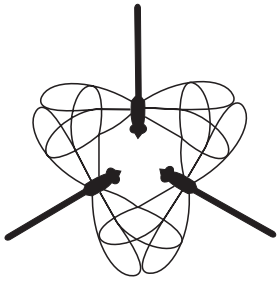

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PHENOLOXIDASE PRODUCTION: THE IMPORTANCE OF TIME AFTER JUVENILE HORMONE ANALOGUE ADMINISTRATION IN *HETAERINA AMERICANA* (FABRICIUS) (ZYGOPTERA: CALOPTERYGIDAE)

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It has been suggested that juvenile hormone (JH) negatively affects the phenoloxidase (PO), a key enzyme of the immune response in invertebrates. However, this negative effect has only been recorded over a short time period (2 to 3 h) after the administration of JH (or a JH analog). In the present study, using *H. americana*, it was corroborated that PO decreased a short time (3 h) after the administration of methoprene, a JH analog (JHa), but no effect was observed 24 h after the JHa application. This suggests that the time after the application of JHa should be taken into account in order to assess its actual effect on the immune response and PO expression and in studies that use the JH as a link between secondary sexual characters and immune response.

INTRODUCTION

It has been suggested that juvenile hormone (JH) is a key to understanding the physiological mechanism of behaviour and the life history of insects (NIJHOUT, 1994; FLATT et al., 2005). However, a topic that remains poorly studied is the effect of JH upon the immune response (ROLFF & SIVA-JOTHY, 2002; RANTALA et al., 2003; FLATT et al., 2005; CONTRERAS-GARDUÑO et al., 2009). For example, this hormone has been found to negatively affect the activity of phenoloxidase (PO) (ROLFF & SIVA-JOTHY, 2002; RANTALA et al., 2003; CONTRERAS-GARDUÑO et al., 2009), a key enzyme related to both humoral

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and cellular immune response (CERENIUS & SÖDERHÄLL, 2004; NAPPI & CHRISTENSEN, 2005). However, in another study, no differences were observed between methoprene (a Juvenile Hormone analog; JHa) and control treatments, when Phenoloxidase (PO) was recorded between 1 and 9 days after JHa application (ALONSO-SALGADO, 2010). Since different species were used in these studies, it is unclear whether such differences are attributable to the time elapsed between the JH administration and its effect on the immune response. Excess of JH is regulated by Juvenile Hormone Esterase (JHE), which hydrolyzes it and converts it into JH acid. This last molecule is biologically inactive (BONNING et al., 1997). The JH elimination could explain the null effect of JH on the immune response with a sufficient time elapsed. However, this question has not previously been tested in a single species.

In the calopterygid *Hetaerina americana*, males show a red wing spot and males with larger wing spots (a) defend the territories to which females arrive to mate (GRETHER, 1996) and (b) produce more melanin and PO to combat any immune threat (CONTRERAS-GARDUÑO *et al.*, 2006, 2007). In other calopterygids it has been found that wing spot size and immune response expression are mediated by JH. For example, in males of *C. virgo*, methoprene negatively affected PO generation but increased territorial behavior (CONTRERAS-GARDUÑO et al., 2009) and wing spot size (CONTRERAS-GARDUÑO et al., 2011). However, in these studies, wing spot size was not controlled between treatments (JHa *vs* control males) and therefore possible differences in this parameter between the two groups could account for distinct behaviours and PO levels.

In the current study *H. americana* was used to determine whether methoprene negatively affects PO expression by recording the levels of PO 3h and 24 h after its application. Differences in wing spot size between methoprene and control groups were taken into account.

MATERIAL AND METHODS

One hundred and thirteen *Hetaerina americana* males were captured in Xochitepec, Morelos, Mexico between September and December 2009. Given that JH concentrations in the haemolymph of odonates have not been recorded, we used a concentration of nanograms (ng), following the doses established in studies of other calopterygids to assess the relationship between methoprene, a JH analog (Jha) application and the parameters of territoriality, PO activity and wing pigmentation (CONTRERAS-GARDUÑO et al., 2009, 2011). The methodology of CONTRERAS-GARDUÑO et al. (2009, 2011) was followed. Five mg of methoprene acid (Sigma) were dissolved in 1000 µL of distilled water to obtain 5 mg/mL. To obtain a final concentration of 5 ng/µL, this mixture were vortexed for 5 minutes, following which 1 µL was diluted in 1000 µL of acetone grade HPLC (SIGMA) and the tubes contained this mixture were covered with metallic paper.

One µL (5 ng/µL) of JHa was added to 51 individuals topically on the cuticle between the head and the thorax. A further 59 individuals only received 1 µL of acetone. The level of PO was recorded after 3 h and 24 h. Thus there were four groups:

- Jha3 – experimental group assessed after 3 hours (N = 27).

- Jha24 – experimental group assessed after 24 hours (N = 27).
- C3 – control group assessed after 3 hours (N = 31).
- C24 – control group assessed after 24 hours (N = 28).

Each damselfly was placed in a transparent plastic container (4.5 × 1.4 cm^2) with a wooden perch and a damp cotton ball (CONTRERAS-GARDUÑO et al., 2006).

PROTEIN CONTENT AND PHENOLOXIDASE – The haemolymph was extracted after injecting 5 µL of PBS (Phosphate Buffer Saline 19 mM NaH_2PO_4, 8.1 mM Na_2HPO_4, 154 mM NaCl, pH 7.4; Sigma) in the thorax (between the insertion of the four wings; see 6,21), using a syringe (10 µL; Hamilton) . Each damselfly was decapitated to obtain the hemolymph + PBS and the drop of hemolymph (approximately 2 µL) obtained was collected with a micropipette (Rainin 10 µL) and deposited in pre-cooled vials of 1.5 mL (Axigen) that contained 60 µL of PBS and protease inhibitors (1µL:100µL of TLCK, PMSF and Leupeptin).

The protein content was quantified with the BCA protein assay kit (Thermo scientific) according to the method used by CONTRERAS-GARDUÑO et al. (2007, 2009). A micro plate with 96 wells was used. A serum albumin (1mg/mL) curve was used as standard concentration of protein. Ten µL of each sample were added to 40 µL of PBS and this mixture was added to 150 µL of the reagents A and B mixture following the manufacturer's indication. Samples were recorded in an ELISA reader (OpsysMR) at 540 nm. This method was very important to control the protein content per sample (10 µg) during the PO analysis because our method of perfusion could case differences in haemolymph quantities between treatments and possible differences in protein content (CONTRERAS--GARDUÑO et al., 2007). This method also avoids differences in PO due to methodological errors (differential extraction of hemolymph by perfusion) in order to determine accurately the physiological effects of JHa.

After controlling for 10 µg of protein in each sample, the optical density of PO was evaluated by the oxidation of L-dihydroxiphenylalanina (L-DOPA, Sigma) to dopacrome, the formation of which was recorded on a spectrophotometer at 490 nm. Readings were performed at 5, 15, 30, 45 and 60 min after adding L-DOPA. The mean of 5 readings of the PO reaction product was compared between groups (JHa3, JHa24, C3 and C24).

As data did not reach the normality, no the variances homogeneity, they were transformed to ranks prior to perform a factorial ANOVA. In this way, it is possible to perform parametrical tests with the data transformed to ranks but they are expressed in medians rather than in means (CONOVER & IMAN, 1981).

RESULTS

We asked whether the wing pigmentation could differ between treatments, previous to establish the experimental groups. However, no differences were found in the wing spot size between the JHa and control treatments (Mann-Whitney U Test = 3953.5, P = 0.78).

The effect of time (3 vs 24 h; $F_{1, 106} = 80.52$, $P < 0.0001$) and treatment (JHa vs C: $F_{1, 106} = 4.91$, $P = 0.02$) showed significant results in phenoloxidase production but the interaction time/treatment was not significant ($F_{1, 106} = 2.29$, $P = 0.07$). The Tukey HSD test revealed significant differences between JHa and control males after 3 h (P = 0.039. Fig. 1), with the former showing a possible repression of phenoloxidase expression (median = 0.12; minimum = 0.005, maximum = 0.41) compared to the control group (median = 0.21; minimum = 0.063, maximum = 0.64). However, no differences were found after 24 h (P = 0.9).

DISCUSSION

The wing spot size, and hence the physiological condition, is a possible confounding factor which could increase the difference in PO expression between treatments (HJa and control). If the wing spot size is more pronounced in the control treatment compared to the JHa, it should be expected more PO production in the former group than the latter. This is a problem that was not previously resolved in other calopterygids (CONTRERAS-GARDUÑO et al., 2009, 2011). However, the present study suggests that JHa still affects the PO activity when wing spot size and hence the animals' physiological condition, is controlled for. Nevertheless, it still needs to be determined if the same concentrations of JH applied to territorial (more pigmented) and non-territorial (less pigmented) males produces a weaker negative effect on PO activity (and possibly another immune marker) on the former, as their better physiological condition should produce a better immune response compared to that of non-territorial males.

Our results in *H. americana* and those previously found in *C. virgo* (CONTRERAS-GARDUÑO et al., 2009) suggest that JHa affects PO (at 5 ng/mL) between 2 and 3 h after its application. It has been speculated that results similar to those found in the present study could be accounted for as a trade-off between reproduction and immune response if both traits are expressed at the same time and if the resource used by both functions is scarce (RANTALA et al., 2003; CONTRERAS-GARDUÑO et al., 2009, 2011). This clearly needs to be tested. We suspect that the similar PO production observed in the control and JHa groups after 24 h could be due to a JH inhibitor, such as JHE production (BONNING et al., 1997).

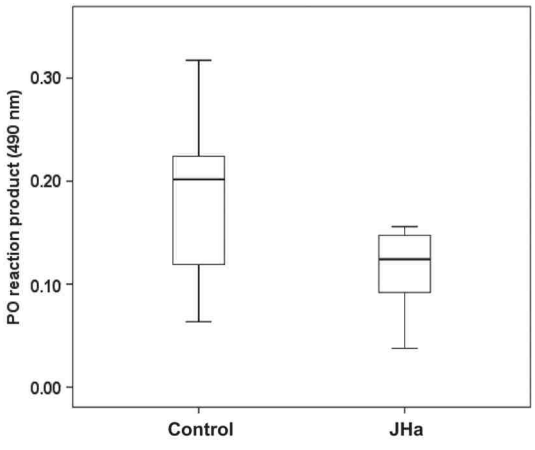

Fig. 1. Phenoloxidase expression (mean reaction product) three hours after JHa or acetone (control) administration recorded at 490 nm. The plot shows the median, upper and lower quartiles (box) and minimum and maximum data values.

In our experimental protocol, damselflies were maintained in laboratory conditions inside plastic tubes that do not let them to fly, a condition which is not found in nature, although males rest at night (GRETHER & SWITZER, 2000). In the absence of male fighting behavior or activity, the JH could be degraded and would therefore not impose a cost on the immune response. Although further studies need to be carried out, indirect evidence

supports this hypothesis in studies done with *Calopteryx* and *Tenebrio molitor*. In *C. haemorrhoidalis*, the males treated with 5 ng/mL of JHa survived for less time than control males treated with acetone but in *C. splendens* no such differences were found (CONTRERAS-GARDUÑO et al., 2011). The difference between these species could be due to the greater time spent fighting with conspecific damselflies in the former than in the latter, as this could affect their immune response and survival after JHa treatment (CONTRERAS-GARDUÑO et al., 2011). ROLFF & SIVA-JOTHY (2002) found a decrease in PO after 24 h in *T. molitor* but in this case they transplanted the *corpora allata* (the organ that produces the JH; NIJHOUT, 1994) of mated males to virgin ones and it is possible that the JH expression of this organ was not suppressed or that the previously produced hormone could still have been negatively affecting the PO production.

As hormones affect invertebrate physiology, their study could be useful for understanding the life history and evolution of insects (KETTERSON & NOLAN 1992, 1999 RICKLEFS & WIKELSKI, 2002; ZERA & HARSHMAN, 2001; ZERA et al., 2007). The knowledge of what conditions affect the immune response and which immune response parameters are affected would be helpful in establishing the importance of the male condition on reproductive strategies. We suggest that future studies should take into account the time after the JH treatment, measure more than one parameter of the immune response (such as antimicrobial peptides and the number of haemocytes) and combine laboratory and field studies to help understand the effect of JH on the immune response and to establish the link between the immune response and physiological signals of the male condition resulting from the production of JH.

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Odonatologica 41(1): 7-15 *March 1, 2012*

NO FIRM EVIDENCE OF IMMUNOLOGICAL COSTS OF INSECT OVIPOSITION AND COPULATION: A TEST WITH DRAGONFLIES (ZYGOPTERA)

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The immune response is a costly trait as investment in immunity is frequently traded off against life history components. In insects, for example, experimental tests have provided evidence that oviposition and copulatory activities impair immune ability in the form of encapsulation ability. Here such tests are replicated by using four zygopteran spp., viz. *Argia joergenseni*, *Calopteryx splendens*, *C. virgo* and *Hetaerina americana*, having encapsulation, phenoloxidase and nitric oxide activity − three key components in the insect immune response − as dependent variables. The results provide no consistent results. Only in *A. joergenseni* there was any evidence of oviposition activity (or, in the case of *H. americana*, submergence) affecting encapsulation, but neither in *C. splendens* nor in *H. americana* did copulation have any such effect. In *H. americana,* nitric oxide activity was lower in ♀♀ that had been submerged but there was no effect on phenoloxidase activity. Thus, former observations indicating that oviposition and copulation negatively affect the immune response, cannot be generalized.

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INTRODUCTION

Current evolutionary ecology theory has included the cost of producing and maintaining an immune response as a potential source of trade offs between this function and life history traits. A number of empirical works have supported this, with immunity expression covarying negatively with growth, reproduction and survival (reviewed by SCHMID-HEMPEL, 2005; SADD & SCHMID-HEMPEL, 2009; SCHULENBURG et al., 2009). The underlying logic for this relationship is that, similar to other resource-based trade offs, resources are finite for an organism, thus leading to resource allocation conflicts between costly functions. Two classical cases of immunity costs derived from costly behavioural activities are oviposition and copulation. Such costs have been documented in Zygoptera (SIVA-JOTHY et al., 1998), crickets (ADAMO et al., 2001; BASCUÑÁN-GARCÍA et al., 2010) and beetles (ROLFF & SIVA-JOTHY, 2002). In these cases, oviposition and copulatory activities have negatively affected the immune response and vice versa. The underlying physiological link is the juvenile hormone whose action mediates gamete and accessory gland production, restricting the allocation of resources to immunity (ROLFF & SIVA-JOTHY, 2002). Periods of juvenile hormone action may lead to immune-suppression, rendering animals more vulnerable to infections (ROLFF & SIVA-JOTHY, 2002). In these studies, two immunological parameters were used: phenoloxidase activity (PO - an enzyme that gets activated at the onset of immune response; GONZÁLEZ-SANTOYO & CÓRDOBA-AGUILAR, 2012) and encapsulation (a defense mechanism against parasitic protozoans and metazoans, fungi and parasitoids such as wasp eggs or larvae (GILLESPIE et al., 1997; LAVINE & STRAND, 2002; BRENNAN & ANDERSON, 2004). These parameters have usually been acknowledged as good indicators of immune capacity (i.e. CONTRERAS-GARDUÑO et al., 2007; RANTALA & ROFF, 2007).

Here we have re-addressed the question of whether oviposition and copulation bear an immunological cost in insects, using four species of damselflies as study subjects. Odonates have been widely used in ecological and evolutionary studies (CÓRDOBA-AGUILAR, 2008). Regarding ecological immunity, a wealth of studies in this group have provided key results, indicating that sexual activities and functions are coupled with immune condition in a trade off fashion (e.g. SIVA-JOTHY et al., 1998; CONTRERAS-GARDUÑO et al., 2006, 2007, 2008; CÓRDOBA-AGUILAR & MÉNDEZ, 2006). Here we have included encapsulation ability, PO and nitric oxide (NO) activity as dependent variables. This last variable has not been included in previous studies of oviposition and copulatory costs. NO is a reactive free radical gas that suppresses protein catalytic activity with protein and has harming effects on pathogens' DNA (RIVERO, 2006). This characteristic makes NO another key indicator of immunological condition (RIVERO, 2006) and studies on Zygoptera have corroborated this (i.e. CÓRDOBA-

AGUILAR et al., 2009). The use of more than one immunological parameter has been recommended as a single measure cannot be used to cover the entire host's immune ability (BOA-AMPONSEN et al., 1999; ADAMO, 2004). Our aim was to see the extent of the supposed physiological costs imposed by insect oviposition and copulatory activities. The four species we used in our study show considerable differences in their mating systems: a non-territorial species (*Argia joergenseni*) and three territorial species (*Calopteryx splendens*, *C. virgo* and *H. americana*). This diversity is a significant sample of the sexual biology spectrum found in the Zygoptera (SERRANO-MENESES et al., 2008) and thus makes our selection valid for the aim of our study.

We followed the damselfly experimental protocol of SIVA-JOTHY et al., (1998) in which females that ended oviposition were immune challenged and males were also immune challenged but after copulation. Oviposition behaviour in Zygoptera may include costs other than that of laying eggs *per se*, such as the ovipositing posture, male harassment and/or water immersion (CORBET, 1999). Thus it is important to determine what in particular is potentially affecting the immune response. Therefore, in our experimental protocol, we disentangled the costs of laying eggs from the behaviour that accompanies this activity.

MATERIAL AND METHODS

Argia joergenseni was collected in Cabalango (31º1'S, 64º34'W), Sierras Chicas, Córdoba Province, Argentina, from November 2008-January 2009. *Calopteryx splendens* and *C. virgo* were studied in the Creeks Mynäjoki (60°38'N, 21°55'E) close to Turku, Finland from June-July 2009. *Hetaerina americana* was studied in the Amacuzac river, south Mexico city (18°32'56"N, 99°16'23"W) in June 2003 and September 2009.

EFFECTS OF OVIPOSITION BEHAVIOUR ON IMMUNITY – Thirteen in-tandem *A. jorgenseni* females were allowed to lay eggs in a plastic container filled with water and containing the aquatic plant (*Elodea* sp.) obtained from the damselfly collection site. Oviposition was interrupted to immune challenge the females. This challenge consisted of inserting a previously-disinfected (in 100% ethanol) piece of nylon (1.5-2.0 mm long and 0.5 mm wide), which was kept within the animal for 12 h. Control females were 13 in-tandem animals that were not allowed to oviposit and that were immune-challenged for the same 12 h. In both groups, implants were extracted and preserved in 70% ethanol for encapsulation measurement (see below).

Females *C. splendens* (N = 4) and *C. virgo* (N = 5) were allowed to oviposit until they finished. After oviposition, each female was caught. Additionally, non-ovipositing females were also caught (N = 4 and 5 for *C. splendens* and *C. virgo*, respectively). Age of both female sets was similar as judged from the body colour and wing aspect (for a rationale of age differences see CÓRDOBA-AGUILAR, 2009). Both female sets were placed individually in cylindrical plastic containers (75 mm height and 45 mm diameter), which were then placed in a cool box until a nylon challenge. A sterile 2 mm length nylon monofilament (diameter 0.18 mm) was inserted into the fourth abdominal pleura on the dorsal side of the sternal-tergal margin of all females. Each insect was then returned to its plastic container, and was left for 24 h at constant room temperature (22°C).

In 2003, 22 fully mature *H. americana* females (as judged from their hardened exoskeleton and developed body and wing coloration; CÓRDOBA-AGUILAR, 2009) were collected and gently tethered (with a thread on their thorax, to avoid obstructing wing movements) to a wooden stick, allowing

for ca. 5 cm of thread. Females were able to grab the stick and when they did so, were submerged to the river water for 15 minutes. This situation resembles that of natural oviposition behaviour in this species (CÓRDOBA-AGUILAR, 2009). A previously disinfected nylon implant (1 mm length, 0.2 mm diameter) was inserted through the fourth abdominal pleura on the ventral mid-line using fine forceps. As control animals, 22 fully mature females were collected and a nylon implant with similar characteristics was inserted in the same region as in the experimental females. Ages were similar in both groups as judged from body colour and wing aspect. Implants were left for 8 h. in both groups. We did not use ovipositing females as, unlike the other species in our study and those used in previous studies (i.e. SIVA-JOTHY et al., 1998), we wanted to disentangle the effect of laying eggs from the accompanying behaviour. After insertion, each female was put in a plastic, transparent container (4.5 × 1.4 cm) with a piece of wood for perching and a piece of humid cotton. Containers were maintained within a dark, cool box in the shade, to reduce the animals' activity (so that they did not incur an unnecessarily high energy expenditure).

In 2009, 11 fully mature *H. americana* females were treated similar to those we submerged in 2003 and 28 fully mature females were used as control individuals. Again, females of both sets showed a similar age as indicated by their colour and aspect. Each of these animals was treated for PO and NO activity (see below).

For all females of the four species, the length of the right forewing was measured (in mm) as an indicator of body size.

EFFECTS OF COPULATION ON IMMUNITY − Sixteen *C. splendens* territorial males were captured soon after they finished copulation. These males were treated similar to those ovipositing *C. splendens* females that were nylon-challenged (described above). As a control group, 16 territorial males that were not copulating were also nylon challenged. For encapsulation measurement, these males were treated as the control *C. splendens* females used for the oviposition experiment and described above. Both sets of males had similar ages according to the criteria of PLAISTOW & SIVA-JOTHY (1996).

In July 2000, 12 *H. americana* males that had finished copulation were captured, separated from the females and challenged in a similar fashion to those *H. americana* ovipositing females described above. As a control group, another set of 12 fully sexually mature males (as judged from their territorial behaviour and brilliant body and wing colours) was captured and were immune challenged similar to the copulating males. As with the experimental *H. americana* females that were nylon-challenged in 2003, implants were left for 8 hrs while the animals were placed individually in a plastic container with a perching piece and humid cotton, in the dark. Encapsulation was measured.

As an indicator of size, the length of the right forewing was measured (in mm) for both species.

