimba (Séréngbara, Guinée; 8-X-2008); deposited in Mus. Natn. Hist. Nat., Paris.
- (19090) PAPAŽIAN, M., 2011. La sinuosité de la nervure costale de l'aile antérieure chez les Palpopleurinae (Odonata, Anisoptera, Libellulidae). *Bull. Soc. ent. Fr.* 116(4): 389-395. – With Engl. s.). – (Le Constellation, bât. A, 72 av. des Caillols, F-13012 Marseille).
The undulation of the costal vein in the forewing occurs in Diastatops, Palpopleura and Zenithoptera. It is closely related to the shape of the eyes. The very forward positioning at the wings during perching may have a physio-behavioural origin.
- (19091) PAPAŽIAN, M. & G. VIRICEL, 2011. Anomalie morphologique chez *Calopteryx xanthostoma* (Charpentier, 1840) (Odonata, Calopterygidae). *Entomologiste* 67(3): 113-114. (With Engl. s.). – (First Author: La Constellation, bât. A, 72 av. des Caillols, F-13012 Marseille).
The occurrence of a pseudo-pterostigma in a *C. xanthostoma* ♂ from Pierrefeu-du-Var (12-IX-2010), France, is described, illustrated and briefly discussed.
- (19092) PHAN, Q.T. & M. HÄMÄLÄINEN, 2011. *Matrona taoi* spec. nov., a new damselfly species from northern Vietnam (Odonata: Calopterygidae). *Zootaxa* 2927: 63-68. – (First Author: Dept Biol., Vietnam Natn. Mus. Nature, Vietnam Acad. Sci. Technol., 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam).
The new sp. is described and illustrated from both sexes and compared with the congeners. Holotype ♂: Vietnam, Phu Tho prov., Tan Son distr., Xuan Son Natn. Park, Xom Coi (alt. 442 m), 15-XI-2010; deposited in Vietnam National Mus. of Nature, Hanoi.
- (19093) POIRON, C. & F. MEURGEY, 2011. The Odonata of St Lucia (Lesser Antilles): survey report March 9-30, 2011. *Herminier nat. Hist. Soc. Contr. Odonatol.* 2: 1-21, distr. maps excl. – (Mus. Hist. Nat., 12 rue Voltaire, F-44000 Nantes).
21 spp., with locality maps. *Lestes spumarius*, *Tricentrogyna caribbea*, *Brechmorhoga archboldi*, *Miathyria marcella* and *Tramea calverti* are new to the island.
- (19094) ZIA, A., M. NAEEM, M.A. RAFI, F. NAZ, S. AFSHEEN & M. ILIAS, 2011. Damselflies (Zygoptera: Odonata) of Pakistan, 1. *J. Insect Sci.* 11(102): 27 pp., available online: insectscience.org/11.102 – (First Author: Natn. Insect Mus., Natn. Agric. Res. Cent., Islamabad, Pakistan).
The literature is reviewed and the 2004-2009 records are presented for 48 spp., of which *Libellago l. lineata*, *Elatoneura atkinsoni* and *E. souteri* are reported for the first time from Pakistan.

2012

- (19095) BARNDT, D., 2012. Beitrag zur Kenntnis der Arthropodenfauna der Zwischenmoore Butzener Bagen, Trockenes Luch und Möllnsee bei Lieberose (Land Brandenburg). *Märkische ent. Nachr.* 14(1): 147-200. (With Engl. s.). – (Bahnhofstr. 40/D, D-12207 Berlin-Lichterfelde).
Lists 7 odon. spp. from 2 Sphagnum-dominated mires and 1 calcareous fen, situated 90 km SE from Berlin, Germany.
- (19096) BEDJANIČ, M., N. VAN DER POORTEN, S. GUNASINGHE & A. ŠALAMUN, 2012. *Distribution atlas of the dragonflies of Sri Lanka*. Bedjanič, Slovenska Bistrica. 92 pp. Spiral binding (19.5 × 21.7 cm). ISBN none. – (Available from the first Author: Kolodvorska 21/B, SI-2310 Slovenska Bistrica).
A preliminary edn (March 2012), with a checklist (124 spp., 7 of these unnamed since they are in the process of description) and species maps, based on almost 10.000 records from over 1000 localities. The final edn is expected shortly.
- (19097) BORAH, P., B. KUMAR ACHARJEE, M. DAS & P. KUMAR SAIKIA, 2012. Diversity and distribution of damselflies in Gauhati University Campus, Assam, India. *NeBio* 3(2): 33-36. – (First Author: Dept Zool., Gauhati Univ., Guwahati-781014, Assam, India).