MEASURES OF ENCAPSULATION, PO AND NO ACTIVITY − For *A. jorgenseni* and *H. americana*, and while the animals were still alive, each nylon implant was retrieved by carefully removing the abdominal cuticle around the implant under a dissecting microscope. The implant was preserved in ethanol (70%) for 7 days and re-hydrated during 24 h. Implants were photographed using a digital camera attached to a microscope. The encapsulation area around the nylon was measured using the software Image Tool ®. The relative encapsulated value was obtained in relation to the whole implant area. For *C. splendens* and *C. virgo*, each implant was gently removed from the insect and frozen for later analysis. Each implant was photographed from two different angles under a light microscope with a digital camera. Images were then analysed using the computer program Image Pro ®. As a measure of encapsulation rate, we used the mean of the grey values of reflecting light from the two digital pictures of each implant. The data were transformed by subtracting the observed grey values from a control value. The control value was obtained by photographing a haphazardly selected new (i.e. non-used) implant. The darkest grey values corresponded to the highest encapsulation rates. Despite the methodology differences of encapsulation measurements between American and European species, the fact that the comparison is made within species (but not between species) does not invalidate our study aims.

For PO activity, seven mL of phosphate buffer saline containing protease inhibitors (PBS-IP) were

injected in the mid region of each damselfly thorax. Heads were then removed and the thorax was gently pushed to obtain 2 µL of haemolymph/PBS-PI per animal. To these 2 µL per animal 100 µl of PBS-PI were added and PO activity measured spectrophotometrically twice by recording dopachrome formation from $_{L}$-dihydroxyphenylalanine ($_{L}$-DOPA, Sigma). From this last mixture (102 µL of haemolymph/PBS-PI plus PBS-PI), twenty five µL of sample with a concentration of 10 µg/lL of protein (see this method in Contreras-Garduño et al. 2007) were added to 150 µL of PBS-PI and mixed on a micro-well plate with 25 µL of $_{L}$-DOPA (3mg/ml of PBS-PI) as substrate (in total 200 µL of sample, PBS and substrate were added per animal). Optical density was registered at 490 nm using a micro-plate reader (Model 350, Bio-Rad). As blanks, 175 µL of PBS were mixed with 25 µL of $_{L}$-DOPA and the optical density was recorded also at 490 nm. Enzyme activity is expressed as units, where one unit represents the change in absorbance min^{-1} (SÖDERHÄLL & HÄLL, 1984). Three readings of PO were taken every 15 minutes so that each datum represents the mean PO activity for the three recordings. For NO activity, the Griess reaction was used. For this, 50 µl of each haemolymph sample (from the 102 µL of haemolymph/PBS-PI plus PBS-PI indicated above) was mixed with 50 µl of sulfanilamide and 50 µl of 0.1 % naphthylethylenediamine (Sigma, St. Louis, MO, USA). This mixture was incubated for 10 min at room temperature. Using a plate reader and at 540 nm, absorbance was recorded after 15 and 30 minutes and an average for each individual was obtained for both recordings. NO was quantified using a $NaNO_2$ (1-100 µM) standard reference curve for each assay. Results are provided as nitrite and nitrate concentrations.

STATISTICAL ANALYSES − When encapsulation values were measured as proportions, data were transformed with the following equation: encapsulation = arcsin (square root(value)). If data were amenable for transformation or were normally distributed, general linear models were used in which treatment (experimental and control animals) was entered as a factor, immune responses (encapsulation, PO and NO) were entered as response variables and size was entered as a covariate. When general linear models were used, interactions were tested and reported, but they were not included in the final model when they were non-significant. Analyses were carried out in SPSS 15.0. Results are reported as mean ± STD unless stated otherwise. Mann Whitney U tests were used when normality or homogeneity of variances assumptions were not satisfied after transformation.

RESULTS

EFFECTS OF OVIPOSITION ON IMMUNITY

In *A. joergenseni*, encapsulation response was lower in females that were allowed to oviposit (16.30 ± 7.58 %) than in females that did not oviposit (37.87 ± 20.48 %; t test = 3.613, P = 0.002, N = 26; Fig. 1). There was no correlation between wing length and encapsulation response either in ovipositing ($r_{pearson}$ = 0.396, P = 0.180, N = 13) or non-ovipositing females ($r_{pearson}$ = -0.228, P = 0.454, N = 13).

In *C. splendens*, there was no difference in encapsulation response in females that oviposited (39.17 ± 25.17) vs. females that did not oviposit (47.58 ± 19.55; $F_{1,6}$ = 0.085 P = 0.782, N = 8). Wing length was not related to encapsulation activity ($F_{1,6}$ = 1.140, P = 0.335, N = 8) and there was no effect of the interaction group (oviposition/no oviposition) × wing length ($F_{1,5}$ = 1.382, P = 0.305, N = 8).

In *C. virgo*, there was no difference in encapsulation response in females that oviposited (44.07 ± 10.85) vs. females that did not oviposit (51.99 ± 17.12; $F_{1,7}$ = 1.371, P = 0.280, N = 10) and wing length did not have any effect ($F_{1,7}$ = 0.643, P = 0.449, N = 10). The interaction group (oviposition/no oviposition) × wing length

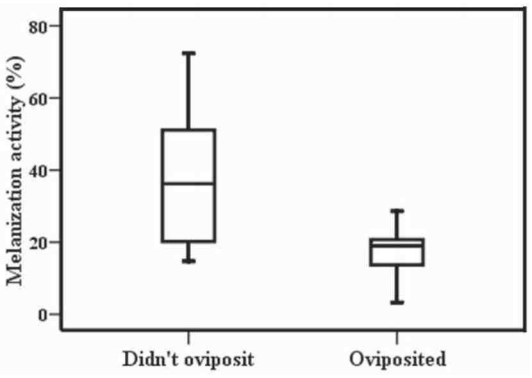

Fig. 1. Difference in encapsulation response in ovipositing and non-ovipositing *Argia joergenseni* females.

was also non-significant in the model ($F_{1,6}$ = 0.005, P = 0.947, N = 10).

In *H. americana*, encapsulation response did not differ between experimental (N = 16; 10.18 ± 2.42 %) and control females (N = 14; 11.19 ± 2.81 %; $F_{1,27}$ = 0.173, P = 0.681). The response was positively correlated with female size ($F_{1,27}$ = 6.101, P = 0.020) but this positive trend was independent of the treatment ($F_{1,27}$ = 0.034, P = 0.855). PO activity did not differ between experimental (N = 11; 0.131 ± 0.147 U / mg protein) and control females (N = 28; 0.055 ± 0.034 U / mg protein; Mann-Whitney U = 104.00; P = 0.124; N = 39), and the non-significant trend remained after removing two outliers from each group (Mann-Whitney U = 87.001, P = 0.271, N = 35). PO activity was not related to female size in submerged ($r_{spearman}$ = -0.530, P = 0.115) or control ($r_{spearman}$ = -0.233, P = 0.233) females. NO activity was lower in submerged females (0.015 ± 0.016 nitrite / nitrate) than in control females (1.05 ± 1.14 nitrite / nitrate; Mann-Whitney U = 10.001, P < 0.001, N = 38), even excluding three outliers from the control group (Mann-Whitney U = 10.000, P < 0.001, N = 35; Fig. 2). There was no relationship between female size and NO activity in control ($r_{spearman}$ = -0.237, P = 0.233, N = 27) or submerged females ($r_{spearman}$ = 0.232, P = 0.518, N = 10).

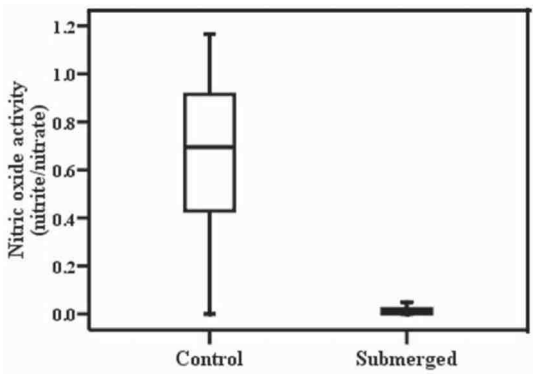

Fig. 2. Difference in NO activity between experimental and control *Hetaerina americana* females.

EFFECTS OF COPULATION ON IMMUNITY

In. *C. splendens*, there was no difference in encapsulation activity of males that copulated (48.02 ± 14.65) and males that did not copulate (43.87 ± 14.89; $F_{1,29}$

= 1.753, P = 0.196, N = 32). Wing length was not related with encapsulation activity ($F_{1,29}$ = 3.603, P = 0.068) and there was no effect of the interaction group (copulated/did not copulate) × wing length ($F_{1,28}$ = 0.633, P = 0.433).

In *H. americana*, there was no difference in encapsulation activity of males that copulated (11.23 ± 1.17 %) and males that did not copulate (10.75 ± 1.30 %; $F_{1,20}$ = 4.070, P = 0.057, N = 24). Wing length was not related with encapsulation activity ($F_{1,20}$ = 0.003, P = 0.954) and the interaction group × wing length was marginally significant ($F_{1,20}$ = 4.240, P = 0.053). When excluding the interaction group × wing length from the model, group and wing length remained non-significant (group: $F_{1,21}$ = 0.905, P = 0.352; wing length: $F_{1,21}$ = 0.086, P = 0.772).

DISCUSSION

In only one species, *A. joergenseni*, did we find that females laying eggs paid the costs of such activity via a reduction in melanization ability. This result was not replicated in the other three calopterygids, in which both laying eggs and the behaviour that accompanies this were investigated. Furthermore, the assumed costs of copulation were not found. Thus, despite previous results in insects, which include one odonate species, regarding immunological costs of copulation and oviposition activities, we did not find support for this. Our experimental framework is robust considering: (1) that more than a single immunological component was used; (2) the immune components used have been frequently identified as indicators of immune condition; (3) our experimental approach replicated experimental procedures used in previous studies (which separate the possible differential costs of females laying eggs and females carrying out ovipositing behaviour but not laying eggs); and 4) we used four good representative species of the sexual diversity found in the Zygoptera. Given these considerations, one can safely generalize that the previously identified immunological costs are unlikely to apply to other odonates. It remains to be explored whether our results also apply to insects in general.

One alternative explanation for our results is that the costs of both copulation and oviposition activities are not high enough to be detected. Previous evidence in odonates regarding the costs of some behavioural activities has been widely documented. For example, it has been found that fighting for territories in males of *C. virgo* and *H. americana* imposes a reduction in encapsulation ability (KOSKIMÄKI et al., 2004; CONTRERAS-GARDUÑO et al., 2006), while sexual harassment reduces PO activity (CÓRDOBA-AGUILAR, 2009) and fat reserves (CÓRDOBA-AGUILAR & GONZÁLEZ-TOKMAN, 2011) in females of *H. americana*. This implies that these activities entail higher energetic costs than oviposition and copulation. Another explanation is that such costs will emerge based on the animal's condition. For example, in *H. americana*, an animal that is sexually active the entire year, there is seasonal variation in male energetic and

immunological condition (CÓRDOBA-AGUILAR et al., 2009). This implies that some activities may be more costly in some months compared to others. In fact, after a bacterial challenge, males die sooner in seasons when animals are in worse condition (CÓRDOBA-AGUILAR et al., 2009). However, although this may apply to *H. americana*, this is not the case for the other three species given that their sexual activities are seasonal.

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ADDITIONS AND REFINEMENTS TO THE MOLECULAR PHYLOGENY OF THE CALOPTERYGINAE S.L. (ZYGOPTERA: CALOPTERYGIDAE)

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Of 8 previously unstudied calopterygine taxa, the ITS 1 and 2 was sequenced and inserted into a pre-existing phylogenetic tree of all Eurasian and American genera. ITS is mainly appropriate for looking at shallow phylogenetic relationships, and resolved the relationship within and between genera best, with weak support for relationships at the subfamily level. Thus, *Atrocalopteryx*-*Matrona* was found to be a complex but very robust clade, while *Vestalis* s.l. was confirmed to consist of 2 distinct genera. The generic versus specific or subspecific status of few other taxa is discussed. Within *Mnais* and *Vestalis*, the position was tested of 2 suspected "aberrant" members, *M. gregoryi* and *V. beryllae.* Both were confirmed to belong to the genera to which they had been traditionally assigned.

INTRODUCTION

DUMONT et al. (2005) published a comprehensive phylogeny of the Caloptera, based on the DNA sequence of the 18S rDNA operon. That paper, that includes estimates of the absolute age of its clades, defined the Calopteryginae as a group of clades that had originated at or just after the K/T extinction event. All other clades of the Calopterygidae, each of which was believed to be of a higher, perhaps subfamily rank (e.g. *Vestalis* s.l. and *Iridictyon*), were found to be older and survivors of that event. That same paper also confirmed earlier findings by MISOF et al. (2000), that the type genus of the family, *Calopteryx,* as until then defined, was not a monophyletic group. However, the problem could be rectified by creating a separate genus, *Atrocalopteryx*, for the East Asian species, "*Calopteryx" atrata*, that was causing the problem. The redefined genus *Calopteryx*

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was further found to be composed of three clades: the Eurasian *splendens-virgo* group, the North American *amata-maculata* group, and the Japanese endemic *Calopteryx cornelia*. Like MISOF et al. (loc.cit.), it was found that the American group was sister to the other two, although the consensus tree by Misof et al. casts some doubt on this, and suggests that *C. cornelia* might be the sister taxon to all other *Calopteryx*. DUMONT et al. (2007), having analysed additional East Asian calopterygines and corrected an identification error in *Archineura* in their earlier paper, specifically updated the phylogenetic tree for the Calopteryginae. Two more East Asian *Calopteryx* were found to belong in *Atrocalopteryx*, and that latter genus formed a robust clade with *Matrona*, another exclusive East Asian genus. *Neurobasis-Matronoides* was the sister to that clade, and *Calopteryx* was sister to the combined *Matrona-Atrocalopteryx-Neurobasis* clade. In *Calopteryx* s.s. the topology had slightly changed, and *C. cornelia* had become sister to all other species, including the North American group.

Still, genera such as *Mnais* and even *Atrocalopteryx* remained only very partially studied, while of some other, deeper clades, like *Vestalis* s.l. no new representatives were analysed at all.

Here, we extend the phylogeny given by DUMONT et al. (2007) by adding the intergenic spacer 1 and 2 of the 18 S rDNA operon (ITS 1 and 2) of another

Table I

Taxon	Origin	Collector's name	EMBL accession number
Atrocalopteryx melli	Nankunshan, Guangdong, China	H.J. Dumont & L.J. Xiao	JQ341026
Atrocalopteryx oberthureri	Kangding, Sichuan, China	X. Yu	JQ341025
Neurobasis longipes	Loksado, Kalimantan, Indonesia	H.J. Dumont & J. Vermeir	JQ341024
Mnais gregoryi	Tangman River Power Station, Shangri-La, Yunnan, China	Z.Y. Guan	JQ341028
Vestalis amaryllis	Loksado, Kalimantan, Indonesia	H.J. Dumont & J. Vermeir	JQ341022
Vestalis atropha	Loksado, Kalimantan, Indonesia	H.J. Dumont & J. Vermeir	JQ341023
Vestalis beryllae	Kinabalu, Borneo	R. Dow	JQ341027
Vestalaria velata	Nankunshan, Guangdong, China	H.J. Dumont	JQ341021

eight taxa to the phylogenetic trees. Four of these are *Vestalis* s.l., prompting us to include the *Vestalis* clade into the Calopteryginae tree, although it is believed to represent a taxon of subfamily rank in its own right, the origin of which predates the K/T boundary. Because we included the North American group of *Calopteryx*, we decided to also include *Iridictyon*, which is the second group of true Calopterygidae in the Americas. We did not, however, include the African genera *Umma* and *Sapho,* although these are true Calopteryginae, because no new material became available to us.

MATERIAL AND METHODS

Our analysis includes 41 taxa in the ingroup, and three outgroup taxa. The geographical origin of 33 of these taxa can be found in DUMONT et al. (2005, 2007) and need not be repeated here. The eight additional taxa for which we sequenced the two ITS fragments are listed in Table I.

Animals collected from the field were preserved in 70% ethanol until analysed; occasionally, dried specimens were used. As a rule, pieces of thoracic muscle were dissected out to extract DNA from. DNA extraction, PCR amplification, and sequencing were done exactly as in DUMONT et al. (2007); primers used to amplify the ITS region can also be found in that paper. For sequence alignments, the program MAFFT (KATOH et al., 2009) was given preference, with alignment option G-INS-I, which assumes that the entire region under study can be aligned, and to which the Needleman-Wunsch algorithm applies. Phylogenetic analysis and tree construction were carried out exactly as in DUMONT et al. (2005, 2007), using the Bayesian inference algorithm Mr Bayes version 3.Ob4 (HULSENBECK & RONQUIST, 2001) and the maximum likelihood (ML) and maximum parsimony algorithms in PAUP 4.Ob 10 (SWOFFORD, 2003). Bayesian estimates of posterior probability are added to the nodes of the trees, as well as bootstrap values (in percent) for the ML and MP trees. For details of the mathematical manipulations, see DUMONT et al. (2005).

RESULTS

The ITSes (and intervening, conserved 5.8S gene) varied little in length. Phylogenetic trees derived from the 41+3 sequences are shown in Figures 1-3. All trees are strongly similar, with the two main calopterygine clades (*Matrona-Atrocalopteryx-Neurobasis-Calopteryx* and *Mnais-Psolodesmus-Archineura*) well resolved, but their common ancestor either not resolved (ML and MP trees) or resolved with weak support (Bayesian tree). Within *Vestalis* s.l., a clear dichotomy is evident. In some presumed taxa, the DNA is either identical, or shows so few differences, that either a subspecific status or a synonymy must be advocated (*Matrona* and *Psolodesmus*, see hereunder).

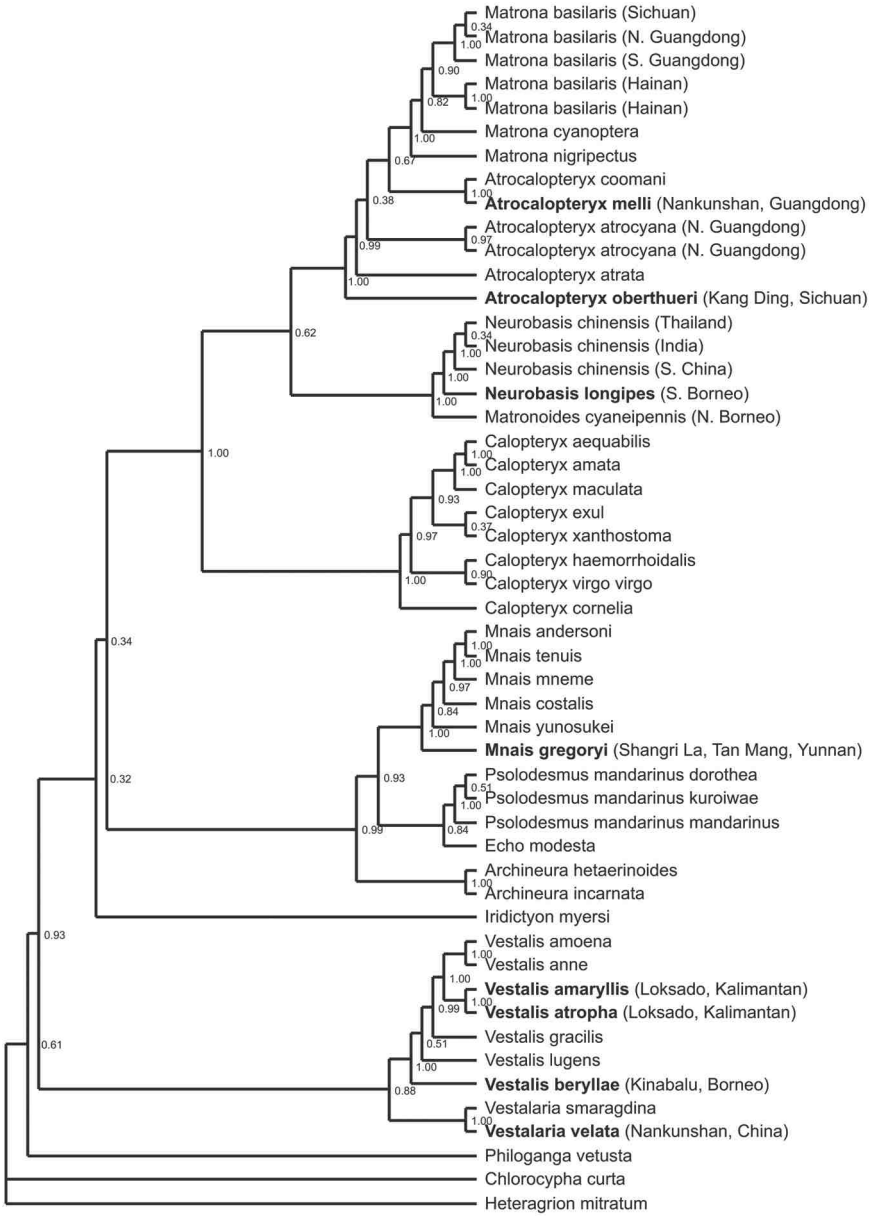

Fig. 1. Bayesian estimate of the phylogenetic descent of the Calopteryginae of Eurasia and the Americas, and of *Vestalis* s.l. and *Iridictyon*, based on the sequences of the Internal Transcribed Spacers (ITS) of the nuclear 18S rDNA operon. Species not previously included in any molecular analysis are shown in bold. Probabilities below 50% are also given.

DISCUSSION

The trees support the concept of a subfamily Calopteryginae, composed of two main branches, with *Calopteryx* s.s. sister to the ancestor of four other genera, all exclusively East and South-East Asian, and including *Atrocalopteryx*. Including the African genera would probably have revealed a third branch, and all of these evolved at or after the K/T extinction. *Iridictyon* and *Vestalis* s.l. are older, but can only be studied well by adding some more conserved genes to the study, which is not our current objective. Here, we focus on strengthening our insights into within and between-genus relationships. Thus, with two extra taxa added, we now have a reasonable overview of the species-richness of the genus *Atrocalopteryx*. *Matrona* is recovered as a recent, perhaps mid-Miocene, offshoot of this taxon. *Atrocalopteryx oberthueri* is sister to all *Atrocalopteryx* and *Matrona* combined. It would in fact be equally defendable to single *A. oberthueri* out in a separate genus, as to merge the whole clade into a single genus.

Neurobasis and *Matronoides* share a similar relationship: although *Matronoides* is sister to all *Neurobasis* so far analysed, the relationship is close, and the generic status of *Matronoides* again turns out to be a matter of convenience. The dated time scale in DUMONT et al. (2005) reveals that both started diverging, again, around the middle of the Miocene.

A third similar case in the tree is that of *Calopteryx cornelia.* If this should ever be raised to genus level, the name *Anaciagrion* is available for it (KENNEDY, 1920).

Some taxa were found to be so closely related that they had better be assigned a subspecific status: such is the case for the *Matrona basilaris* of the island of Hainan, that still awaits description and a name, while in *Psolodesmus*, the taxa *dorothea* and *kuroiwae* have an identical ITS 1 and 2 and therefore could be subspecies, but even that level is now doubtful. On the other hand, *dorothea* and *mandarinus* differ sufficiently (12 bp) to be maintained at the subspecies level.

Mnais gregoryi is a taxon that might be called somewhat "aberrant" on account of its unusual colour and wing banding, and because of its uncharacteristic habitat, consisting of mountain streams in Yunnan (FRASER, 1924; NEEDHAM, 1930). The specimen analysed was captured at between 2700 and 3000 m asl, which is indeed atypical for most calopterygids. However, by its DNA signature it was confirmed as a rather typical *Mnais*.

The four new entries to the phylogeny of the medium-sized genus *Vestalis* s.l. clarify several issues within that clade. Moreover, three come from the island of Borneo, where vestalids show a mild radiation (ORR, 2003). MAY (1935) divided *Vestalis* in three genera. Of these, KENNEDY's (1920) *Vestinus* (with *V. gracilis* as the type species) is clearly not supported here. However, MAY's (1935) *Vestalaria* is recovered as valid, as correctly claimed by HÄMÄLÄINEN (2006). In contrast, the "aberrant" *Vestalis beryllae*, expected to stand out because of its un-

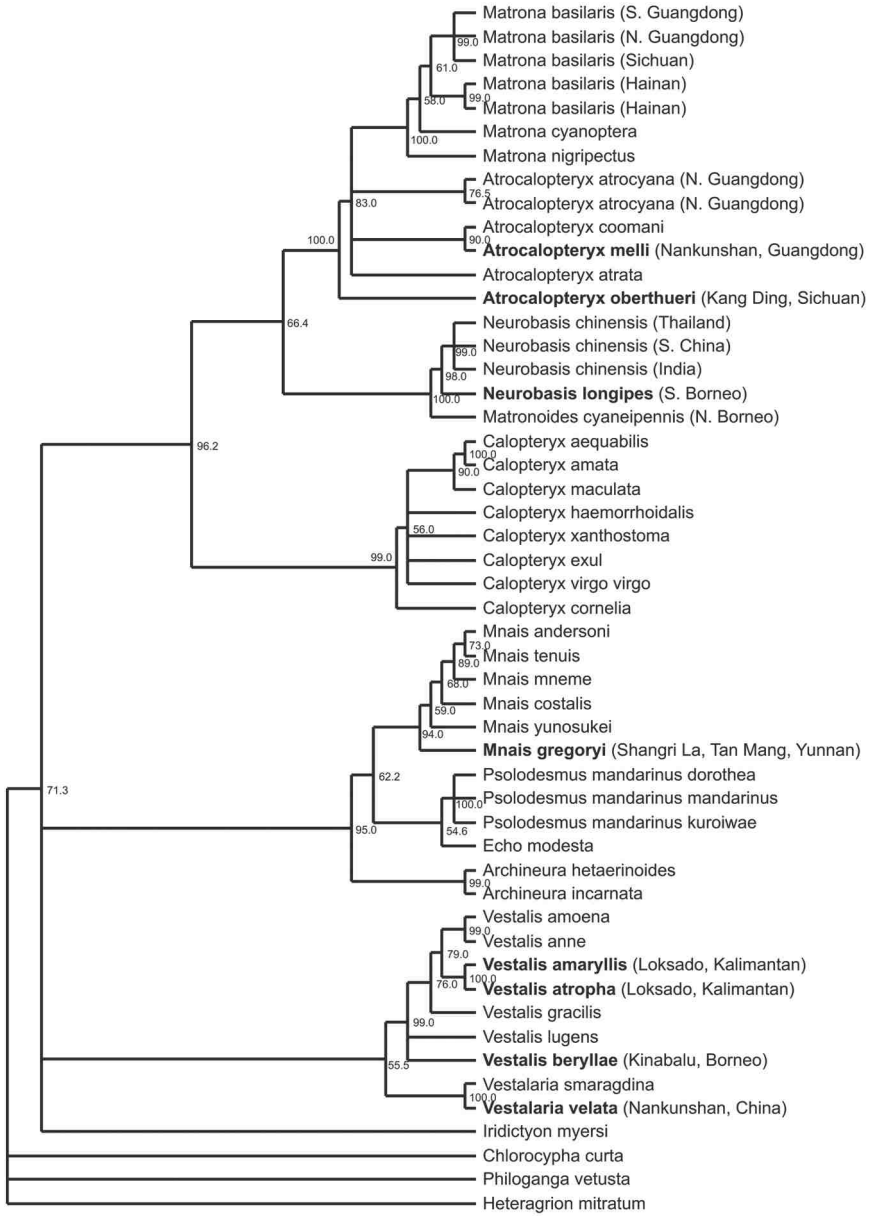

Fig. 2. Maximum likelihood estimate of the phylogeny of the Calopteryginae, plus *Vestalis*, and *Iridictyon*. Support based on 100 bootstraps with ten replicates each and expressed as percentage.

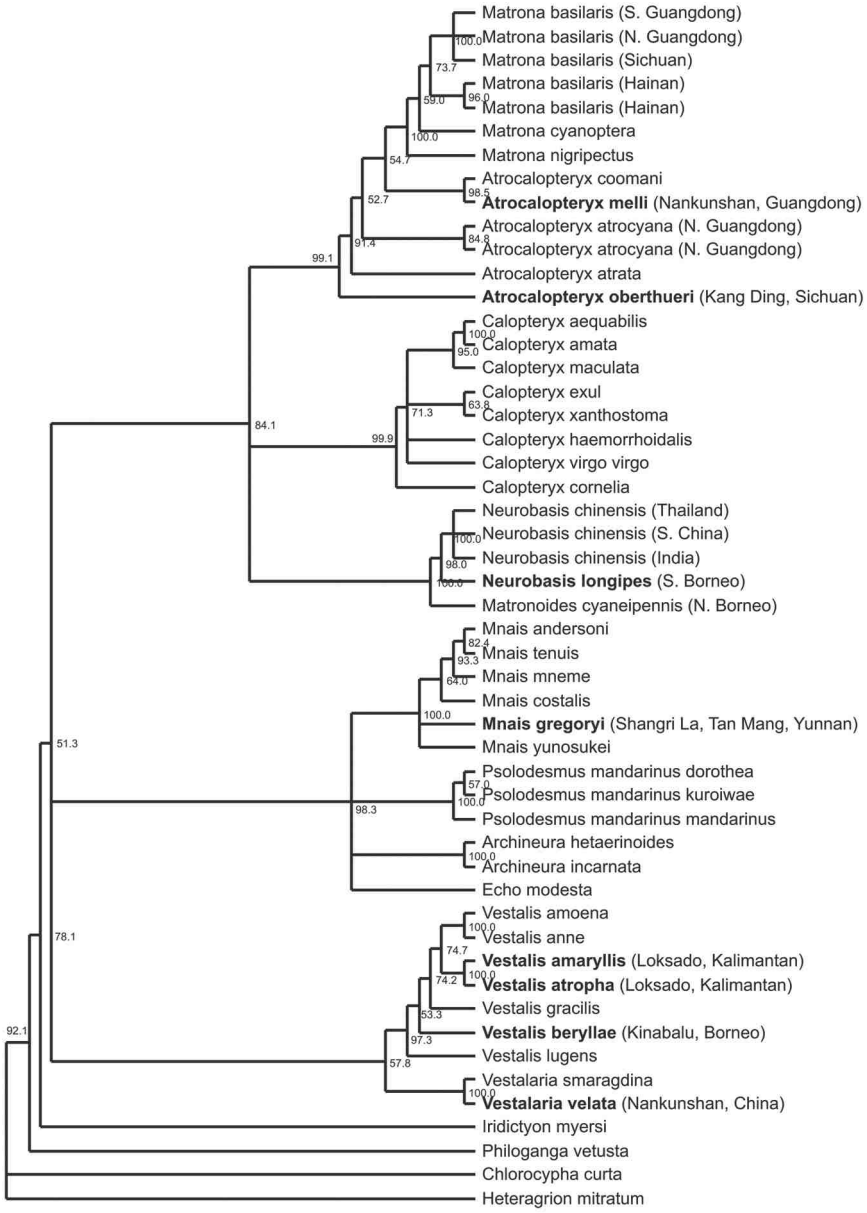

Fig. 3. Maximum parsimony estimate of the phylogeny of the Calopteryginae, plus *Vestalis* and *Iridictyon*, (100 bootstraps and 10 replicates per bootstrap).

usually long abdomen, emerges as a "normal" *Vestalis*. Apparently, developing a long abdomen, somewhat reminiscent of the South American Pseudostigmatidae, does not require a major revolution of the genome, and may be an adaptation to life in dense forest that evolved several times independently in the zygopterans.

ACKNOWLEDGEMENTS

Out thanks to all colleagues mentioned in Table I for helping us with material. Support by a grant for leading talent scientists of Guangdong Province to Dr Henri Dumont and an innovative grant to Dr Zhaoying Guan (Hydrobiology Program of 211 Project at Jinan University) is appreciated

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SHORT COMMUNICATIONS

DESMOGOMPHUS ANCHICAYENSIS SPEC. NOV. FROM COLOMBIA (ANISOPTERA: GOMPHIDAE)

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The new sp. is described and illustrated based on larvae collected in the Anchicayá zone, Valle del Cauca, Colombia. Holotype ♂: F2 larva, 12-IX-2008; deposited in Instituto de Ecologia, Xalapa, Mexico. It differs from the 2 described congeners in the position of dorsal and lateral abdominal hooks, the presence of a beveled edge in the dorsal surface of the prementum and an angled ventral margin of the paraprocts. Specimens are rare and difficult to collect because they inhabit threatened habitats in an area restricted to researchers.

INTRODUCTION

The neotropical dragonfly genus *Desmogomphus* includes only two described species to date: *D. paucinervis* (SELYS, 1873) (BELLE, 1979) and *D. tigrivensis* WILLIAMSON, 1920. The larva of *D. paucinervis* was described by WESTFALL (1989), and that of *D. tigrivensis* by BELLE (1970). The genus is distributed from southern Nicaragua to Colombia, Venezuela, Guyana and Surinam (GARRISON et al. 2006). In Colombia, only *D. paucinervis* has been reported (SELYS, 1873; BELLE, 1970). Here we describe a new species, *D. anchicayensis* sp. nov., based on a F2 instar collected in the Anchicayá zone, Valle del Cauca, Colombia, as part of an effort to increase the knowledge of Gomphidae in this country.

DIAGNOSIS OF *DESMOGOMPHUS* LARVAE

Body stout with a granulose appearance, yellow to light brown, colour pattern of abdomen weakly developed. Head wider than long, cephalic lobes bulging and covered with minute stiff setae; antennae 4 jointed, longer than head, segment 3 the longest, club-shaped, slightly upcurved and covered with long hairs, segment 4 minute. Labium with squared ligula slightly prominent, its distal border convex and fringed with a dense row of flabellate scale-like setae and a small but stout tubercle on each side of the midline. Labial palps without setae, ending bluntly; inner margin with conspicuous, sharply pointed or blunt teeth decreasing in size from the tip to the base. Thorax robust; prothorax with lateral and posterior margins rounded and granulose, except for a large bare area to each side of midline. Fore- and middle legs with curved femora and a strong burrowing hook on the external margin of tibiae. Wing cases in full grown larvae usually extending to abdominal segment 4. Abdomen long, robust and somewhat flat; abdominal segments 3-9, 5-9 or 6-9 with lateral spines, those on segment 9 reaching or surpassing posterior margin of segment 10; a single row of mid-dorsal hooks on abdominal segments 4-9 or a double row on 5-7 becoming single on 8-9. Paraprocts as long as or longer than epiproct, much longer than cerci, all sharply pointed. Conspicuous tufts of long hairs ventrally at base of paraprocts.

DESMOGOMPHUS ANCHICAYENSIS SP. NOV.

Figures 1-9

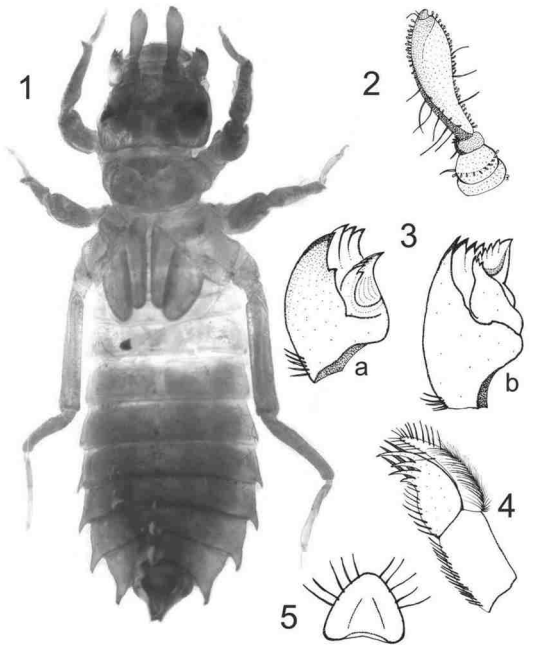
M a t e r i a l. – **Holotype** ♂: F2 larvae: COLOMBIA: Alto Anchicayá, unnamed forest creek (622 m.a.s.l.), 03.58448ºN, 076.87728ºW, 12-IX-2008, V. Amaya leg. Deposited in Colección Entomológica del Instituto de Ecología, A. C., Xalapa, Veracruz, México (IEXA).

E t y m o l o g y. – The name refers to the zone where the species was found (Anchicayá rainforest, Valle del Cauca, Colombia).

MALE. – **Holotype**. – Body yellowish-brown with granulose appearance. Head narrower than thorax and abdomen. Abdomen with diffuse colour pattern of light and dark brown spots, fully covered with scale-like setae. Anal appendages dark brown. All legs covered with long and short hair-like setae.

H e a d. – Markedly wider than long (Fig. 1), with bulging cephalic lobes covered with minute spines, the occipital margin slightly concave. Compound eyes small and triangular, slightly protruding from head. Antennae 4-segmented (Fig. 2); first segment pale with transverse row of scale-like setae in middle; second segment with long setae in lateral margin; third segment longest, club-shaped, slightly curved upward, covered with scale-like setae and scattered long setae on lateral margins; fourth segment very small and curved inward; proportions of antennomeres: 0.16, 0.14, 1.0, 0.06. Labrum mostly bare, setose on distal margin. Frons with distinctive pair of tubercles between bases of antennae, densely covered with

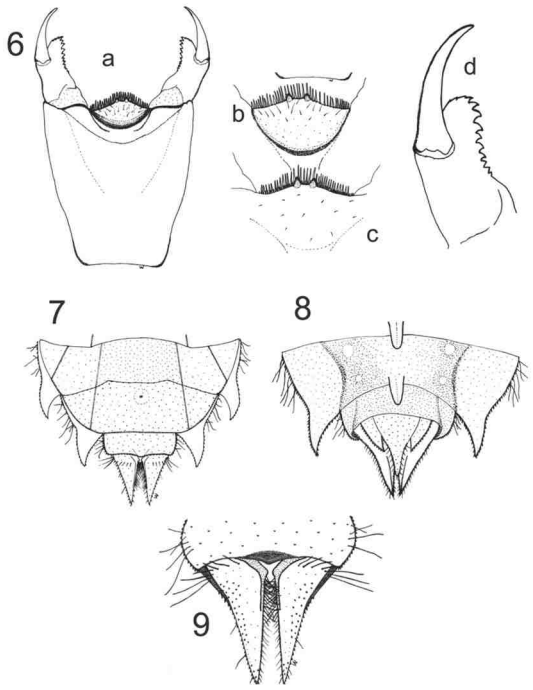
scale-like setae (Fig. 1). Mandibles biramous (Figs 3a, b), with the following formula (sensu WATSON, 1956): L 1 2 3 4 0 a(m 1,2,3,4,5,6)b/ R 1 2 3 4 y a(m 1,2,3)b, with wide gap between teeth of *m* and tooth *b* on right mandible (Fig. 3a). Galeolacinia with 7 acute and long teeth (Fig. 4), its base covered with long, hair-like setae; maxillary palp slightly shorter than galeolacinia, acutely pointed and covered with rows of long, hair-like setae. Hypopharynx subtriangular (Fig. 5), longer than wide, with 10 long hair-like setae on the ventral side. Prementum - postmentum articulation reaching level of forecoxae. Prementum (Fig. 6a) flat ventrally; as long as widest part; narrowed at base; covered with scattered short, hair-like setae on apical 0.10 on the ventral side; lateral margins covered with short, stiff setae and with sparse, long, hair-like setae. Ligula slightly triangular and poorly developed (Figs 6a-c); its dorsal surface somewhat flat, appearing beveled when viewed dorsolaterally or dorsocaudally (Figs 6a-b); distal margin fringed with dense row of flabellate, scale-like setae and a small, stout tubercle each side of midline (Figs 6a-c). Labial palp without setae, ending bluntly, inner margin with 9 conspicuous teeth decreasing in size from apex to base, each tooth sharply pointed. Movable hook strong and sharply pointed (Fig. 6d).



Figs 1-5. F2 instar of *Desmogomphus anchicayensis* sp. nov: (1) general aspect, dorsal view; – (2) left antenna, dorsal view; – (3a) right mandible, ventral view; – (3b) left mandible, ventral view; – (4) galeolacinia, dorsal view; – (5) hypopharynx, dorsal view.

T h o r a x**.** – Pronotum with lateral and posterior margins rounded; disk granulose except for a large, bare area each side of midline. Anterior and posterior margins of propleuron covered with long, hair-like setae. Wing pads almost reaching S3. Hind legs when fully extended reaching S9. Fore and middle legs short, burrowing type, with strong hooks on external margin of tibiae. All legs covered with long, hair-like setae.

A b d o m e n. – Longer than wide, moderately depressed, segments 3-5 with low mid-dorsal protuberances increasing in size, gradually becoming blunt



Figs 6-9. Details of the morphology of *Desmogomphus anchicayensis* sp. nov: (6a) dorsal surface of prementum; – (6b) detail of beveled edge of dorsal surface of ligula; – (6c) detail of ventral surface of ligula; – (6d) left labial palp, dorsal view; – (7) anal appendages, ventral view; – (8) same, dorsal view; – (9) detail of thickenings and tufts of setae in ventral surface of paraprocts.

hooks on segments 6-9. Lateral spines on segments 5-9, minute on segment 5, increasing in size and robustness from segment 6-9, slightly incurved and upturned, hook on segment 9 more than half mid-dorsal length of 9 and almost reaching posterior margin of epiproct. Sternite 8 divided into five plates (Fig. 7). Caudal appendages pyramidal, acutely pointed; epiproct with hair-like setae on margins, tubercles in basal half, shorter than paraprocts; cerci 1/3 length of paraprocts, lateral margins covered with small, stiff setae (Fig. 8); paraprocts with mesal margins covered with hair-like setae, more abundant near bases and giving them a brush-appearance. Mesal margins of paraprocts angled in the ventral basal side (Fig. 9), angles surrounded by conspicuous thickening, and close to angles is a row of hair-like setae increasing in size near lateral margins that are covered with short, stiff setae and some scattered hair-like setae.

M e a s u r e m e n t s (mm): length (with appendages) 17.50; maximum width of head 5.42; hind femur 5.54; cerci 0.93; left paraproct 1.95, right paraproct 1.98; epiproct 1.40; maximum width of the abdomen at segment 6, including lateral spines: 9.03.

DISCUSSION

Desmogomphus anchicayensis differs from its two described congeners mainly in the dorsal and lateral hooks of the abdomen. *D. tigrivensis* is recognized by a pair of submedian, dorsal hooks, instead of a usual, single, mid-dorsal hook on each of abdominal segments 5 to 7 (BELLE, 1970). Also, the lateral spines begin on segment 6 and the epiproct is as long as the paraprocts. *D. paucinervis* is

more similar to the new species, but the mid-dorsal hooks begin on segment 4, and the lateral spines begin on segment 5 with those on segment 10 not reaching the tip of the epiproct, as in *D. anchicayensis.* The new species also has two special characteristics that are not described in the others: the presence of a beveled edge in the dorsal surface of the prementum and the conspicuous angle in the mesal margins of the paraprocts, surrounded by a thickening; *D. tigrivensis* also has a particular depression in the anteromesal angles of the paraprocts, forming an arch, that is believed to be the entrance of a tube running between the appendages (BELLE, 1970), but this structure is not as it is in *D. anchicayensis.*

The new species is described based on the larval stage because it was the only specimen and stage collected during two years of field work, and presently the area where it was collected is going through an accelerated process of habitat degradation. Further, future field work may be threatened by public order problems of the country that restricts access of researchers to the area.

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EFFECT OF PAPER MILL EFFLUENT ON THE EGG CHORION OF THE DRAGONFLY *ANAX GUTTATUS* (BURMEISTER) (ANISOPTERA: AESHNIDAE)

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The egg of *A. guttatus* is endophytic and is cylindrical with a pointed anterior and a rounded posterior end. The chorion is divided into 2 layers, a thin, outer exochorion and a tough, thick, inner endochorion. The exochorion is modified anteriorly into a collar which is sculptured with 18-20 tiers of rectangular hexagonal impressions. Profound morphological and structural modifications are found in the eggs incubated in paper mill effluent for 5 days. The eggs became distorted due to swelling and the posterior rounded end became angular. The membranous exochorion degraded and transformed into thin, plate-like flakes which are shed, exposing the endochorion. The non-laminated, uniformly thick endochorion is converted into a laminated structure of overlapping plates with uneven thickness. The collar became pitted with minute perforations and started to disintegrate and detach from the egg and the hexagonal impressions became obliterated. 100% mortality was found in paper mill effluent treated eggs for 5 days, whereas eggs kept in pond water only had 10-13% mortality.

INTRODUCTION

The chorion in insect protects the egg from pathogens, predators, mechanical stress and environmental hazards. It allows sperm entry and provides elasticity for easy oviposition. Later, it protects the growing embryo, ensures sufficient oxygen and carbon dioxide exchange and helps in liberation of the larva. The egg chorion is therefore an extensively modified dynamic structure with major taxonomic and functional significance (HINTON 1981; MARGARITIS, 1985).