- A commented list of 7 spp.
- (19098) BORISOV, S.N., 2012. Translatitudinal migration of dragonflies (Odonata) in Middle Asia. *Proc. russ. ent. Soc.* 83(1): 62-72. (Russ., with Engl. s.). – (Inst. Anim. Syst. & Ecol., Sib. Br. Russ. Acad. Sci., ul. Frunze 11, Novosibirsk-630091, Russia). Characteristic seasonal translatitudinal migrations occur in *Anax ephippiger*, *Pantala flavescens* and *Sympetrum fonscolombii*. In the spring, the adults arrive from the southern parts of their ranges to Middle Asia, where the second generation develops. In the autumn, the descendants of the immigrants return to the South.
- (19099) DAS, S.K., R.A. AHMED, S.K. SAJAN, N. DASH, P. SAHOO, P. MOHANTA, H.K. SAHU, S.D. ROUT & S.K. DUTTA, 2012. Diversity, distribution and species composition of Odonata in buffer areas of Similipal Tiger Reserve, Eastern Ghat, India. *Acad. J. Ent.* 5(1): 54-61. – (Dept Wildl. & Conserv. Biol., North Orissa Univ., Sriram Chandra Vihar, Takatpur-757003, Baripada, Orissa, India). The Reserve (surface 2730 km²) is located in the Mayurbhanj distr. (Orissa), the buffer zone covers an area of 1555 km². 58 spp. are listed. Alfa Diversity indices for different habitat types are stated, and distribution profiles of the odon. fauna are provided.
- (19100) EHISIANYA, C.N., K.C. EMEASOR, T.N.C. ECHENDU, C.N. EGESI & E.N.A. MBANASO, 2012. Preliminary sampling of arthropod fauna of transgenic cassava in confined field trial. *Afr. J. Biotechnol.* 11(21): 4802-4809. – (First Author: Natn. Root Crops Res. Inst., Umudike, Abia state, Nigeria). The population dynamics of arthropod fauna was studied in Umudike, alt. 122 m (Nigeria) during Aug.-Nov. 2009 and Feb.-July 2010 using water pitfalls and sweepnets. “*Anax* spp.” were the only odon. represented in samples. Their relative abundance amounted to 7.36% (143 individuals) in 2009, and to 1.14% (18 ind.) in 2010.
- (19101) EMILIYAMMA, K.G., M.J. PALOT & C. RADHAKRISHNAN, 2012. *Microgomphus* southerni Fraser, a new addition to the Odonata (Insecta) fauna of Kerala, southern India. *J. threatened Taxa* 4(6): 2667-2669. – (Western Ghat Reg. Cent., Zool. Surv. India, Jeferkhan Colony, Eranhilalam P.O., Kozhikode-673006, Kerala, India). A ♂ was collected from the Aralam Wildlife Sanctuary, 6-VI-2010. Its field portrait and a photograph of the terminalia are included.
- (19102) FALICO, D.A., J.A. LÓPEZ & C.E. ANTONIAZZI, 2012. Opportunistic predation upon dragonflies by *Pseudis limellum* and *Pseudis paradoxa* (Anura, Hylidae) in the Gran Chaco region, Argentina. *Herpetol. Notes* 5: 215-217. – (Second Author: Inst. Nac. Limnol., Ciudad Universitaria, Paraje El Pozo, AR-3100 Santa Fe). The gastrointestinal tract of the 2 frogs contained the remains of Collembola, Diptera, Coleoptera, Heteroptera, Hymenoptera, Orthoptera and Araneae, but 74.68 and 77.90% of the consumed prey was represented by Odon.
- (19103) HENRICSSON, A., 2012. *Bottenfauna i Stockholms län 2011: en undersökning av Örans och Trönsjöns litoralzon samt två lokaler i Åvaån*. Länsstyrelsen & Stockholms län. 30 pp. ISBN 978-91-7281-489-9. (Swed.). – (Author's postal address not stated). A report on the results of the 2011 sampling of benthic fauna at Trönsjöns, Örans and Åvaån (Sweden), including records of several odon. spp.
- (19104) *IDF REPORT*. Newsletter of the International Dragonfly Fund (ISSN 1435-3393), Vols 43-45 (2012). – (c/o M. Schorr, Schulstr. 7/B, D-54314 Zert). [Vol. 43]: *Ulmar, D.M., M.G. Marinov, M. Schorr & H.M. Chapman*: Odonata attracted by light, a new topic for myth-busters (pp. 1-52); – [Vol. 44]: *Dow, R.A. & R.W.J. Ngiam*: Odonata collected in the Hose mountains, Kapit division, Sarawak, Malaysia in April 2011 (pp. 1-18); – [Vol. 45]: *Kosterin, O.E.*: Odonata in the Cambodian coastal regions in late rainy season of 2011 (pp. 1-102).
- (19105) JOHNSON, J., 2012. Wintertime *Sympetrum corruptum* in Oregon. *Bull. Oregon ent. Soc.* 2012 (Spring): 6. – (Author's postal address not provided). A review (2005-2012) of sightings of adults on wing in various counties of Oregon (USA), between 1 Dec. and 7 Feb.
- (19106) [KIAUTA, M./KIAUTA, B.] SITAR, S., 2012. Konjski azil Kiauta. – [The Horse Asylum Kiauta]. *Revija o konjih*, Ljubljana 20(7): 54-55. (Slovene). –