The structure of the egg and the fine structure of the chorion in insects is greatly modified according to the mode of oviposition (MARGARITIS, 1985). In odonates, the two major type of oviposition observed are endophytic, when the eggs

are inserted in submerged plant tissue, and exophytic, where the eggs are released directly into water (CORBET, 1999). Fine structural studies of the egg chorion in Odonata indicate that there are remarkable structural modifications to accommodate the type of oviposition (MILLER, 1987; TRUEMAN, 1991; SAHLEN, 1995; ANDREW & TEMBHARE, 1992, 1995, 1996, 1997; ANDREW, 2002, 2009; GAINO et al., 2008).

Pollution due to the paper mill industry has a cascading, harmful effect on biotic and abiotic aspects of the environment (SERVOS et al., 1996) and paper mill effluent (PME) is a serious threat to aquatic organisms (SEPULVEDA et al., 2003; ORREGO et al., 2005; POLLOCK et al., 2010). In odonates, PME alters the histochemical and biochemical parameters, modifies developmental patterns and causes histopathological changes at tissue level (SUBRAMANIAN & VARADARAJ 1993; VARADARAJ, et al., 1993; ANDREW et al., 2006a; PRABHU et al., 2008; THANGAVEL et al., 2008). PME causes major structural changes in the egg chorion of the exophytically ovipositing, *Bradinopyga geminata* (ANDREW et al., 2006b). The present paper deals with the effect of PME on the egg shell of *Anax guttatus* which exhibits endophytic oviposition.

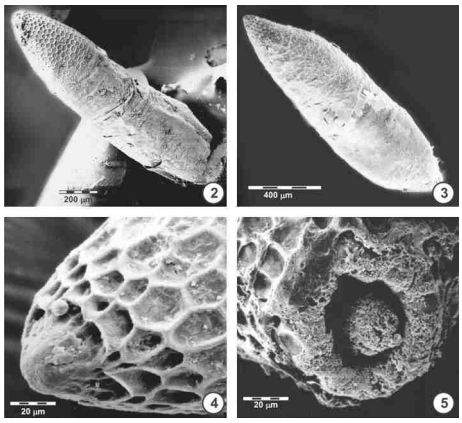
MATERIAL AND METHODS

Gravid *A. guttatus* were collected near small local ponds of Nagpur city (21°10'N, 79°12'E), Maharashtra State, India during the post-monsoon periods (September-November) of 2004-2009. To obtain eggs, ovipositing females were forced to lay eggs by placing them on the surface of filter paper floating on the surface of 500ml beakers filled with water. The female oviposited by inserting the eggs in the filter paper (Fig.1). The eggs were divided into two groups. One group of eggs was placed in petri-dishes containing pond water while the other group was placed in paper mill effluent (PME). After five days, the eggs of both the groups were prepared for scanning electron microscopy (SEM). The eggs were collected by gently teasing the paper with fine-tipped forceps, dehydrated in ethanol, transferred to acetone, air dried, mounted on stubs, coated in a gold-coating unit (E-5200) and examined under a steroscan 250MK II Cambridge scanning electron miscroscope.

Fig. 1. *Anax guttatus* ovipositing endophytically in a beaker filled with water and lined with filter paper.

OBSERVATIONS

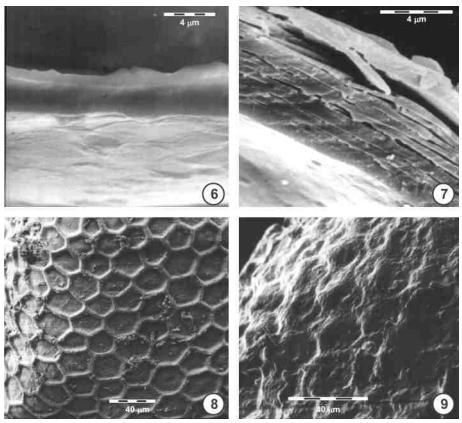
The eggs of *A. guttatus* are cylindrical with a pointed anterior end and a rounded posterior end (Fig. 2). The egg is 1.65+0.5 mm long and 0.35+0.02 mm wide at the mid region. The egg chorion is composed of an outer exochorion and an



Figs 2-5. SEM micrographs of water and paper mill effluent (PME) treated eggs of *Anax guttatus*: (2) five days old egg incubated in normal water; – (3) five days old egg treated with PME. Note the swelling and flaking of the exochorion in the latter; – (4) apical tip of the egg incubated in water; – (5) disintegrating apical tip (pitted with minute perforations) of the egg incubated in PME.

inner endochorion. The exochorion bears 18-20 tiers of distinct hexagonal reticulations. This reticulated region or collar is loosely attached and slips up to cover the anterior tip of the egg. The endochorion is of uniform thickness with faint reticulations at the anterior end. The anterior end bears five micropylar orifices (ANDREW & TEMBHARE, 1997).

Eggs treated with PME showed swelling and the posterior end changed from being rounded to angular (Figs 2, 3). The exochorion showed signs of thinning and became flaky (Figs 3, 5), while the endochorion became uneven and laminated (Fig. 7). The collar, which normally shows distinct hexagonal reticulations (Figs 4, 8), became pitted and started to disintegrate, the reticulation becoming less obvious (Figs 5, 9). The changes are summarized in Table I.



Figs 6-9. SEM micrographs of the chorion of normal and paper mill effluent (PME) treated eggs of *Anax guttatus*: (6) section of normal chorion showing its smooth, non-laminated structure; – (7) section of chorion of PME treated egg showing its laminated structure; – (8) collar of normal egg showing well-developed tiers of distinct hexagonal reticulation; – (9) collar of PME treated egg showing disintegration of the hexagonal reticulations.

DISCUSSION

The physical property of the egg chorion is the result of the chemical stability of the chorion, which in turn depends upon the cross link between the component molecules of the chorion (MARGARITIS, 1985). These properties help to protect the growing embryo from environmental hazards. Ninety five percent of the insect egg chorion is protein, along with traces of organic (carbohydrates, lipids) and inorganic (Calcium,Iron Ca++, Na+, K+) atoms/molecules (PETRI et al., 1976; REIGER et al., 1980, 1982). Disulphide bridges, dityrosine, trityrosine bonds form cross-links between the proteins of the chorion. The chorion is further strengthened through sclerotization by the tanning of quinine (KAWASAKI et al., 1972; PETRI et al., 1976). In the egg chorion of the dragonflies *Sympetrum infuscutum* and *S. frequens*, the disulphide bonds form the major cross-link between protein molecules (KAWASAKI et al., 1972). The present investigation indicates that the paper mill effluent contains compounds that denature the chorion protein, probably by breaking these di-sulphide bridges, as reported in *B. geminata* (ANDREW et al., 2006b).

In the exophytically ovipositing dragonfly *B. geminata,* incubation in PME caused bunching of the naturally spongy exochorion into lobules or granules with a sandy texture (ANDREW et al., 2006b), whereas in *A. guttatus,* the exochorion peels off as small thin flakes and the exochorionic collar becomes pitted with

Table I
Changes in the eggs of *Anax guttatus* induced by incubation in paper mill effluent (PME) for five days

Parameter	Water incubated eggs	PME incubated eggs
Mortality	10-13%	100%
Morphology	Cylindrical with a pointed anterior and rounded posterior end. The egg measures 1.65±0.5mm long and 0.35±0.02 mm wide at the mid region (Fig. 2).	The egg swells and measures 0.62 ± 0.05 in diameter in the mid region. The posterior rounded end becomes angular (Fig. 3).
Exochorion (EX)	Smooth, well developed and thick at anterior end but thinner in the mid region. There is a collar at the anterior end (Figs 2, 4).	The exochorion forms thin, plate-like flakes that are easily shed (Figs 3,5).
Endochorion (EN)	Uniformly thick, non-laminated and unsculptured (Fig. 6).	Forms overlapping plates, develops lamination and exhibits uneven thickness (Fig.7).
Collar	It bears 18-20 tiers of distinct hexagonal reticulations. It is loosely attached and covers the anterior tip (Figs 4, 8).	The collar becomes pitted with minute perforations and starts to disintegrate. The hexagonal reticulation becomes less pronounced (Figs 5, 9).

minute perforations and starts to disintegrate. The endochorion of PME treated *B. geminata* looses its reticulation and develops cracks and tiny holes, whereas in *A. guttatus* it looses its uniform thickness and develops a laminated, overlapping plate-like formation. In *B. geminata* the variation in the intensity of denaturation of the chorion indicates that the exochorion proteins are mostly linked with disulphide bridges, since the intensity of protein denaturation by the PME is more severe in the outer exochorion than in the inner endochorion. A similar cause can also be attributed to the changes in the PME treated eggs of *A. guttatus.*

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ATROCALOPTERYX MELLI OROHAINANI SSP. NOV. ON THE ISLAND OF HAINAN, CHINA (ZYGOPTERA: CALOPTERYGIDAE)

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The new sp. is described from the mountain core of Hainan, southern China, where it usually occurs at altitudes not lower than 300 m asl. It lives on the same type of small, shaded rivers as the nominate ssp. on the continent, and is distinguished by its larger size, slightly less enfumed wings, and a 2.6% difference in the sequence of the barcoding portion of the mitochodrial DNA-cytochrome c oxidase subunit I gene (COI). Holotype ♂: Diaoluoshan mountain, 6-VIII-2011; deposited in the Inst. Hydrobiol., Jinan Univ., Guangzhou. It is argued that this geographically defined ssp. evolved because of persistent poor gene flow with continental populations, caused by the lowland "panhandle" between Hainan and the continent. This barrier was probably functioning equally well during interglacials (like at present) as during pleniglacials (when Hainan was connected to the mainland), because lack of suitable environments (small sized running waters), and dry and cold conditions continued to limit the contact with *A. melli* of the mainland.

INTRODUCTION

The island of Hainan, the southernmost province of China, is well known for its tropical climate, high biodiversity, and high level of endemism in different animal and plant groups. The number of odonate species known from the island currently amounts to 165. Including the taxon described hereinafter, there are 23 endemics (REELS & ZHANG, 2012), with *Pseudolestes mirabilis*, the sole representative of the family Pseudolestidae, the flagship species.

The island is currently separated from the mainland by an 18 km wide sea-strait that became exposed during the most recent pleniglacial, in principle opening up the island to colonization from the mainland. The core of the island is a granit-

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ic mountainous region that represents the geologically oldest part of China. It peaks at 1867 m asl (Wuzhishan mountain), and is covered in tropical rainforest, from which numerous streamlets descend to a number of larger rivers.

Here, we discuss the representative of *Calopteryx melli* that lives on these streamlets, generally beginning around 300 m and with the upper limit still ill-defined. In all, populations are now known from 3 such localities (WILSON & REELS, 2001). It mainly stands out by its size, the significance of which is here tested by sequencing a fragment of a mitochondrial gene (COI) in a comparison involving also several mainland populations. It was originally described by RIS (1912) from Guangdong ("Kwan-Tung"), in a locality named "Tsa Yiu San" (San almost certainly standing for Shan, hill or mountain) and has since been found to occur in several (see below) southern provinces of China. The reasons for moving this

Table I
The eight populations of *Atrocalopteryx melli* included in this study

Date	Site	GPS / Altitude	Location in China
8-VI-2011 24-VII-2011	Dinghushan mountain, Zhao Qing city, Guangdong province	N 23º10'21"; E 112º31'39" / 200 m	South, Continent
6-VIII-2011	Diaoluoshan mountain, Hainan	N 18°43'30.76"; E 109°52'06.12" / 908 m	South Island
8-VIII-2011	Sanyatang mountain, Cong Hua City, Guangdong	N 23° 45' 50.33"; E 113°49'1.15" / 600 m	South, Continent
9-VIII-2011	Chebaling Nature Reserve, Shao Guan City, Guangdong	N 24°40'29"; E 114°09'04" / 450 m	South, Continent
12-VIII-2011	Tian men shan mountain, Yongtai county, Fujian	N 25°49'17.15"; E 119°00'45.20" / 210 m	East, Continent
18-VIII-2011	Lingui Country (near Huaping National Reserve), Guilin City, Guangxi	N 25°32'11.99"; E 110°00'28.23" / 503 m	West, Continent
19-VIII-2011	Qingshitan mountain, Lingchuan County, Guilin City, Guangxi	N 25°30'52.70"; E 110°13'21.05" / 208 m	West, Continent
23-VIII-2011	Baiyunyan mountain, Longquan County, Lishui City, Zhejiang	N 28°06'11.97"; E 119°05'38.45" / 103 m	East-north, Continent

species to the genus *Atrocalopteryx*, created by DUMONT et al. (2007), are found in a paper (GUAN et al., 2012) updating the phylogeny of the Calopteryginae.

MATERIAL AND METHODS

Most material was collected in summer 2011, although visits to the provinces of Guangdong, Guangxi, Fujian, Zhejiang and Hainan had been made since 2008. Animals were collected by netting and preserved in 70% alcohol in the field. In the laboratory, they were stored in a refrigerator until further study, which consisted of measuring the abdomen, wing length, and size of the apical wing spot (a diagnostic feature of the species), and removing pieces of thoracic muscle for DNA extraction.

Table I provides an overview of the populations included in this study, their geographic origin, and the dates of sampling.

DNA studies involved the isolation and sequencing of the barcoding portion of the mitochondrial COI gene, which has been shown to be a marker for relatively shallow phylogenetic relationships (roughly from subspecies to family) in the Odonata. For detailed procedures, from DNA extraction to gene alignments and mathematical manipulations, see BYBEE et al. (2008), DUMONT et al. (2005, 2007, 2010) and WEEKERS et al. (2001). In all, four specimens from four populations were analyzed (see Fig. 2 for origin of these populations).

RESULTS

Figure 1 gives a maximum likelihood estimate of the relationship between the different *melli*-populations, rooted against *Atrocalopteryx oberthueri* as an outgroup. The result convincingly shows three continental populations to cluster closely together, with minimal sequence variation (the specimens sequenced contained only three haplotypes and differed by maximum two base pairs). The island population, in contrast, stood out with an average of 2.6 % sequence difference (19 base substitutions) with the mainland ones.

Tables IIa and b show the result of the measurements and of pairwise t-tests with exact

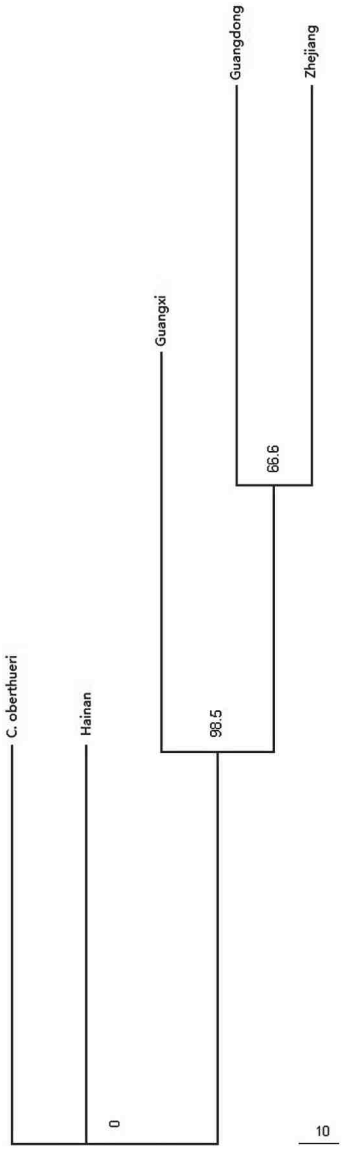

Fig. 1. Estimate of the phylogenetic tree of *Atrocalopteryx melli* (maximum likelihood method, 100 bootstraps, 10 replicas), using *A. oberthueri* from Sichuan, China, as an outgroup.

Table IIa
Values of body lengths in eight *A. melli* populations, means ± SE (cm)

		Body length	Wing width	Wing length	Wing spot
Male	Late Season (n=15)	6.95±0.14	1.44±0.06	4.61±0.11	0.73±0.02
	Mid-Season (n=21)	7.39±0.09	1.43±0.03	4.73±0.06	0.81±0.02
	Hainan (n=6)	7.83±0.09	1.53±0.03	5.02±0.05	0.83±0.04
	Mainland (n=30)	7.10±0.08	1.41±0.03	4.62±0.06	0.77±0.02
Female	Late Season (n=3)	6.38±0.12	1.53±0.03	4.47±0.03	0.90±0.10
	Mid-Season (n=7)	6.76±0.16	1.49±0.02	4.87±0.09	0.87±0.02
	Hainan (n=0)	–	–	–	–
	Mainland (n=10)	6.65±0.13	1.51±0.02	4.75±0.09	0.88±0.03

probabilities of body lengths, wing lengths and maximum width, and size (length) of the apical wing spot in eight populations. It was found that Hainan animals are consistently and significantly taller and have broader wings than mainland ones, but they do not differ in apical wing spot size. The latter is a secondary sexual character, however, and was found to be significantly bigger in females than males.

Atrocalopteryx melli is a species with a long flight period, extending from May till October (with maximum in August), and an effect of season on size and wing spot was also noted.

ATROCALOPTERYX MELLI OROHAINANI SSP. NOV.

Figures 1-2

M a t e r i a l. – **Holotype** ♂: China, Hainan, Diaoluoshan mountain, 6-VIII-2011; deposited (in 70% ethanol) in Inst. Hydrobiol., Jinan Univ., Guangzhou; – **Paratypes** 2♂, same data, deposited in H.J. Dumont collection.

E t y m o l o g y. – The name is a composition of the Greek noun "oros" (= "mountain"), combined with the name of the island, in order to bring out the fact that the animal is restricted to the mountain zone of Hainan.

DESCRIPTION. – Body entirely metallic green, darkening towards tip of abdomen. Legs black. No postocular tubercles. Face metallic green, labrum black with

Table IIb
Pairwise *t*-tests of body measurements in eight *A. melli* populations, with exact P values. Significant probabilities are marked in bold

	Body length	Wing width	Wing length	Wing spot size
Hainan vs Mainland	-4.387 / **0.007**	-7.445 / **0.001**	-5.678 / **0.002**	-1.195 / 0.286
Female vs Male	0.634 / 0.542	-2.788 / **0.021**	-1.497 / 0.168	-3.737 / **0.005**
Early vs Late Season	-2.473 / **0.025**	-0.272 / 0.789	-2.014 / 0.061	-2.252 / **0.039**

two lateral yellow patches. Ligula as in *Calopteryx*. Superior appendices forcipate, *Calopteryx*-like; inferiors straight, markedly shorter than superiors. Wing venation typical for *Atrocalopteryx,* wing apex deep brown, venation brownish, darkened along costal margin of wing but no or indistinct darkened central zone on wings. Total length of holotype 7.9 cm, abdomen 6.6 cm, forewing 5.1 cm.

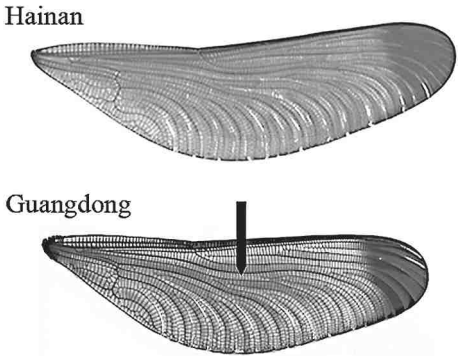

Figure 2. A comparison of the forewings of an insular and a continental *Atrocalopteryx melli* population. The somewhat fuzzy brown spot close to the centre of the wing surface in the continental population is arrowed.

DIFFERENCES WITH *ATROCALOPTERYX M. MELLI* (RIS, 1912). — Morphologically, and apart from the larger size of the insular taxon, no differences could be found, but Hainan animals had clearer wings than mainland ones (Fig. 2). The arrow on the figure indicates a patch of brown colour on the male wings, roughly below the nodus, that is less well expressed in Hainan animals.

DISCUSSION

The above results lead us to conclude that the Hainan population is best ranked as a geographic subspecies to *Atrocalopteryx melli*. *A. m. orohainani* ssp. n. is restricted to the mountain zone of Hainan, where it probably has no genetic contact with other, continental populations. This isolation, emphasized by its specific DNA, is the most important argument to raise it to the level of an endemic taxon. The other characters (size, wing colour), taken alone, could be considered debatable evidence upon which to base such a decision.

The 2.6 % base difference in the COI is tacitly assumed to be representative for the whole genome. This level of difference strongly suggests that the age of the subspecies is much older than the last glacial episode, and probably goes back to the early Pleistocene. During interglacials, rising sea-levels repeatedly created a sea strait between Hainan and the continent, preventing any contact with the mainland, while during pleniglacials, the island would become a peninsula, but colder and drier conditions than today would again prevent the dispersal of such rheophilic organisms across a dry lowland between the mountains of Hainan and the hills of Guangdong province. Consequently, the origin of *A. melli orohainani* must be sought in the generally warm and humid climate during the transition period between the Pliocene and Pleistocene.

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ON THE GENERIC STATUS OF *SCHIZOCORDULIA* MACHADO, 2005 (ANISOPTERA: CORDULIIDAE)

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R.W. GARRISON et al. (2006, *Dragonfly genera of the New World*, Hopkins Univ. Press, Baltimore) synonymized *Schizocordulia* Machado, 2005 with *Aeschnosoma* Selys, 1870, alleging that the characters used to separate them are specific rather than generic. However, a study of the literature revealed that except for size all these characters have always been regarded as generic and therefore *Schizocordulia* is revalidated as a good genus.

INTRODUCTION

Based on a study of 36 specimens including the undescribed female, MACHADO (2005) erected the monotypic genus *Schizocordulia* for *Aeschnosoma rustica* Hagen in Selys, 1871. The following characters were used to separate the new genus from *Aeschnosoma*: (1) bifid male epiproct, (2) long internal branch of hamule, (3) presence of pilose plates on male sternum S7, (4) large female vulvar lamina, (5) genital lobe minute, (6) male membranule with free margin straight and ending distally to the apex of anal triangle. Alleging that the differences observed between *Schizocordulia* and *Aeschnosoma* in characters 1-4 are specific rather than generic, GARRISON et al. (2006) did not accept the new genus that was made synonym of *Aeschnosoma*. This synonymy was followed by CARVALHO et al. (2008) and SCHORR et al. (2010) but not by PINTO & LAMAS (2010) who maintained *Schizocordulia* as a valid genus. In order to define clearly the generic status of *Schizocordulia,* each character used by MACHADO (2005) to separate it from *Aeschnosoma* was analyzed in the literature to know whether they have been used as generic or specific characters.

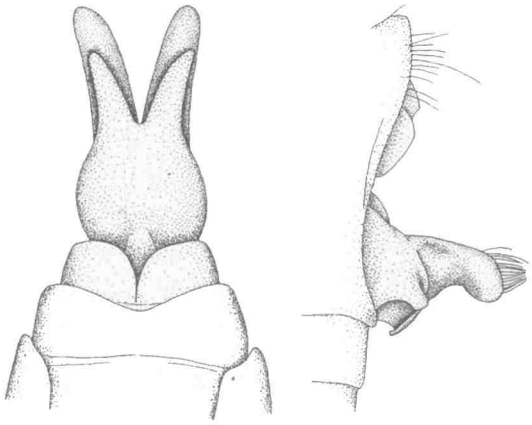
CHARACTER ANALYSIS

(1) THE BIFID MALE EPIPROCT (Fig. 1). – This character was used for the first time as a generic character in the genus *Cordulia* Leach in Brewester, 1815 by SELYS (1840) and since then has been maintained as a good generic character in all the *Cordulia* literature, the most recent references are GARRISON et al. (2006), HECKMAN (2006) and MARINOV & SEIDENBUSCH (2007). The bifid epiproct has been regarded as an unique character of *Cordulia* by GARRISON et al. (2006) but it occurs also in *Schizocordulia* and according to MARINOV & SEIDENBUSCH (2007) it is also an important generic character of their new genus *Corduliochlora*.

(2) LONG INTERNAL BRANCH OF HAMULE (Fig. 2). – The shape of the hamules has been used by GARRISON et al. (2006) as a generic character to separate *Aeschnosoma* from *Neocordulia* and *Rialla*. In *Schizocordulia* (Fig. 2) the hamule is unique in neotropical Corduliidae by having the inner branch extremely high and provided with a brush of long hairs on top (MACHADO, 2005).

(3) PILOSE PLATE ON MALE STERNITE. – The presence of specialized pilose structures on the sternite of S7 has been studied by MACHADO & COSTA (1995) in all genera of Neotropical Corduliidae, except *Paracordulia* and *Schizocordulia*. It is regarded as a good generic character to separate *Navicordulia* from the other Corduliidae genera. It is an unique character of *Navicordulia* and *Schizocordulia*.

(4) LARGE VULVAR LAMINA. – The size and shape of vulvar lamina is the most used generic character in the key to Corduliidae females of GARRISON et al. (2006), appearing in 7 couplets. It is also the main character used by GEIJSKES (1970) and HECKMAN (2006) for generic identification of female Corduliidae. The vulvar lamina was used for the first time as a generic character of Corduliidae by SELYS (1878). Its shape formed by two tapering subtriangular processes is a unique character of *Schizocordulia*.



Figs 1-2. *Schizocordulia rustica* structural characters: (1) epiproct, ventral view; – (2) genitalia of 2nd abdominal segment, lateral view. – [From MACHADO, 2005]

(5) THE GENITAL LOBE. – It has been used by GARRISON et al. (2006) to separate *Lauromacromia* from *Gomphomacromia*. It is minute in *Schizocordulia* (Fig. 2) and well developed in *Aeschnosoma*.

(6) EXTENSION OF THE

MALE MEMBRANULE. – The extension of the male membranule in relation to the apex of the anal triangle has been used as a generic character by GARRISON et al. (2006) and HECKMAN (2006). In *Schizocordulia* it ends distally to the apex whereas in *Aeschnosoma* it ends at the apex.

CONCLUSION

Except for size, all characters used by MACHADO (2005) to separate *Schizocordulia* from *Aeschnosoma* have been previously used as generic characters in Corduliidae, some since a very long time (SELYS, 1840, 1878), some more recently (GEIJSKES, 1979; MACHADO & COSTA, 1995; GARRISON et al., 2006; HECKMAN, 2006). *Schizocordulia* is therefore not a synonym of *Aeschnosoma*, but a valid genus, quite different from it.

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DESCRIPTION OF THE LARVA OF *BOYERIA CRETENSIS* PETERS AND COMPARISON WITH *B. IRENE* (FONSCOLOMBE) (ANISOPTERA: AESHNIDAE)

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B. cretensis larva, endemic to the Mediterranean island of Crete, is described and illustrated from specimens collected at the Mili river near Rethymno in NW Crete, Greece and biometric data are provided from larval stadia F-0 to F-6. Based on a biometric analysis, exuviae of the W Palaearctic *B. cretensis* and *B. irene* have been compared. In respect to some characters only small morphological differences have been found. However, major differences exist in the length of the body, abdomen, cerci, prementum and paraprocts; also in the paraproct-epiproct ratio; this applies to both males and females. Measurements of *B.irene* need to be taken from a wider geographical range to cover the variation in this species; this is discussed.

INTRODUCTION

In Europe, the genus *Boyeria* McLachlan 1896 is represented by two species (DIJKSTRA, 2006). The western Mediterranean *B. irene* (Fonscolombe, 1838) occurs in the south of Europe in Portugal, Spain, France, Italy, Switzerland and Germany. In northern Africa *B. irene* has been recorded in Tunisia, Algeria and Morocco (BOUDOT et al., 2009). *B. irene* is missing in the Balkans probably due to the strong competition with *Caliaeschna microstigma* (HECKER, 1999). The second European species, *B. cretensis* PETERS (1991), is endemic to the Greek island of Crete. Because of specific habitat conditions and the massive human impact, the area of the species currently includes less than 500 km² of the 8300 km² of Crete (LOPAU, 2000; MÜLLER, 2005; SCHNEIDER & MÜLLER,

2006). The species is endangered due to degradation of its breeding sites, mainly due to water extraction for irrigation and tourism. On the island of Crete only small and relatively isolated subpopulations still exist (MÜLLER, 2005; SCHNEIDER & MÜLLER, 2006; MÜLLER, 2008). At the locus typicus, a stream near Fodele 35°22´N 24°57´E, where the type was collected in 1987 (BATTIN, 1989), the species is now extinct.

The identity of *Boyeria* on Crete as a separate species was recognized by PETERS (1991). Previously records of *Boyeria* specimens were interpreted as *B. irene* (Fonscolombe, 1838) by several odonatologists (SELYS & HAGEN, 1850; HAGEN, 1863; COWLEY, 1940; SCHMIDT, 1965; BATTIN, 1989). PETERS (1991) used 50 qualitative and quantitative criteria to distinguish the Cretan *Boyeria* specimens from *B. irene* of western Europe. He focused on the description of the imagines. Further support for relevant differences between *B. cretensis* and *B. irene* came from the different colouration patterns (BOUDOT, 1998). However, the larva of *B. cretensis* has not been described. Here we describe the larva of *B. cretensis* and compare its exuviae to those of *B. irene*.

MATERIAL AND METHODS

All exuviae of *Boyeria cretensis* were collected at the Mili river near Rethymno, Crete, (30°20´N, 24°30´E) during several occasions, i.e. from 05-10 July 2004, 08-12 October 2004, 05-08 October 2005 and 17- 20 April 2006 (leg. O. Müller). Additionally, at the same stream, all larval stadia available from F-0 to F-6 were sampled. Body length, head width and length of hindwing cases of 250 individuals were measured with a micrometer-magnifier and a slide gauge in the field, then the larvae were set free.

For quantitative comparison exuviae of *Boyeria irene* from sampling sites of different localities in Europe and northern Africa were used. The material employed for the measurements originated from France (48°78 N, 3°76 E, leg. B. Kunz, 1988; 44°18 N, 05°18 E, leg. H. Wildermuth, 2003/ 2004; several places between 45°99 and 45°12 N, 06°97 and 00°34 W,, leg. P. Jourde, 1998-2004), Switzerland (46°98 N, 08°32 E, leg. S. Kohl, 1994, 2005, 2007), Sardinia (40°25 N, 9°22 E, leg. B. Kunz, 1990) and Tunisia (36°44 N, 08°42 E, leg. B. Kunz, 2000, 2002).

Table I
Comparison of three parameters of seven larval stadia of *Boyeria cretensis* (mm ± sd)

Character	*F-0*	*F-1*	*F-2*	*F-3*	*F-4*	*F-5*	*F-6*
N	8	22	50	103	28	38	1
Total length	32,2 ±11,63	28,14 ± 2,45	23,37 ± 1,71	18,84 ± 1,80	14,11 ± 1,54	10,66 ± 1,73	9,3 -
Head width	8,31 ± 0,17	6,74 ± 0,24	5,66 ± 0,15	4,74 ± 0,19	3,87 ± 0,15	3,15 ± 0,12	2,71 -
Wingsheath length (hindwing)	9,79 ± 0,25	4,64 ± 0,25	2,64 ± 0,17	1,64 ± 0,13	0,96 ± 0,14	0,61 ± 0,1	0,35 -

All exuviae of *B. irene* and *B. cretensis* were measured with an ocular micrometer in the laboratory. The larval stadia of *B. cretensis* (Tab. I) were measured with a slide gauge in the field. The following characters based on the measurements of exuviae of both *Boyeria* species were quantified and analysed: Total body length, length of hindwing case, length and maximum width of abdomen, length of cerci (inner margin in dorsal view), length of paraproct (inner margin in ventral view), length of epiproct (in ventral view), length of female gynapophyses, length of femur of forelegs, maximum length and width of prementum between the articulations of labial palps.

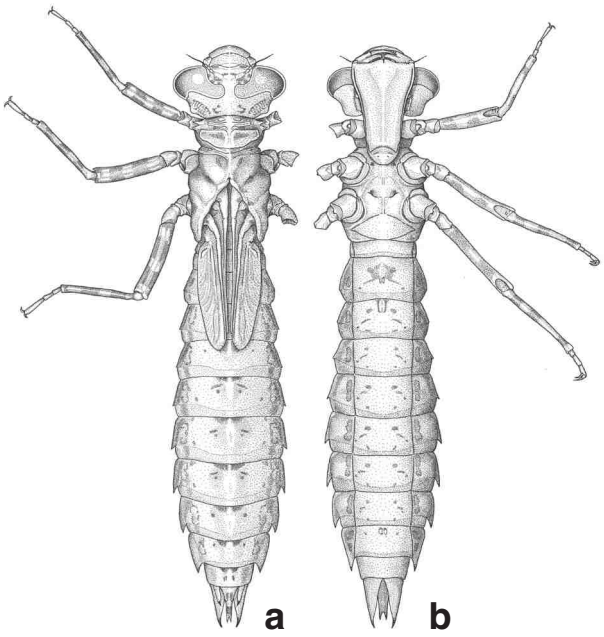

Fig. 1. General features of the final instar of *Boyeria cretensis*: (a) dorsal view; – (b) ventral view.

To test multivariate differences among *Boyeria* species to identify which morphological variables were most useful for discriminating between the two species we conducted a stepwise discriminant analysis. Six variables to describe differences between the two species were considered: (1) total body length, (2) length of prementum, (3) length of abdomen, (4) length of cerci (dorsal view, only the males were compared because of the presence of two types of female cerci in *B. irene*; forma typica versus forma brachycerca, see below, all female exuviae from *B. cretensis* belonged to the forma brachycerca), (5) length of paraprocts (inner margin), and (6) ratio paraproct to epiproct. These variables were selected because they could be rather easily measured and differences could be expected. Box's M statistic was used to test for homogeneity of covariance matrices. The Wilk's lambda test was adopted to test the significance of the differences explained by the discriminant variables. Only statistically significant discriminating variables were retained in the description of the results. In order to verify the test efficiency, a classification matrix test was used to check the number and percentage of correctly classified cases in each group. The student´s t test was used to compare equality of group means. A p value ≤ 0.05 was considered significant. The statistical analyses were performed using SPSS version 17.0 (SPSS Inc.). We applied only exuviae of both species for this multivariate analysis.

BOYERIA CRETENSIS PETERS

Figures 1, 2a, c, e, f, i

The general appearance of the larvae is very similar to that of *B. irene*: body elongated, the colour basically varying between yellowish light brown and dark brown,

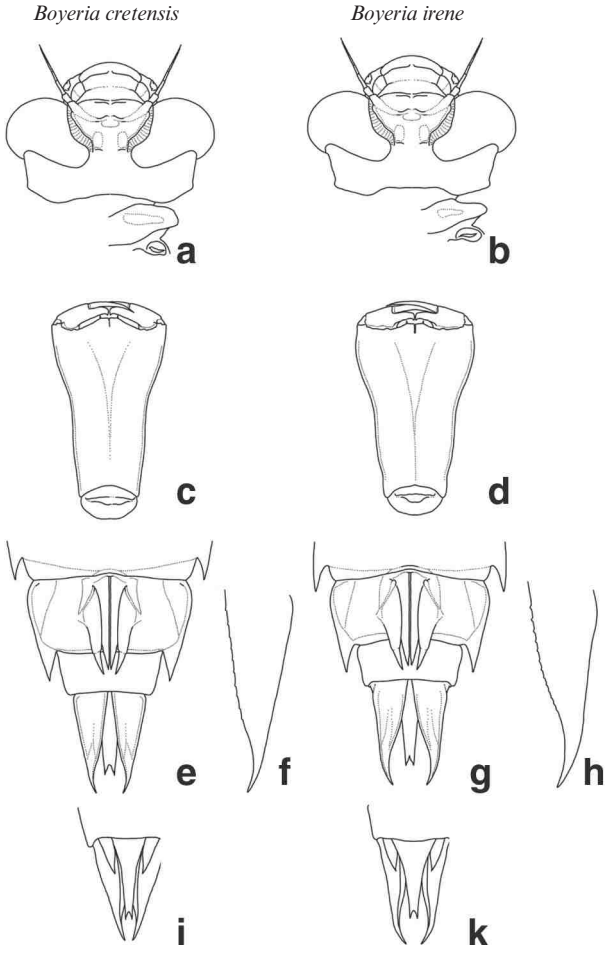

Fig. 2. Discriminating characteristics of *B. cretensis* (a, c, e, f, i) and *B. irene* (b, d, g, h, k): (a, b) dorsal view of head and prothorax; – (c, d) prementum in ventral view; – (e, k) female gonapophyses; – (f, h) shape of the epiproct; – (i, k) female anal appendages in dorsal view.

with well-defined dark pattern (Fig. 1), the whole body sparsely setosed.

H e a d. – Pentagonal, wider than long, the rear edge squared (Fig. 2a), like in other *Boyeria* species. Antennae 7-segmented, all segments nearly cylindrical and only with very short setae, the first two segments strong and short, the third segment being the longest. Prementum long (Fig. 2c), reaching posterior to the second coxae. Apical border of prementum convex, with two short hooks and a dense row of thin setae on each side of a deep median cleft. Labial palps not bent and not pointed, the inner margin finely serrated, movable hooks long and curved inward.

T h o r a x. – The prothoracic processes are pointed and approximately of the same size (Fig. 2a). Wingsheaths reaching to the middle of fourth abdominal segment (Fig. 1a). Legs long, covered with short setae and a small number of long hairs, femora marked with two, and tibiae with three, dark bands.

A b d o m e n (Fig. 1a). – Slender, widest on S6, dorsally convex and ventrally flattened, mid-dorsal spines absent, lateral spines on S5 to S9, gonapophyses of female reaching the middle of S10, epiproct shorter than paraprocts and caudally notched. Cerci conical and shorter than the other anal appendages.

Seven distinct stadia could be separated by comparing the total body length, the head width and the length of the hindwing. The data originate from 250 individuals that were sampled at all sites of the Mili river. All three parameters increased stepwise at each moult (Table 1). The early larval stages younger than F-6 were not observed in October and April during the sampling periods.

DISCRIMINATING CHARACTERISTICS COMPARED TO *BOYERIA IRENE*

The larvae of both *Boyeria* species were homogeneous in a number of basic characters. Nevertheless, *B. cretensis* can be separated from *B. irene* by several morphological characters of the head, the prothorax, the shape and the proportions of the anal appendages as well as female gonapophyses (Fig. 2).

B. irene has a more angular shape of the head with prominent occipital processes, the distal edge of the pronotum being more pointed than in *B. cretensis* (Fig. 2a, b) and the prementum of *B. cretensis* is slightly longer than that of *B. irene* (Fig. 2c, d), resulting in different proportions between width and length of the prementum in both sexes. In contrast to *B. irene*, the female gonapophysis of *B. cretensis* reaches only the middle of the abdominal segment S10 in ventral view (Fig. 2e, g). The paraprocts of *B. irene* are slightly more curved inwards, the inner margins with regular diminutive teeth. In most cases *B. cretensis* has more rudimentary teeth (Fig. 2f, h). Furthermore, both sexes of *B. irene* exhibit shorter epiprocts (Fig. 2i, k; Tab. II).

Females of *B. cretensis* possess uniformly short cerci (forma brachycerca).

Table II
Groups statistics of exuviae (statistical mean ± standard deviation)

Morphology characteristics	*B. cretensis*	*B. irene*
Total body length	♂ 39.93 ± 1,09	37.97 ± 1,45
	♀ 40.69 ± 0,87	39.66 ± 1,26
Length of abdomen	♂ 26.64 ± 0,73	25.41 ± 1,40
	♀ 27.92 ± 1,29	26.70 ± 0,89
Length of cerci (dorsal view of inner margin)	♂ 1.74 ± 0,17	1.90 ± 0,12
Length of prementum	♂ 6.10 ± 0,25	5.65 ± 0,22
	♀ 6.43 ± 0,18	5.90 ± 0,17
Length of paraproct		
(ventral view of inner margin)	♂ 3.39 ± 0,09	3.70 ± 0,20
	♀ 3.47 ± 0,13	3.83 ± 0,18
Ratio paraproct to epiproct	♂ 1.23 ± 0,09	1.34 ± 0,08
	♀ 1.21 ± 0,08	1.32 ± 0,06

Table III
Classification results from discriminant analysis (based on exuviae) with cross validation. Origin: (1) Crete; – (2) elsewhere

	Origin	Predicted Group Membership		Total
		1	2	
Male	1	34	0	34
	2	2	25	27
% of original grouped cases correctly classified				96.7%
Female	1	27	1	28
	2	0	19	19
% of original grouped cases correctly classified				97.9%

BIOMETRICAL ANALYSIS

Group statistics for the six selected variables which are based on the measurements of exuviae are shown in Table II. All variables yielded significant results ($p<0.01$) in tests of equality of group means. The Box's M statistics revealed a significant variance in homogeneity for the selected morphological variables among the groups of the males ($p < 0.01$), whereas no significant variance in homogeneity was found among the groups of the females (0.45). In stepwise analysis, the length of the prementum (Wilk's lambda 0.30, $p < 0.01$) and the length of the paraproct (inner margin) (Wilk's lambda 0.41, $p<0.01$) remain in the final model (Tab. II). The results of the classification extracted by the discriminant analysis indicate that 96.7% (males) and 97.9% (females) of the original grouped cases are classified correctly (Tab. III).

DISCUSSION

The morphometric analysis of several anatomical structures revealed significant statistical differences between the two species. However, even in those with distinctive differences there are some overlapping values at the extremities of the range (outside the 95% CI), indicating that a 100% discrimination between the exuviae of *B. irene* and *B. cretensis* may be problematic. Thus, without knowing the geographic origin, 100% identification of exuviae from *B. cretensis* and *B. irene* may be impossible, even if all the six differentiating characteristics described here are included in the analysis. For the group of males, however, a significant variance in homogeneity for the selected morphological variables was found, and therefore the results have to be interpreted cautiously.

An important limitation of our study is the low number of investigated exuviae. Thus we were not able to compare the differences between different geographic

origins within *B. irene* to the differences of *B. cretensis.* Indeed, the differences between distinct geographic origins within *B. irene* may be greater than those described here between *B. irene* and *B. cretensis*. *B.irene* is widely distributed in Europe (see Introduction). On the contrary, the material of *B. cretensis* comes from a very small territory on the island of Crete. The breeding sites in which *B. irene* develops are manifold. Apart from material sampled in ecologically diverse streams in France and Sardinia, exuviae from a lake in Switzerland were also investigated. The different ecological conditions of various habitats in which the larvae taken for this analysis grew may possibly result in a greater genetic variation.

It would be also of great interest to compare exuviae of *B. cretensis* with those of *B. irene* population from SE of Calabria, which represents geographically the *B. irene* population closest to the *B. cretensis* localities (SCHNEIDER & MÜLLER, 2010).

A female polymorphism regarding the lengths of the cerci was described in *B. irene* (NAVAS, 1919; WENGER, 1959). The two types were called "forma typica" with longer cerci and "forma brachycera" with shorter ones (NAVAS, 1919). The proportion of females with short or long cerci may differ significantly from one river system to the next (MIKOLAJEWSKI et al., 2000). Forma typica were not found in the tunisian or calabrian population so far (KUNZ, 2005; SCHNEIDER & MÜLLER, 2010). Like in tunisian and calabrian populations of *B. irene* all females from *B. cretensis* belonged to forma brachycera.

This is the first description of the larvae and exuviae of *B. cretensis* and the first attempt to compare them descriptively and, in the case of the exuviae, by means of biometrical analysis with those of *B. irene*. Furthermore, genetical analysis may better characterise the status of the Crete endemic *B. cretensis* and elucidate the provenience of the population isolated on the isle of Crete.

CONCLUSION

In a direct comparison it is almost impossible to discriminate between *B. irene* and *B. cretensi* larvae. However, with the help of a magnifying glass the following are the best discriminating characters: *B. irene* has a more angular shape of the head with prominent occipital processes, the distal edge of the pronotum being more pointed than in *B. cretensis* and the prementum of *B. cretensis* is slightly longer than the prementum of *B. irene*. In contrast to *B. irene*, the female gonapophysis of *B. cretensis* reaches only the middle of abdominal segment S10 in ventral view. The paraprocts of *B. irene* are slightly more curved inwards, the inner margins with regular diminutive teeth. Furthermore, both sexes of *B. irene* exhibit shorter epiprocts.

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DESCRIPTION OF THE LAST INSTAR LARVA OF *AMPHIGOMPHUS HANSONI* CHAO, WITH NOTES ON THE SYSTEMATIC STATUS OF THE GENUS *AMPHIGOMPHUS* CHAO (ANISOPTERA: GOMPHIDAE)

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The larva is described and illustrated based on 2 specimens from Fujian province (China), and a comparison with *Nihonogomphus lieftincki* and *Orientogomphus armatus* larvae is provided. Judging from larval morphological characters, the genus *Amphigomphus* is closer to *Orientogomphus* than to *Nihonogomphus*.