- (Author: Štihova 15, SI-1000 Ljubljana).
A well-illustrated description of the Asylum for aged, mutilated or for any other reason rejected horses and ponies, operated by the odonatologists Mrs M. & Dr B. Kiauta. It also includes a note on their odonatol. work. Address: Callunastraat 6, NL-5853 Siebengewald, The Netherlands.
- (19107) LI, Y., A. NEL, D. REN & H. PANG, 2012. A new damselfly from the Lower Cretaceous of China enlightens the systematics of the Isophlebiidae (Odonata: Isophlebioptera: Campteropteroptera) *Cretaceous Res.* 34: 340-343. – (First Author: State Key Lab. Biocontrol & Inst. Ent., Sun Yat-Sen Univ., Guangzhou-510275, China).
Paraflekiium senjituense gen. n., sp. n. is described and illustrated from the Yixian formation of Fengning co., Hebei prov., NE China. The holotype is deposited in Lab. Insect Evol., Capital Normal Univ., Beijing. The taxon has several significant structures currently considered as typical of either the Campteropteroptera or the Isophlebiidae, therefore it helps to clarify the morphology and taxonomy of this group.
- (19108) OHBA, S.-y. & Y. INATANI, 2012. Feeding preferences of the endangered diving beetle *Cybister tripunctatus orientalis* Gschwendtner (Coleoptera: Dytiscidae). *Psyche* 2012: 3 pp.; – DOI: 10.1155/2012/139714. – (First Author: Cent. Ecol. Res., Kyoto Univ., Otsu, 520-2113, JA).
In laboratory experiments, the 2nd and 3rd instar beetle larvae consumed significantly more odon. larvae (Coperia, Lestes, Sympetrum) than the *Hyla japonica* tadpoles. All the 1st instar beetle larvae developed into the 2nd instar when feeding on motionless odon. larvae, but their survival rate was lower when they were supplied with motionless tadpoles.
- (19109) ORWA, P.O., P. RABURU, J. NJIRU & J.B. OKEYO-OWUOR, 2012. Human influence on macroinvertebrate community structure within Nyando wetlands, Kenya. *Int. J. appl. Sci.* 3(2): 28-48. – (First Author: Dept Fish. & Aquat. Sci., Chepkoilel Univ., Eldoret, Kenya).
The identification of the 4 odon. genera mentioned (incl. e.g. *Cordulegaster*) is unreliable, therefore, as far as the Odon. are concerned, the paper is meaningless.
- (19110) TIPLE, A.D., S. PAUNIKAR & S.S. TAL-MALE, 2012. Dragonflies and damselflies (Odonata: Insecta) of Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, central India. *J. threatened Taxa* 4(4): 2529-2533. – (First Author: Forest Ent. Div., Trop. Forest Res. Inst., Jabalpur, Madhya Pradesh-482021, India).
A commented list of 48 spp.
- (19111) WILLIGALLA, C. & T. FARTMANN, 2012. Patterns in the diversity of dragonflies (Odonata) in cities across central Europe. *Eur. J. Ent.* 109: 235-245. – (Second Author: Dept Community Ecol., Inst. Landscape Ecol., Univ. Münster, Robert-Koch-Str. 28, D-48149 Münster).
Urbanisation is an important cause of spp. extinctions. Although urban water systems are highly modified, studies on aquatic or semi-aquatic organisms are rare. The aim of this study is to identify the factors that determine odon. spp. richness in 22 central European cities and along an urban-rural gradient within 6 of them. With 64 indigenous spp. in total and an average of 33 spp. per city the odon. spp. richness in central European cities is comparatively high. A generalised linear model indicates that it is positively related to city area. Additional predictors are climatic variables (temperature amplitude, sunshine duration and July temperature) and the year last studied. Since most cities are usually located in areas with naturally high habitat heterogeneity, it is assumed that cities should be naturally rich in odon. The role of city area as a surrogate for habitat and structural richness most likely explains why it is strongly associated with odon. spp. richness. The relationship between species richness and the climatic variables probably reflects that odon. spp. richness in central Europe is limited by warm and sunny conditions more than by availability of water. The temporal effect (the year last studied) on species richness is likely to be a consequence of the recent increase in Mediterranean spp. associated with global warming. Urbanisation clearly has an adverse effect on the species diversity of Odon. The latter increases along a gradient from the centre of a city to the rural area and is significantly highest in rural areas. This pattern probably reflects a gradient of increasing habitat quality from the city centre to rural areas. Moreover, the number of water bodies is generally very low in the city centres. Based on these observations recommendations are made for increasing the abundance and number of odon. spp. in the cities.

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COWLEY, J., 1935. Remarks on the names of some odonates. *Entomologist* 26: 154-156.

FRASER, F.C., 1957. *A reclassification of the Odonata*. R. zool. Soc. N.S.W., Sydney.

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