INTRODUCTION

The genus *Amphigomphus* was established by CHAO (1954), based on a single male from Fujian, China, under the name of *A. hansoni*. There are three species in this genus up to now, viz.: *A. hansoni*, *A. somnuki* and *A. nakamurai*. They are distributed in China, Thailand and Vietnam, respectively. None of the larvae of *Amphigomphus* species have been so far described, and the opinions on the relationship between *Amphigomphus* and the related genera are different (CHAO, 1954, 1990; HÄMÄLÄINEN, 1996). In the present paper, the last instar larva of *Amphigomphus hansoni* is described and a comparison among the larvae of *A. hansoni, Nihonogomphus lieftincki* and *Orientogomphus armatus* is provided. Based on the comparison of morphological characters of the last instar larvae, the relationship between *Amphigomphus* and the related genera is clarified, and the systematic status of *Amphigomphus* is determined.

AMPHIGOMPHUS HANSONI CHAO, 1954

Figures 1-6

M a t e r i a l. – 2 last instar larvae. China: Fujian Province, Huaan County (24°49'N, 117°45'E), 01-V-2010, Q.-h. Xu leg. Larvae are deposited at Zhangzhou City University in Fujian Province, China.

A medium-sized gomphid larva with a spindle-shaped body as shown in Fig.1.

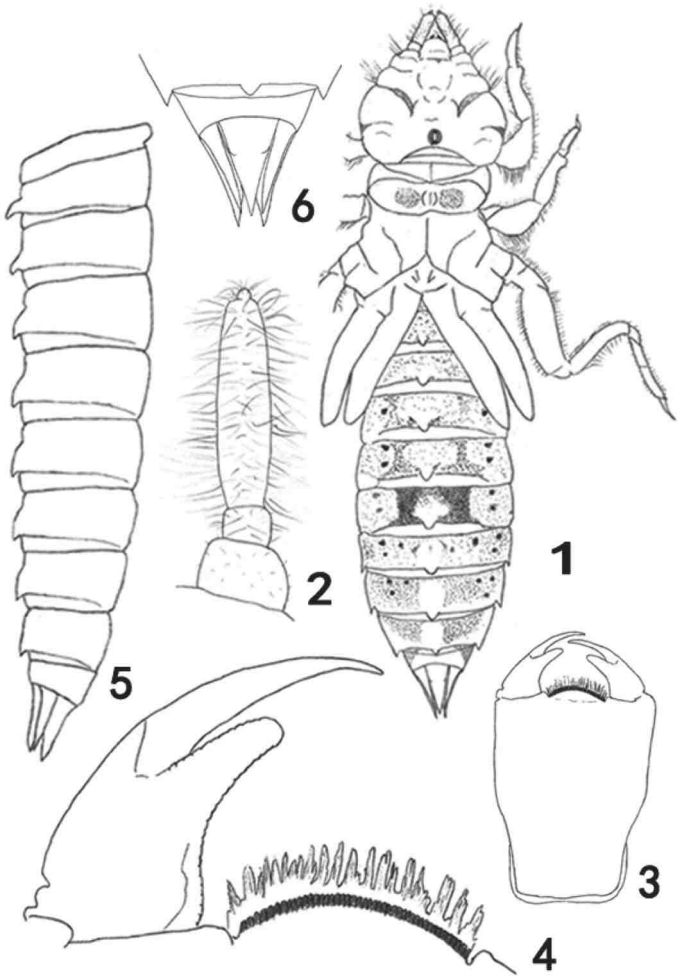
H e a d. – Broad and flat; widest across eyes, which are comparatively large. Postocular lobes protuberant behind. Central occiput with a pair of small kidney-shaped blackish-brown bulges as shown in Fig. 1. Antennae (Fig. 2) with first segment short, wide and cylindrical; second segment nearly square-shaped, about 3/5 width of first segment; third segment slender, stick-shaped, slightly flattened dorso-ventrally and a little upcurved; fourth segment vestigial, knob-like. First antennal segment bears short and sparse hairs; the other three segments bear long and dense hairs. Prementum (Figs 3-4) of large size, longer than wide, in a ratio of 3:2, extending back to the point between procoxae and mesocoxae; median lobe arched in front, furnished with about 40 brownish-black finger-shaped serrations, which bear long brown hairs in clusters; lateral lobes short and robust, broad at base, gradually narrowed toward apex, which is blunt and rounded; its inner margin arched inward, feebly serrulate; the outer margin of end hook also feebly serrulate; movable hook about twice the length of end hook, its apex sharp.

T h o r a x. – Prothorax wider than long, but narrower than head. Anterior lobe raised, located between two postocular lobes, its front margin evenly rounded, posterior margin triangulate; middle lobe wider and bulged upward, with a pair of depressed blackish-brown areas, one on each side of the median tubercle; posterior lobe not developed. Mesepisternum ridged upward markedly, metepisternum bulged largely. Wing cases strongly divergent, tips of hind wing reaching half the length of segment 4. Legs short, end of metafemora barely reaching base of abdominal segment 3; all femora a little curved and laterally compressed; the anterior two pairs moreover somewhat inflated; claws evenly curved, 1/3 length of tarsi.

A b d o m e n. – Broadly lanceolate, ventral surface flat, dorsal surface strongly convex; greatest width across distal margin of segment 5 or at middle of segment 5. Dorsal hooks present on segments 2-9. When viewed in dorsal view, dorsal hook on segment 2 sharply triquetrous, its tip somewhat sharp-pointed; dorsal hooks on segments 3-5 and 8-9 triangulate, their tips blunt; dorsal hooks on segments 6-7 arched backward, their tips rounded. In lateral view (Fig. 5), dorsal hook on segment 2 nearly semi-erect, backwardly directed; remaining dorsal hooks decreasing gradually in height from before backwards, all backwardly directed. Lateral spines present on segments 7-9, their tips backwardly directed, parallel to the longitudinal axis of body. Anal pyramid (Fig. 6) nearly equal in length to

segments 9+10; epiproct and cerci subequal in length; paraprocts longer than the other appendages.

Colour pattern as shown in Figure 1. The larva coloured predominantly with brown or yellowish-brown, marked with dark spots on dorsal abdomen. The dorsal hook on abdominal segment 6 surrounded by a large conspicuous brownish--black marking. The living larva marked also with a touch of light green all over abdomen, especially on ventral surface.



Figs 1-6. Larva of *Amphigomphus hansoni*: (1) general appearance, dorsal view; – (2) antenna, dorsal view; – (3) prementum, ventral view; – (4) lateral lobe and median lobe, ventral view; – (5) abdomen, lateral view; – (6) anal pyramid, dorsal view.

Measurements (mm). – Total length 28.4-30.3, greatest width of head 5.8-6.0, length of metafemur 4.7-5.1, length of abdomen (including caudal appendages) 18.8-19.9, greatest width of abdomen 6.7-7.2, length of hindwing bud 8.2-8.4, length of antennae 3.6-3.8; N = 2.

HABITAT. – Larvae were collected from a small stream which ran through the woods. They were found buried themselves deeply in the sand, at an elevation of ca 950m a. s. l.

DISCUSSION

Regarding the systematic status of the genus *Amphigomphus*, CHAO (1954, 1990) cited Lieftinck's opinion that: "this species had better be regarded as an intermediate type between genus and genus, but should be placed still in *Nihonogomphus*". He (CHAO, 1954, 1990) considered also that the genus *Amphigomphus* was closest to *Nihonogomphus*. HÄMÄLÄINEN (1996) thought, when he described *A. somnuki*, that: "the generic combination of the new species is not straightforward, since it seems to combine characters of the genera *Amphigomphus* Chao 1954 and *Orientogomphus* Chao 1987 as defined in CHAO's (1990: 471) key". KARUBE (2001) described *A. nakamurai*, the third member of the genus, and then pointed out that: "judged by body markings and appendage structure, it seems closer to *somnuki* than to *hansoni*". From the opinions that odonatologists

Table I
A comparison among the larvae of three gomphid dragonfly genera

Structural features	*Amphigomphus hansoni*	*Nihonogomphus lieftincki*	*Orientogomphus armatus*
Third antennal segment	stick-shaped, longer than antennal segments 1+2	stick-shaped, longer than antennal segments 1+2	spindle-shaped, shorter than antennal segments 1+2
Prementum length to width ratio	about 3:2	11:8	about 3:2
Front margin of median lobe	furnished with about 40 finger-shaped serrations	furnished with about 28 square-shaped serrations	furnished with about 60 finger-shaped serrations
Lateral lobe	inner margin arched inward, feebly serrated; outer margin of end hook also feebly serrated	inner margin somewhat parallel to outer margin, furnished with about 14 square-shaped serrations	inner margin arched inward, without any serrations
Wing cases	strongly divergent, tips of hindwing reaching half the length of segment 4	strongly divergent, tips of hindwing reaching distal border of segment 3	strongly divergent, tips of hindwing reaching half the length of segment 4
Dorsal hooks on abdomen	present on segments 2-9	present on segments 2-9	present on segments 2-9
Lateral spines on abdomen	present on segments 7-9	present on segments 2-9	present on segments 7-9

have expressed above, we can see that *Amphigomphus* is close to *Nihonogomphus* and to *Orientogomphus*. But, judging from morphological characters of adults, there are different views as to which genus *Amphigomphus* is closest.

CHAO (1990) has described the larvae of *Nihonogomphus lieftincki* and *Orientogomphus armatus*. In Table I a comparison among the larvae of *Amphigomphus hansoni* and the former two gomphid dragonflies is listed above.

Based on the comparison among the larvae of three gomphid dragonflies listed in Table I, the larva of *A. hansoni* could be distinguished from the other two larvae by front margin of median lobe furnished with about 40 finger-shaped serrations, and by inner margin of lateral lobe and outer margin of end hook all feebly serrulate.

From the comparison table above, we can find that the larva of *Amphigomphus hansoni* is similar to the larva of *Nihonogomphus lieftincki* only in the morphological characters such as third antennal segment, dorsal hooks on abdomen, and to some extent, in the morphological characters such as wing cases, lateral lobe; that the larvae of *Amphigomphus hansoni* shares a high similarity with *Orientogomphus armatus* in the morphological characters such as prementum length to width ratio, front margin of median lobe, wing cases, dorsal hooks on abdomen, lateral spines on abdomen, and to some extent, in the morphological characters such as lateral lobe. Based on the comparison of morphological characters of last instar larvae which belong to three different genera above, we can conclude that the genus *Amphigomphus* is closer to *Orientogomphus* than to *Nihonogomphus*, that is similar to HÄMÄLÄINEN's (1996) opinion on the relationship between *Amphigomphus* and *Nihonogomphus*.

ACKNOWLEDGEMENTS

I am grateful to Dr DO MANH CUONG for his kind help in providing papers necessary for the present study, and to Dr HAO-MIAO ZHANG for his comments on the manuscript.

REFERENCES

CHAO, H-f., 1954. Classification of Chinese dragonflies of the family Gomphidae (Odonata). 4. *Acta ent. sin.* 4(4): 399-426.

CHAO, H-f. [= ZHAO, X.-f.] , 1990. *The gomphid dragonflies of China (Odonata: Gomphidae)*. Sci. & Technol. Publ. House, Fuzhou, Fujian. − [Chin., with Engl. summary and keys].

HÄMÄLÄINEN, M., 1996. Amphigomphus somnuki n. sp. from North Thailand (Odonata: Gomphidae). *Ent. Z*. 106(5): 177-180.

KARUBE, H., 2001. Three new species of Gomphidae from Vietnam (Anisoptera). *Odonatologica* 30(3): 271-279.

ODONATOLOGICAL ABSTRACTS

2000

(18694) ALFRED, J.R.B. & N.. NANDI, 2000. Faunal diversity in Indian wetlands. *ENVIS Newsl. zool. Surv. India* 6(2): 1-3. – (Zool. Surv. India, M-Block, New Alipore, Calcutta-700053, India).
Includes a reference to Epiophlebia laidlawi from hill streams in Darjeeling, W Bengal (India).

(18695) BIRGE, W.J., D.J. PRICE, J.R. SHAW, J.A. STROMBERG, A.J. WIGINTON & C. HOOSTRAND, 2000. Metal body burden and biological sensors as ecological indicators. *Envir. Toxicol. Chem.* 19(4): 1199-1212. – (First Author: Sch. Biol. Sci., Univ. Kentucky, 101TH Morgan Bldg, Lexington, KY 40506-0225, USA).
Mean density (ind/m^2) of 4 odon. fam. at 9 sampling stations on the Big Bayow Creek, McCracken co. (KY, USA) is given in a tab., lower taxa are not stated and no specific reference to the odon. is made in the text.

(18696) KOTENKO, T.I., 2000. The European pond turtle (Emys orbicularis) in the Steppe Zone of the Ukraine. *Stapfia* 69: 87-106. – (Schmalhausen Inst. Zool., Natn. Acad. Sci., Khmelnitsky St. 15, UKR-252030 Kiev).
Larval Coenagrionidae, Lestidae, Aeshnidae and Libellulidae are reported among the diet items of the turtle in the Ukraine.

(18697) TITTIZER, T. & M. BANNING, 2000. Biological assessment in the Danube catchment area: indications of shifts in species composition induced by human activities. *Europ. Water Mngmt* 3(2): 35-45. – (German Federal Inst. Hydrobiol., Kaiserin-Augusta-Anlagen 15-17, D-56068 Koblenz).
The fundamental changes in macroinvertebrate fauna of the German Danube section between Kelheim (river-km 2414) and Jochenstein (river-km 2202) are outlined and reference is made also to the post-1979 situation in the lower courses of the river. In Germany, Gomphus vulgatissimus is presumably recolonising the Danube from the floodplain and the tributaries. The stability and the capability of its populations to regenerate in the Danube remains uncertain. The results from the surveys in the Bulgarian (and partly also the Romanian) Danube show a meaningful decline of the odon. fauna since 1979. Here, the serious reduction in species diversity can be assigned nearly exclusively to higher pollution of tributaries and to effluents from the settlements along the water reach.

2001

(18698) BEREZINA, A.N., 2001. Influence of ambient pH on freshwater invertebrates under experimental conditions. *Russ. J. Ecol.* 32(5): 343-351. [Originally published in Russ. in *Ekologiya* 2001(5): 372-381]. – (Zool. Inst., Russ. Acad. Sci., Universitetskaya nab. 1, St Petersburg-199034, Russia).
In a graph, the average rates are presented of mortality upon a 10-day exposure to acid media (pH 3.0) with different levels of mineralization, viz.: river water, diluted river water and snow melt, for Epitheca bimaculata (30, 40 and 70% resp.) and Libellula depressa (50, 80 and 100% resp.).

(18699) BINDER, H., 2001. Libellen, urtümliche perfekte Flugkünstler. *Studium integrale J.* 8(1): 33-34. – (Author's address not stated).
Based on various works of S.N. Gorb and R.J. Wootton, mobile vein joints, head-arresting system and

other structures facilitating odon. flight are briefly (and somewhat selectively) described and presented with an undertone of the philosophy of creationism (deny of evolution, peculiar ideas on the sequence and age of geological epochs etc.).

(18700) BRÄU, M., M. SCHWIBINGER & F. WEIHRAUCH, 2001. Die Libellenfauna der Stadt München (Odonata). *NachrBl. bayer. Ent.* 50(4): 128-137. (With Engl. s.). – (Third Author: Jägerstr. 21/A, D-85283 Wolnzach).
A commented list of 52 spp. so far recorded within the present limits of the city of Munich, Germany, with more detailed information on 6 spp. of particular interest.

(18701) EDOKPAYI, C.A. & E.C. OSIMEN, 2001. Hydrobiological studies on Ibiekuma river at Ekpoma, southern Nigeria, after impoundment: the faunal characteristics. *Afr. J. Sci. Technol.* (Sci. & Engin.) 2(1): 72-81. – (First Author: Dept Zool., Univ. Lagos, Akoka, Lagos, Nigeria).
The distribution and abundance of 3 Anisoptera fam. at the 3 sampling stations is indicated in a tab.; a list of spp is not provided.

(18702) EFITRE, J., L.J. CHAPMAN & B. MAKANGA, 2001. The inshore benthic macroinvertebrates of lake Nabugabo, Uganda: seasonal and spatial patterns. *Afr. Zool.* 36(2): 205-216. – (First Author: Zool. Dept, Makerere Univ., P.O. Box 7062, Kampala, Uganda).
The lake is located off the western shores of Lake Victoria (alt. 3800 m). The study was conducted during June-Nov. 1997. The odon. larvae abundance (mostly Aeshnidae and Libellulidae) did not vary significantly during the months of study. Odon. were most abundant at 2 of the Vossia cuspidate stations, but none occurred at the water-lily stations and only few were found at a single of the forest edge stations. In the stepwise multiple regression, odon. density was negatively related to conductivity and positively related to percentage of organic matter. A list of spp. is not provided.

(18703) FELLOWES, J.R. et al., [Eds], 2001. Report of rapid biodiversity assessments at Bawangling National Nature Reserve and Wangxia Limestone Forest, western Hainan, 3 to 8 April 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 2: 11+28 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
31 odon. spp. are listed, incl. Drepanosticta zhoui.

(18704) GÜNTHER, A, 2001. Differenzierung von Drohflügen and Balzverhalten verschiedener Rhinocypha-Formen Sulawesis (Indonesien). *Abh. Ber. NaturkMus. Görlitz* 73(1): 25-26. (With Engl. s.). – (Arbeitsgr. Biol. / Ökol. Inst. Biowiss., TU Bergakad. Freiberg, Leipziger Str. 29, D-09599 Freiberg).
Rhinocypha spp. exhibit ritualised threatening flights and specialised courtship behaviour, both of which are closely related to oviposition substrate. The differentiation of this behaviour in several spp. is briefly described and discussed.

(18705) YOURTH, C.P., 2001. *Ecological immunology of lestid damselflies: explaining variation in immune defence against parasitic water mites*. M.Sc. thesis, Dept Zool., Univ. Toronto. ix + 75 pp. ISBN 0-612--63244-X. – (Author's present address unknown).
The predictions of the theory of ecological immunology are tested using variation in immune expression of Lestes congener, L. dryas, L. forcipatus and L. unguiculatus to a generalist parasitic water mite, Arrenurus planus. Immunological responses of the 4 Lestes spp. were compared as they relate to prevalence and intensity of mite infection; these measures of parasitism did not fully explain among-species variation. Within-species variation in immunity of L. forcipatus was related to time of season, but not to host body size or asymmetry, measures of host condition. When L. forcipatus were allowed to respond to Sepahdex beads at a fixed temperature across season, no seasonal pattern in immunity was observed and a positive correlation between condition and immune response in ♂♂ was detected. These results implicate seasonal variation in temperature as being a major factor in determining immune responsiveness of lestids.

2002

(18706) BURCHER, C.L. & L.A. SMOCK, 2002. Habitat distribution, dietary composition and life history characteristics of odonate nymphs in a blackwater coastal plain stream. *Am. Midl. Nat.* 148: 75-89. – (First Author: Dept Biol., Virginia Polytech. Inst. & St. Univ., Blacksburg, VA 24060, USA).
The ecology and life histories of odon. were studied in a headwater, sand-bottomed coastal plain stream in Virginia (USA). Quantitative sampling in sand

and silt sediments, on submerged snags and in debris dams was conducted monthly for 13 months. 6 spp. were common in the stream. Calopteryx maculata had a univoltine life history, whereas Boyeria vinosa, Cordulegaster maculata, Gomphus cavillaris, Hagenius brevistylus and Progomphus obscurus were semivoltine. The odon. were most abundant in debris dams, less abundant in silt and sand sediments and least abundant on snags. Habitat-specific production was 1.3 g m^{-2} y^{-1} in debris dams and 0.1-0.3 g m^{-2} y^{-1} in the sand, silt and snag habitats. The production to biomass ratio (P/B) for Calopteryx was 5.9, whereas ratios for semivoltine spp. ranged from 2.0-4.0. Analysis of overlap in the use of habitat, food and time showed that greatest ecological separation of the spp. was in their different use of habitat. B. vinosa and C. maculata primarily inhabited debris dams, H. brevistylus and G. cavillaris were most abundant in silt and P. obscurus was found almost exclusively in sand. C. maculata occurred throughout the stream except on snags. Narrow niche breadths for B. vinosa, C. maculata and P. obscurus based on their use of habitat suggest high fidelity of these spp. to one habitat, whereas C. maculata, with the broadest habitat niche breadth, was a habitat generalist. There was little difference among the spp. in prey items. Trophic niche breadths of all spp. were broad, all spp. feeding on a wide variety of invertebrates, in particular Chironomidae, Ephemeroptera and Plecoptera. Little ecological separation of the spp. occurred based on their use of time, all spp. occurring in the stream throughout the year with little staggering of life history events or growth patterns. Seasonal patterns of changing resource availability and the dynamic nature of the stream environment likely are important in regulating the distribution, abundance and interactions of the odon. community in this stream.

(18707) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Qixingkeng Nature Reserve, Southwest Guangdong, 29 April to 1 May and 24 November to 1 December 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 4: ii + 22 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
Commented records of 38 odon. spp.

(18708) FELLOWES, J.R. et al., [Eds], 2002. Report of a rapid biodiversity assessment at Yangchun Baiyong Nature Reserve, Southwest Guangdong, 3 May 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 5: ii + 14 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 10 odon. spp.

(18709) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Heweishan Forest Farm, Nature Reserve, Southwest Guangdong, 4 to 5 May 1999. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 6: ii + 15 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 16 odon. spp.

(18710) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Dinghushan Biosphere Reserve, western Guangdong, 1998 and 2000. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 7: ii + 24 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
6 odon. spp. were recorded during the survey, and the complete list of the fauna is presented, based on K.D.P. Wilson (1999, *Int. J. Odonatol.* 2/1: 23-53). Cephalaeschna dinghuensis is endemic to Dinghushan.

(18711) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Qinglongshan Headwater Forest Nature Reserve, Southwest Guangxi, China, 24 May 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 8: ii + 8 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
Commented records of 4 odon. spp.

(18712) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Chunxia Headwater Forest Nature Reserve, Southwest Guangxi, China, 24 May 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 9: ii + 9 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 16 odon. spp.

(18713) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment of Nonggang National Nature Reserve, Southwest Guangxi, China, 19 to 27 May 1998. *Sth China Forest Biodiv. Rep.*

Ser. (Online simplified Version) 10: ii + 34 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 62 odon. spp., among which that of Dysphaea basitincta is a new record for mainland China and Euphaea superba is a new record for China. Both spp. were originally described from Vietnam.

(18714) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Fusui Rare Animal Nature Reserve, Southwest Guangxi, China, 1998 and 2001. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 12: ii + 12 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 24 odon. spp.

(18715) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Mulun National Nature Reserve, North Guangxi, China, 18 to 23 July 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 13: ii + 26 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 37 odon. spp.

(18716) FELLOWES, J.R. et al., [Eds], 2002. Report of a rapid biodiversity assessment at Jiuwanshan Headwater Forest Nature Reserve, North Guangxi, China, 24 to 27 July 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 14: ii + 18 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 24 odon. spp.

(18717) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Maoershan Nature Reserve, Northeast Guangxi, China, 1998 and 2001. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 16: ii + 20 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 31 odon. spp. Boyera sinensis has not been reported previously from Guangxi.

(18718) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Dayaoshan National Nature Reserve, East Guangxi, China, 1998 and 2001. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 18: ii + 29 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 33 odon. spp.

(18719) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Dapingshan Headwater Forest Nature Reserve, East Guangxi, China, 24 to 27 September 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 19: ii + 15 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 10 odon. spp. Boyeria sinensis, restricted to Guangxi and Sichuan, is of potential conservation significance.

(18720) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Xidamingshan Headwater Forest Nature Reserve, Southwest Guangxi, China, 15-17 October 1998. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 20: ii + 15 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
15 odon. spp. are recorded from Xidamingshan.

(18721) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessments at Tongtieling Forest area and Kinglung Tropical Botanic Garden, Southeast Hainan, China, 22-23 May 1999. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 22: ii + 18 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
17 odon. spp. are recorded from Tongtieling, and 10 spp. from Xinglong. Pseudagrion australasiae is the first record from China.

(18722) FELLOWES, J.R. et al., [Eds], 2002. Report of rapid biodiversity assessment at Diaoluoshan National Forest Park, Southeast Hainan, China, 23-28 May 1999. *Sth China Forest Biodiv. Rep. Ser.* (Online simplified Version) 23: ii + 27 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hong Kong, SAR, China).
Commented records of 35 odon. spp., incl. 5 at that time still undescribed taxa.

(18723) HART, E.A. & J.R. LOVVORN, 2002. Interpreting stable isotopes from macroinvertebrate foodwebs in saline wetlands. *Limnol. Oceanogr.* 47(2): 580-584. – (Dept Zool., Univ. Wyoming, Laramie, WY 82071, USA).

Stable-isotope ($\delta^{13}C$ and $\delta^{15}N$) and gut-content analyses of macroinvertebrate foodwebs in saline wetlands of the Laramie Basin, Wyoming (USA) were compared. Standard assumptions of stable-isotope fractionation between trophic levels (<1‰ for $\delta^{13}C$, mean of 3.4‰ for $\delta^{15}N$) suggested that Enallagma spp. larvae consumed mainly amphipods. However, the guts of zygopterans contained no amphipods but rather a mix of chironomid larvae and zooplankton. In all wetlands the Enallamga gut contents indicated that they were secondary consumers (trophic level 3), but enrichment of $\delta^{15}N$ between them and their prey ($\Delta\delta^{15}N$) varied from 1 to 3.4‰ between wetlands. In other studies, such variation in $\Delta\delta^{15}N$ has been interpreted to mean that food-chain length differed between aquatic systems. Alternative interpretations of variable ^{15}N enrichment, namely, varying C : N ratios in food, differential enrichment between consumer species, and habitat-specific variation if $\delta^{15}N$ at the base of the foodwebs are reviewed. It is suggested that variation in the timing and rates of nitrogen cycling can affect measured $\Delta\delta^{15}N$ both within and between foodwebs. For aquatic macroinvertebrates, it is urged that stable isotopes be supplemented with independent observations to avoid incorrect conclusions about trophic pathways, trophic levels, and food-chain lengths in different ecosystems.

(18724) NAGORSKAYA, L., M. MOROZ, T. LAENO, V. VEZNOVETZ, E. MOLLER PILOT, K.-D.B. DIJKSTRA & M. REEMER, 2002. *Macrofauna in floodplain pools and dead branches of the Pripyat river, Belarus*. Inst. Zool., NAS Belarus, Minsk. 157 pp. – (First Author & Publishers: Inst. Zool., Natn. Acad. Sci. Belarus, 27 Akademicheskaya, BY-220072 Minsk)

43 odon. spp. are recorded from the sample sites as well as from the river and bogs on either side of the studied gradient. The fauna of different habitat types is analysed.

2003

(18725) MUKHTAR, M., N. HERREL, F.P. AMERAINGHE, J. ENSINK, W. VAN DER HOEK & F. KONRADSEN, 2003. Role of wastewater in mosquito breeding in South Punjab, Pakistan. *SEast asian J. trop Med. publ. Health* 34(1):72-80. – (Last Author: Dept Int. Health, Univ Copenhagen, Copenhagen, Denmark).

"Agrion" sp. and Pantala flavescens are reported breeding in agricultural area irrigated with untreated urban wastewater around the city of Haroonabad in the Bahawalnaga distr., Punjab prov.

(18726) WONG, A., M.L. SMITH & M.F. FORBES, 2003. Differentiation between subpopulations of a polychromatic damselfly with respect to morph frequencies, but not neutral genetic markers. *Mol. Ecol.* 2003: 9 pp. – DOI: 10.1046/j.1365-294X.2003.02002.x – (Dept Biol., 209 Nesbitt Bldg, Carleton Univ., 1125 Colonel By Dr., Ottawa, ON, K1S 5B6, CA).

Nehalennia irene has 2 distinct ♀ colour morphs. Individuals of one morph have ♂-like colouration and pattern (androchromes), whereas gynochromes are different from ♂♂ and androchromes in these respects. In several zygopterans, such ♀-limited polychromatism is attributable to a single genetic locus. Here, 6 polymorphic genetic markers were developed, which were codominant to test for genetic differentiation in N. irene, collected from 2 sites located 8 km from one another in eastern Ontario, Canada. Based on 3 censuses spanning a 10 yr period (1992-2001), morph ratios differed consistently and significantly between these 2 sites. However, subpopulations at these sites were not genetically differentiated with respect to the putatively neutral markers. These results suggest that site differences in morph ratios of ♀ N. irene cannot be explained by genetic drift, but are consistent with spatially variable selection operating on different morphs, perhaps mediated by ♂ density. Alternatively, morph type may be a plastic trait and cues for induction may differ between sites.

2004

(18727) PATRZICH, R., 2004. *FFH-Artengutachten der Anhang II. Art der FFH-Richtlinie: Grosse Moosjungfer (Leucorrhinia pectoralis Charpentier, 1825)*. Ges. angew. Regionalentwicklung & Landschaftsökol., Giessen. 11 pp. – (Ludwigstr. 72, D-35392 Giessen).

On the status of, and the conservation measures required for L. pectoralis in the state of Hessen (Germany).

(18728) WASHITANI, I., 2004. Invasive alien species problems in Japan: an introductory ecological essay. *Global envir. Res.* 8(1): 1-11. – (Inst. Agric. & Life Sci, Univ. Tokyo, Yayoi, Bunkyo-ku, Tokyo, 113-8657, JA).

Status of invasive alien (plant and animal) spp. problems in Japan is briefly summarized, with emphasis on the invasions after the 1960s. Reference is made to some sunfish spp., native to N America, which have been repeatedly released into lakes and ponds and have explosively multiplied, including largemouth bas, Micropterus sp., known to prey on odon. The fish was reported in the early 1970s from 23, but it now occurs in all 49 prefectures.

2005

(18729) BROCKHAUS, T., 2005. Verbreitung und Schutz in Mooren lebender Libellen in Sachsen (Insecta: Odonata). *Telma* 35: 111-122. (With Engl. s.). – (An der Morgensonne 5, D-09387 Jahnsdorf/Erzgebirge).
On distribution and conservation of odon. in the bogs of Saxony (Germany): Coenagrion hastulatum, Nehalennia speciosa, Aeshna juncea, A. subarctica, Somatochlora alpestris, S. arctica, S. flavomaculata, Leucorrhinia albifrons, L. caudalis and L. pectoralis.

(18730) DAYTON, G.H., D. SAENZ, K.A. BAUM, R.B. LANGERHANS & T.J. DeWITT, 2005. Body shape, burst speed and escape behavior of larval anurans. *Oikos* 111(3): 582-591. – (First Author: Sect. Ecol. & Evol. Biol., Dept Wildl. & Fish. Sci., Texas A & M Univ., Tamus 2258, College Station, TX 77843--2258, USA).
In performance tests, Scapiophus holbrookii tadpoles (habitat: ephemeral pools) were more active, had slower burst speeds and were more susceptible to predation by Anax junius larvae than Rana sphenocephala tadpoles (habitat: more permanent aquatic sites). The amphibians used in experiments were reared from eggs collected in nature.

(18731) HOGSDEN, K.L. & R.D. VINEBROOKE, 2005. Environmental predictors of benthic consumers and autotrophic communities along a recovery gradient. *Can. J. Fish. aquat. Sci.* 62: 2226-2239. (With Fr. s.). – (Freshw. Biodiv. Lab., Dept Biol. Sci., Univ. Alberta, Edmonton, AB, T6G 2E9, CA).
The research was conducted at 6 lakes in Killarney Provincial Park, SW of Sudbury, Ontario, Canada. The coenagrionid, gomphid and libellulid larvae occurred in stressed (mean pH 5.43) as well as in recovering lakes (mean pH 6.42).

(18732) MOISEENKO, T.I., 2005. Effects of acidification on aquatic ecosystems. *Russ. J. Ecol.* 36(2): 93-102. Originally published in Russian in *Ekologiya* 2005(2): 110-119. – (Inst. Water Problems, Russ. Acad. Sci., Gubkina 3, Moscow-119991, Russia).
Effects of acidification on aquatic ecosystems are analysed on the basis of an analytical synopsis of relevant literature. Great numbers of odon. larvae were found in acid lakes in Sweden, which could be perhaps attributed to the reduced pressure of predation by trout and other insectivorous fishes (F. Eriksson et al., 1983, *Hydrobiologia* 101: 145-164).

(18733) RUTHERFORD, J.C. & B.J. KEFFORD, 2005. *Effects of salinity on stream ecosystems: improving models for macroinvertebrates*. CSIRO Land and Water Technical Report 22/05, Canberra. iii+64 pp. – (Postal addresses not provided).
The majority of Australian Odon. only occur below 10-15 g/l^{-1}, but Austrolestes annulosus at 30 g/l^{-1}. A summary of maximum salinity tolerance, estimated from field observations, is presented for 19 odon. spp. – (For 9 Victoria spp., see *OA* 7821).

(18734) STRATZ. C., H. SCHLUMPRECHT, W. POTRYKUS & K. FROBEL, 2005. Veränderungen der Libellenfauna im Obermaintal: Vergleich zwischen 1979 und 2003. *Ber. naturf. Ges. Bamberg* 77: 145-186. – (First Author: Büro ökol. Stud., Oberkonnersreuther Str. 6/A, D-95448 Bayreuth).
A very detailed study and analysis of changes in odon. fauna of the Obermaintal, i.e. a locality in the distr. of Bamberg, Oberfranken, Bavaria (Germany) that have taken place following the restoration.

(18735) TENNESSEN, K.J., 2005. The larvae of Enallagma davisi Westfall and E. recurvatum Davis (Odonata: Coenagrionidae). *Jl N. Y. ent. Soc.* 113(3/4): 205-211. – (125 N Oxford St., Wautoma, WI 54982, USA).
Larvae of E. davisi and E. recurvatum have round gill tips similar to E. minusculum but final stadia are significantly larger (total length 11.4-13.8 mm for davisi and recurvatum combined vs. 9.5-9.7 mm for minusculum) and the lateral carinae of abdominal segments 2-7 have distinct stout setae. The prementum of E. davisi (length 1,85-2.30 mm, width 1.56-1,80 mm; n = 10) is slightly larger than that of E. recurvatum (length 1.75-1.85 mm, width 1.48-1.53 mm; n = 5). The cerci of E. davisi in lateral view are wider than long in ♂♂ and about as wide as long in ♀♀; in E. recurvatum the cerci are longer than wide in both sexes.

2006

(18736) FAUCHEUX, M., 2006. Les organs sensioriels larvaires de libellules: les propriocepteurs et les vibrorécepteurs d'Erythromma lindenii (Selys, 1840) (Odonata: Zygoptera: Coenagrionidae). *Bull. Soc. Sci. nat. Ouest Fr.* (S.N.) 28(3): 153-159. (With Engl. s.). – (70 blvd Robert Schuman, F-44300 Nantes).
E. lindenii larval antennae are short and made up of a scape, a pedicel and a 4-segmented flagellum. They bear 4 types of aporous and exclusively mechanoreceptive sensilla: spatula-shaped sensilla chaetica, curved sensilla chaetica, sensilla filiformia and sensilla campaniformia. The curved sensilla chaetica are proprioceptors which monitor the relative position of the 3rd and 4th flagellomeres. Sensilla filiformia are vibration receptors which play the major role in prey detection. The unique sensillum campaniformium on the pedicel is a proprioceptor which informs the larva on the position of the flagellum relative to the pedicel. Spatula-shaped sensilla chaetica are tactile receptors distributed on the scape and the pedicel. No chemoreceptive sensilla have been observed on the antennae.

(18737) HOGSDEN, K.L. & R.D. VINEBROOKE, 2006. Benthic grazing and functional compensation in stressed and recovered lakes. *Can. J. Fish. aquat. Sci.* 63: 1999-2010. (With Fr. s.). – (Freshw. Biodiv. Lab., Dept Biol. Sci., Univ Alberta, Edmonton, AB, T6G 2E9, CA).
The study was conducted at the same 6 lakes and the information presented on odon. is the same as mentioned in *OA* 18731.

(18738) HUANG, K.-Y., Y.-S. LIN & L. LIU SEVERINGHAUS, 2006. Comparison of three common methods for studying the diet of nestlings in two Accipiter species. *Zool. Stud.* 45(2): 234-245. – (Res. Cent. Biodiv., Acad. Sinica, Taipei, Taiwan).
The efficiency of the methods of direct observation and the analysis of prey remains and pellets are compared. In Yanmingshan National Park (Taiwan), Anotogaster sieboldii was identified only in prey remains of A. virgatus.

(18739) KEFFORD, B.J., D. NUGEGODA, L. METZELING & E.J. FIELDS, 2006. Validating species sensitivity distributions using salinity tolerance of riverine macroinvertebrates in the southern Murray-Darling Basin (Victoria, Australia). *Can. J. Fish. aquat. Sci.* 63: 1865-1877. (With Fr. s.). – (First Author: Biotechnol. Envir. Biol., Sch. Appl. Sci., RMIT Univ., P.O. Box 71, Bundoora-3083, Vic., AU).
A rapid toxicity testing method was used to determine the acute salinity tolerance (72 h LC_{50}) values, i.e. concentration of salinity lethal to 50% of individuals of 11 odon. spp. Salinities that reduced growth of the salt-tolerant Ischnura heterosticta also induced chronic mortality. (See also *OA* 16351).

(18740) KIM, D.G., J.W. YUM, T.J. YOON & Y.J. BAE, 2006. Effect of temperature on hatching rate of Nannophya pygmaea eggs (Odonata: Libellulidae). *Korean J. appl. Ent.* 45(3): 381-383. (Korean, with Engl. s.). – (Last Author: Coll. Life Sci. & Biotechnol., Korea Univ., Seoul-136-701, Korea).
The eggs were obtained from ♀♀ inhabiting a small wetland in Mangyong-si, Kyeongsangbuk-do, Korea, in July and hatching was examined under laboratory conditions at 10º, 15º, 20º, 25º and 30ºC. The hatching rates were 83, 89 and 76% at 20º, 25º and 30ºC, respectively. No eggs hatched at 10º and 15ºC during the study period, lasting 100 days. The derived thermal egg hatching threshold was 14.3ºC, which is relatively higher than in other temperate zone dragonflies.

(18741) LÖNS, H., 2006. *Wasserjungfern und andere Insektengeschichten* […]. Loensia-Verlag, Ascheberg-Herbern. 235 pp. Hardcover (15.0 × 20.5 cm). ISBN 3-9809324-1-9. – (Owner of the publishing house recently deceased and the entire publication stock was apparently discarded).
This is the recentmost edn of this classical, apparently very popular work, of which ca 22 edns had appeared between 1918 (1919) and 1986, some of them simultaneously with different publishers. Author born 1866, deceased 1916. The *Wasserjungfern* contains 13 belles-lettres stories, covering 22 spp., using the taxonomic nomenclature of R. Tümpel's *Die Geradflügler Mitteleuropas* (1898, subsequent edns in 1907 and 1922; see E. Schmidt, 1957, *Ent. Z.* 67: 202-209). In the present edn, the history of the work is outlined (without reference to the 1985 and 1986 edns), incl. the reproduction of some of the related Author's correspondence, and most of the earlier edns are described. The text in all of these is identic, save for the 2 edns of 1953, where the *Abstractor* has noticed the last paragraph, appearing on p. 12-(13) of the first edn, has been removed by the censor, considering probably its contents being

unfit for reproduction close after WWII. The recent edn contains also the reproductions of all other Author's entomological publications, incl. 2 articles on dragonflies, published originally in 1909 and 1911, respectively. An outline of Author's biography and an appreciation of his work are also provided.

(18742) PARK, H.-H. & J.-H. LEE, 2006. Arthropod trophic relationship in a temperate rice ecosystem: a stable isotope analysis with $\delta^{13}C$ and $\delta^{15}N$. *Envir. Ent.* 35(3) 684-693. – (Second Author: Ent. Progr., Sch. Agric. Biotechnol., Coll. Agric. & Life Sci., Seoul Natn. Univ., San 56-1, Shillim-dong, Gwank-gu, Seoul, 151-921, Korea).
The "Aeshnidae" and Lestes sp. carbon and nitrogen stable isotope ratios are reported from a rice field in Dangsu-dong (Korea), as identified during the rice--growing seasons of 2000 and 2001.

(18743) PATRZICH, R., 2006. *Untersuchungen 2004 zur gesamthessischen Situation der Grünen Keiljungfer Ophiogomphus cecilia (Art der Anhänge II und IV der FFH-Richtlinie)*. Ges. angew. Regionalentwicklung & Landschaftsökol., Giessen. 16 pp. – (Ludwigstr. 72, D-35392 Giessen).
On the 2006 status of, and the conservation measures required for O. cecilia in the state of Hessen (Germany).

(18744) POOPATHI, S. & B.K. TYAGI, 2006. The challenge of mosquito control strategies: from primordial to molecular approaches. *Biotechnol. mol. Biol. Rev.* 1(2): 51-65. – (Second Author: Cent. Res. Med. Ent., Chinna Chokkikulam, Madurai-625002, Tamil Nadu, India).
Brachythemis contaminata larvae have a good predatory potential against Anopheles stephensi, A. aegypti and Culex quinquefasciatus and can be used as a biological control agent for control of mosquito breeding.

(18745) RAJAKALLIO, R., 2006. *Parikkalan Pien--Rautjärven Natura 2000 – kohteiden sudenkorenotkartoitus (Odonata) kesällä 2006*. Luonnonlumo Tmi Rajakallio, Lokakuu. 18 pp., 4 figs excl. (Finn.). – (Author's postal address not stated).
[Engl. translation of title and abstract not provided.]

(18746) REINHARDT, R., 2006. Nachtrag der sächsischen entomofaunistischen (odonatologischen) Bibliographie (bis zum Jahre 1999) nach Erscheinen der Libellenfauna Sachsens. *Mitt. sächs. Ent.* 73: 41-42. – (Burgstädter Str 80/A, D-09684 Mittweida).
Additions (1788-1999) to the Saxonian (Germany) odonate bibliography, as published in the work listed in OA 15845.

2007

(18747) ARTHUR, J., 2007. Dragonfly summer. *Kingfisher*, Audubon, Minneapolis 56(4A): 1-2. – (Audubon Minneapolis Chapter, P.O. Box 3801, Minneapolis, MN 55403, USA).
Personal recollections of an outdoor and indoor dragonfly season.

(18748) CHERTOPRUD, M.V. & K.V. PESKOV, 2007. The rithral macrobenthos community biogeography of southeastern Europe. *Zh. obshch. Biol.* 68(2): 52-63. (Russ., with Engl. s.). – (Dept Hydrobiol., Fac. Biol., Moscow Lomonosov St. Univ., Leninskiye Gory, Moscow-119992, Russia).
The rithral and hypocrenal macrozoobenthos fauna of small, rapid streams of northern Greece, eastern Carpathians, montane Crimea and NW Caucasus is analysed based on original material. 10 odon. spp. were considered, but Cordulegaster boltonii is the only sp. mentioned (Greece, Carpathians, Caucasus).

(18749) CUFFNEY, T.F., M.D. BILGER & A.M. HAIGLER, 2007. Ambiguous taxa: effects on the characterization and interpretation of invertebrate assemblages. *Jl N. Am. benthol. Soc.* 26(2): 286-307. – (First Author: US Geol. Surv., 3916 Sunset Ridge Rd, Raleigh, NC 27607, USA).
Damaged and immature specimens often result in macroinvertebrate data that contain ambiguous parent-child pairs (i.e., abundances associated with multiple related levels of the taxonomic hierarchy such as Argia [sp.1] and the associated ambiguous parent Argia sp.). The choice of method used to resolve ambiguous parent-child pairs may have a very large effect on the characterization of invertebrate assemblages and the interpretation of responses to environmental change because very large proportions of taxa richness (73-78%) and abundance (79-91%) can be associated with ambiguous parents. To address this issue were here examined 16 variations of 4 basic methods for resolving ambiguous taxa: RPKC (remove parent, keep child), MCWP (merge child with parent), RPMC (remove parent or merge child with parent depending on their abundances), and DPAC (distribute parents among children). The

choice of method strongly affected assemblage structure, assemblage characteristics (e.g., metrics), and the ability to detect responses along environmental (urbanization) gradients. All methods except MCWP produced acceptable results when used consistently within a study. However, the assemblage characteristics (e.g., values of assemblage metrics) differed widely depending on the method used, and data should not be combined unless the methods used to resolve ambiguous taxa are well documented and are known to be comparable. The suitability of the methods was evaluated and compared on the basis of 13 criteria that considered conservation of taxa richness and abundance, consistency among samples, methods, and studies, and effects on the interpretation of the data. Methods RPMC and DPAC had the highest suitability scores regardless of whether ambiguous taxa were resolved for each sample separately or for a group of samples. Method MCWP gave consistently poor results. Methods MCWP and DPAC had the highest suitability scores regardless of whether ambiguous taxa were resolved for each sample separately or for a group of samples. Method MCWP gave consistently poor results. Methods MCWP and DPAC approximate the use of family-level identifications and operational taxonomic units (OTU), respectively. These results suggest that restricting identifications to the family level is not a good method of resolving ambiguous taxa, whereas generating OTUs works well provided that documentation issues are addressed.

(18750) KIM, K.-G., S.K. JANG, D.W. PARK, M.Y. HONG, K.-H. OH, K.Y. KIM, J.S. HWANG, J.S. HAN & I. KIM, 2007. Mitochondrial DNA sequence variation in the Tiny dragonfly, Nannophya pygmaea (Odonata: Libellulidae). *Int. J. industr. Ent.* 15(1): 47-58. – (Last Author: Coll. Agric. & Life Sci., Chonnam Natn. Univ., Gwangju-500-757, Korea).
A portion of mitochondrial COI gene, corresponding to DNA barcode region (568 bp) from 68 individuals, collected from 6 localities in Korea, is sequenced. The sequence data are used to investigate genetic diversity within sp. and populations, geographic variation within sp., phylogeographic relationship among populations, and phylogenetic relationship among haplotypes. Phylogenetic analysis and uncorrected pairwise distance estimates show overall low genetic diversity within the sp. Regionally, populations from southern localities (Gangjin & Gokseong in Jeollanamdo prov.) show somewhat higher genetic diversity than those from the remaining regions of Korea. Despite the subdivision of N. pygmaea into 2 groups, distance- or region-based geographic partition was not observed.

(18751) PAILLISSON, J.-M., S. REEBER, A. CARPENTIER & L. MARION, 2007. Reproductive parameters in relation to food supply in the whiskered tern (Chlidonias hybrida). *J. Ornithol.* 148: 69-77. (With Germ. s.). – (First Author: Biol. Popul. & Conserv., Univ. Rennes-I, Campus Beaulieu, Av. Général Leclerc, F-35042 Rennes).
The study was carried out during the breeding seasons (2004-2005) at Lake Grand-Lieu (W France). The whiskered tern is an opportunistic feeder that eats a wide variety of prey. Field observations (using a telescope) indicate that adult odon. are among the most commonly consumed invertebrate prey.

(18752) POLLHEIMER, M., 2007. Streifzüge durch die Tierwelt des Kremstals. *Lanius-Information* 16(3/4): 3-5. – (Author's address not stated).
6 odon. spp. are reported from Kremstal, Austria. Vernacular nomenclature only.

(18753) RICHARDS, L.A. & D.M. WINDSOR, 2007. Seasonal variation of arthropod abundance in gaps and understorey of a lowland moist forest in Panama. *J. trop. Biol.* 23: 169-176. – (First Author: Dept Biol. Sci., Macquarie Univ., North Ryde-2109, NSW, AU).
Using 8 Malaise traps, the difference in arthropod abundance between gaps and understorey were examined for 21 weeks during the rainy season and 8 weeks in the dry season on Barro Colorado island. The odon. average capture (individuals d^{-1}) was significantly higher in gaps than in understorey during both seasons. T.E. Shelly (1982; *OA* 3997) found that Argia difficilis preferred gaps and was more active all yr than the shade-seeking Heteragrion erythrogastrum, which preferred the understorey and were not active during the dry season. The greater activity of the gap specialists could explain the higher capture rates of Odon. in gaps. For the Barro Colorado odon. fauna see. *OA* 2644.

(18754) SAMWAYS, M.J., 2007. Insect conservation: a synthetic management approach. *Ann. Rev. Ent.* 52: 465-487. – (Dept Conserv. Ecol. & Ent., Cent. Agric. Biodiv., Univ. Stellenbosch, P. Bag XI, Matieland-7602, SA).

A review paper, with references to some related odonatol. literature. – Threats to insect diversity range from habitat loss and invasive alien organisms to environmental contamination and biological control. Many of the threats are synergistic, with the joint impact of habitat loss and global climate change being highly adversely synergistic. Recent research on insect conservation has elucidated some basic principles for conservation management. There are 6 basic principles that are interrelated and together provide guidelines for synthetic conservation management of insects. They are maintain reserves (principle 1), maintain as much quality landscape heterogeneity as possible (principle 2), reduce contrast between remnant patches and neighbouring disturbed patches (principle 3), outside reserves, introduce land sparing (principle 4), simulate natural conditions and disturbance (principle 5), and connect similar patches of quality habitat (principle 6). These 6 principles constitute a coarse-filter, landscape approach. Permeating all 6 is the principle of maintaining healthy population levels, which require the combined support of the metapopulation trio of large patch (habitat) size, good patch quality, and reduced patch isolation. In addition to these 6 coarse-filter principles is an overlay of the fine-filter, species approach, in which particular spp. are given focused attention and management.

(18755) STAUDACHER, K. & L. FÜREDER, 2007. Habitat complexity and invertebrates in selected alpine springs (Schütt, Garinthia, Austria). *Int. Revue Hydrobiol.* 92(4/5): 465-479. – (River Ecol. & Invert. Biol., Inst. Ecol., Univ. Innsbruck, Technikerstr. 25, A-6020 Innsbruck).
Presents records of Aeshna cf. caerulea and Cordulegaster bidentata.

(18756) TRIGAL, C., F. GARCIA-CRIADO & C.-F. ALÁEZ, 2007. Macroinvertebrate communities of Mediterranean ponds (North Iberian Plateau): importance of natural and human-induced variability. *Freshw. Biol.* 52: 2042-2055. – (Area Ecol., Fac. Biol. & Envir. Sci., Univ. León, Campus de Vegazana s/n, ES-24071 León).
28 ponds (alt. 700-1100 m a.s.l.) were studied (Spain) to determine the best predictors of community structure. Coenagrionidae and Aeshnidae were collected from at least 50% of ponds, irrespective of their condition. The highest Coenagrionidae abundances were found in ponds with low total nitrogen concentrations and high plant density. The influence of fish on Odon. was not strong. The names of the recorded odon. spp. are not provided.

(18757) VANAPPELGHEM, C., 2007. Protocols du nouvel atlas des odonates de la region Nord-Pas-de-Calais. *Héron* 40(1): 43-52. – (15 rue Brûle-Maison, F-59000 Lille).
The technicalities of the presentation and scope of information to be included in the Atlas are outlined.

(18758) YUM, J.W. & Y.J. BAE, 2007. Description of the larva of Copera tokyoensis Asahina (Insecta: Odonata: Platycnemididae) from Korea. *Korean J. syst. Zool.* 23(1): 87-89. – (Second Author: Coll. Life Sci. & Biotechnol., Korea Univ., Seoul-123-701, Korea).
The final instar larva is described and illustrated. It is distinguished from the other known Copera larvae by the absence of lateral setae on abdominal segments and by the labial palpal lobe, which bears 3 setae. C. annulata is the only other congener known from Korea. Its larva was described by D.S. Kong (1987, *A taxonomic study of the Korean dragonfly larvae*, M.Sc. thesis, Dept Biol., Korea Univ., Seoul, pp. 28-29), but the identification was erroneous; the described material is referable to Platycnemis phyllopoda, a widespread and common Korean sp.

2008

(18759) ARENHÖVEL, C., 2008. Interessante Geotope und Biotope zugleich: die geschützten Landschaftsbestandteile „Tobritzteich bei Possendorf", „Seeteich bei Legefeld" und „Erlenwiese" (Stadt Weimar). *Landschaftspfl. Naturschutz Thüringen* 45(3): 120-130. – (Untere Naturschutzbehörde, Stadtverwaltung Weimar, Schwanseestr. 17, D-99423 Weimar).
Based on literature, 4 odon. spp. are listed from the 3 localities, Weimar (Germany).

(18760) CAILLOUËT, K.A., J.C. CARLSON, D. WESSON & F. JORDAN, 2008. Colonization of abandoned swimming pools by larval mosquitoes and their predators following hurricane Katrina. *J. Vector Ecol.* 33(1): 166-172. – (First Author: Dept Trop. Med., Tulane Univ., New Orleans, LA 70112, USA).
The hurricane occurred in Aug. 2005, larval Ischnura ramburii, Anax junius and Pantala hymenaea were found in great numbers in the pools in Jan. 2006.

(18761) CHUZHEKOVA, T.A., E.V. SHATSKIKH & L.B. ZIMAREVA, 2008. Something about the stream macrozoobenthos of Zhigulevsk town and its vicinities. *Proc. Conf. "Aquatic and overland ecosystems: problems and perspectives of research"*, Vologda, pp. 234-238. (Russ., with Engl. s.). – (Authors' incomplete address: Dept. Ichthyol., St Petersburg Univ., Russia).
Includes a list of 8 recorded odon. spp.; – Russia.

(18762) DAVIS, C.A. & J.R. BIDWELL, 2008. Response of aquatic invertebrates to vegetation management and agriculture. *Wetlands* 28(3): 793-805. – (First Author: Nat. Resour. Ecol. & Mngmt Dept, Oklahoma St. Univ., 008C Agricultural Hall, Stillwater, OK 74078, USA).
The effects of vegetation management techniques (prescribed burning, cattle grazing, mowing and disking) on aquatic invertebrate communities in seasonal wetlands were evaluated in the Rainwater Basin Region in Nebraska (USA). Each of the 3 Odon. taxa differed among treatments. Enallagma biomass was highest in grazed wetlands, while Lestes biomass was highest in farmed wetlands, and Libellula biomass was higher in grazed and reference wetlands than in mowed and farmed wetlands.

(18763) DAVIS, R.S. & R.K.D. PETERSON, 2008. Effects of single and multiple application of mosquito insecticides on nontarget arthropods. *J. Am. Mosquito Contr. Ass.* 24(2): 270-280. – (Dept Land Resour. & Envir. Sci., Montana St. Univ., 334 Leon Johnson Hall, Bozeman, MT 59717, USA).
There is a public concern about ecological risks from using insecticides to manage mosquitoes. 2 studies were conducted during the late summers of 2004-2006 at Benton Lake National Wildlife Refuge near Great Falls (Montana, USA). The first experiment was conducted in 2004 and 2005 to assess acute impacts of mosquito adulticides (permethrin and d-phenothrin) and larvicides (Bacillus thuringiensis israelensis and methoprene) on nontarget aquatic and terrestrial arthropods after a single application. The second experiment was conducted in 2005 and 2006 to assess long-term impacts of permethrin on nontarget terrestrial arthropods after multiple repeated applications. Interactions between treatment and time were significant for Odon. Samples had relatively lower counts of odon. for the larvicide-treated plots on the first sampling date, followed by a slight increase on date 2. Each of the adulticide-treated plots and the control plots started with relatively more odon. on date, followed by a decrease on date 2. Power to detect multivariate overall treatment effects was generally low for stickycard samples during 2004 (0.05-0.717), with some exceptions within certain dates, incl. Odon.

(18764) FRIMAN, M., 2008. Sudenkorentoselvitys. *In*: P. Soini et al., *Lahnuksen alueen luontoselvitykset 2007*, pp. 30-46, Espoon ympäristölautakunta, Espoo. (Finn.). – (Engl. translation of title, abstract & addresses not provided).
23 spp. are recorded from the area and the odon. assemblages are listed per site; – Finland.

(18765) KALYONCU, H., B. YORULMAZ, M. BARLAS, M.Z. YILDRIM & M. ZEYBEK, 2008. Water quality of Axu stream and effect of physicochemical parameters on the macroinvertebrate diversity. *Sci. Eng. J. Firat Univ.* 20(1): 23-33. (Turk., with Engl. s.). – (First Author: Fak. Biyoloji, Demirel Univ., Isparta, Turkey).
From the Aksu river (Turkey) Calopteryx splendens, Epallage fatime, Onychogomphus forcipatus and 8 other taxa (generic level only) are recorded (Feb. 2000-July 2001).

(18766) KAZANCI, N. & M. DÜGEL, 2008. Prediction of global climate change impact on structure of aquatic insect assemblages by using species optimum and tolerance values of temperature. *Rev. Hydrobiol.* 2: 73-80. (With Turk. s.). – (First Author: Hydrobiol. Sect., Biol. Dept, Sci. Fac., Hacettepe Univ., Beytepe, Ankara, Turkey).
At 17 sites on the Büyük Menderes tributaries (S Turkey), the optimal development temperature and the deviation tolerance were estimated for Platycnemis pennipes, Epallage fatime, Calopteryx virgo and Gomphus sp. Based on speculations that in the Mediterranean the temperature is likely to rise by 2030 for 1.2ºC and by 2050 for ca 2.0ºC, it is concluded that Gomphus sp. will become extinct locally by 2030.

(18767) LEE, E.-H., H.-K. JANG, M.-Y. PARK, J. YOON, J.G. KIM & Y.-J. BAE, 2008. A preliminary study on a restoration of habitats for Nannophya pygmaea Rambur (Odonata: Libellulidae). *Korean J. envir. Ecol.* 22(1): 35-42. (Korean, with Eng. s.). – (Last Author: Coll. Life Sci. & Biotechnol., Korea Univ., Seoul-123-701, Korea).

The landscape properties, habitat size, vegetation structure, hydrology and microhabitat conditions were investigated of 10 N. pygmaea localities throughout Korea. Generally, the sp. occurs in abandoned paddy fields in hilly regions. The provided information should facilitate the introduction of the sp. into new habitats.

(18768) MAUE, T. & M. SPRINGER, 2008. Effect of methodology and sampling time on the taxa richness of aquatic macroinvertebrates and subsequent changes in the water quality index from three tropical rivers, Costa Rica. *Revta Biol. trop.* 56 (Suppl. 4): 257-271. − (First Author: Hydrobiologie, Univ. Essen-Duisburg, Essen, Germany).
10 odon. taxa (7 fam., mostly generic level) are listed from the Uvita, Balso and San Lorencito rivers.

(18769) McPEEK, M.A., 2008. The ecological dynamics of clade diversification and community assembly. *Am. Nat.* 172: E270-E284. − (Dept Biol. Sci., Dartmouth Coll., Hanover, NH 03755, USA).
Clades diversify in an ecological context, but most macroevolutionary models do not directly encapsulate ecological mechanisms that influence speciation and extinction. A data set of 245 chordate, arthropod, mollusc, and magnoliophyte phylogenies had a majority of clades that showed rapid lineage accumulation early with a slowing more recently, whereas a small but significant minority showed accelerated lineage accumulation in their recent histories. Previous analyses have demonstrated that macroevolutionary birth-death models can replicate the pattern of slowing lineage accumulation only by a strong decrease in speciation rate with increasing species richness and extinction rate held extremely low or absent. In contrast, the metacommunity model presented here could generate the full range of patterns seen in the real phylogenies by simply manipulating the degree of ecological differentiation of new spp. at the time of speciation. Specifically, the metacommunity model predicts that clades showing decelerating lineage accumulation rates are those that have diversified by ecological modes of speciation, whereas clades showing accelerating lineage accumulation rates are those that have diversified primarily by modes of speciation that generate little or no ecological diversification. A number of testable predictions that integrate data from molecular systematics, community ecology, and biogeography and, particularly, the situation in Enallagma are also discussed.

(18770) MELLADO DIAZ, A., M.L. SUAREZ, A. VIDAL & M.R. VIDAL-ABARCA, G., 2008. Biological traits of stream macroinvertebrates from a semi-arid catchment: patterns along complex environmental gradients. *Freshw. Biol.* 53: 1-21. − (Dypto Ecol. & Hidrobiol., Univ. Murcia, ES-30100 Murcia).
The study sites were located in the Segura basin, SE Spain. 16 odon. gen. are among the taxa considered. − See also *OA* 15314 and 18189.

(18771) MONNERAT, C., 2008. Première observation de l'aeschne isocèle Aeshna isosceles (O.F. Müller, 1776) (Odonata: Aeshnidae) en Ajoie (canton de Jura: Suisse). *Entomo helvetica* 1: 135-137. (With Engl. & Germ. s's). − (CSCF, Maximilien de Meuron 6, CH-2000 Neuchâtel).
1 adult ♂ (6-VI-2006) is recorded for the first time from canton Jura (Porrentruy, Etang Corbat, alt. 430 m a.s.l.), Switzerland.

(18772) PARR, A.J., 2008. Dragonfly news for spring and early summer 2008. *Atropos* 35: 54-55. − (10 Orchard Way, Barrow, Bury St Edmonds, Suffolk, 1P29 5BX, UK).
Records of Anax parthenope, Libellula fulva, L. quadrimaculata, Sympetrum flaveolum and S. fonscolombii; − UK.

(18773) PÉLABON, C. & T.F. HANSEN, 2008. On the adaptive accuracy of directional asymmetry in insect wing size. *Evolution* 62(11): 2855-2867. − (First Author: Cent. Conserv. Biol., Dept Biol., Norwegian Univ. Sci. Technol., Trondheim, Norway).
Subtle left-right biases are often observed in organisms with an overall bilateral symmetry. The evolutionary significance of these asymmetries remains uncertain and scenarios of both developmental constraints and adaptation have been suggested. Reviewing the literature on asymmetry of insect wings (incl. 7 Zygoptera spp.), patterns of directional asymmetry in wing size are analysed in order to evaluate the possible adaptive significance of this character. It was found that directional asymmetry in wing size is widespread, with left- and right-biased asymmetries commonly observed. The direction of asymmetry does not appear to be evolutionarily conserved above the species level. It is argued that the very small magnitude of directional asymmetry, 0.7% of the wing size on average, associated with an extremely imprecise expression, precludes directional asymmetry from playing any major adaptive role.

(18774) REINHARDT, K., 2008. Zur Libellenfauna nordostdeutscher Flüsse (Odonata). *Ent. Nachr. Ber.* 52(2): 109-114. (With Engl. s.). – (Dept Animal & Plant Sci., Univ. Sheffield, Sheffield, S10 2TN, UK).
The Tollense, Peene and Uecker rivers (NE Germany were investigated during a 7-day kajak trip (17-22 June 2008). 12 spp. considered typical for the area are recorded. These include the records of Anax imperator, Anax parthenope, Aeshna isosceles, Gomphus vulgatissimus and Libellula fulva for which previous records are rare in NE Germany. Noteworthy are also the records of Crocothemis erythraea, a possible new arrival to that area and the near-absence of the usually abundant Libellula quadrimaculata. Other observations include a detailed protocol of the copulatory behaviour of A. isosceles, the emergence of Calopteryx splendens 6 m away from the banks as well as the finding of eggs, presumably from snails, attached to an exuviae of G. vulgatissimus. It is also concluded that kajaking might be an important means to study the riverine dragonflies, because some spp. may be detected that are hard to observe from the banks.

(18775) RUGGIERO, A., R. CEREGHINO, J. FIGUEROLLA, P. MARTY & S. ANGELIBERT, 2008. Farm ponds make a contribution to the biodiversity of aquatic insects in a French agricultural landscape. *C. r. Biologies* 331: 298-308. (With Fr. s.). – (Second Author: Lab. Ecol. Functionnelle, Univ. Paul Sabatier, 118 rte de Narbonne, F-31062 Toulouse Cedex 9).
The importance of 37 farm ponds in the Astarac area (SW France) for the odon. biodiversity was assessed. Out of the 73 spp. known to occur in SW France (a list is provided), 23 spp. were recorded from the ponds. The species assemblages were not correlated with pond use (e.g., cattle watering, duck farming, etc.) or to landscape variable. Species richness was correlated with pond area, suggesting that community diversity was primarily driven by autecological processes. Farm ponds, thus, make a positive contribution to the maintenance of aquatic biodiversity.

(18776) RUST, J., J.F. PETRULEVICIUS & A. NEL, 2008. The first damselflies from the lowermost Eocene of Denmark, with a description of a new subfamily (Odonata, Zygoptera: Dysagrionidae). *Palaeontology* 51(3): 709-713. – (First Author: Inst. Palaeontol., Univ. Bonn, Nussallee 8, D-53115 Bonn).
Eodysagrion mikkelseni gen. n., sp. n., the type sp. of Eodysagrioninae sfam. n., and Primorilestes madseni sp. n., the first thaumatoneurid spp. from the Lowermost Eocene of Denmark, are described and illustrated from the Fur Formation (Mo-clay).

(18777) SAHUQUILLO, M., M.R. MIRACLE, M. RIERADEVALL & R. KORNIJÓW, 2008. Macroinvertebrate assemblages on reed beds, with special attention to Chironomidae (Diptera), in Mediterranean shallow lakes. *Limnetica* 27(2): 239-250. (With Span. s.). – (First Author: Depto Microbiol. & Ecol., Univ. València, ES-46100 Burjassot/València).
The study was conducted in 6 Phragmites australis natural water bodies along the Comunidad Valenciana coast (Spain). Ischnura elegans and Sympetrum fonscolombii are reported from Xeresa and Cap Terme, respectively.

2009

(18778) GALÁN, C., F.F. HERRERA, A. RINCÓN & M. LEIS, 2009. Cave fauna diversity in northern Venezuela limestone karst. *Boln Soc. venez. Espeleol.* 43: 14 pp. (Span., with Engl. s.). Pag web aranzadi-sciences.org, Archivo PDF, 31 pp. – (Soc. Venezolana de Espeleologia, Apartado 47.334, Caracas 1041-A, Venezuela).
The odon. larvae are reported from Cueva de Los Laureles (Perijá); specific names are not stated.

(18779) GOSDEN, D.P. & E.I. SVENSSON, 2009. Density-dependent male mating harassment, female resistance and male mimicry. *Am. Nat.* 173(6): 709-721. – (Second Author: Dept Anim. Ecol., Lund Univ., Ecol. Bldg, S-223 62 Lund).
Genetic variation in ♀ resistance and tolerance to ♂ mating harassment can affect the outcome of sexually antagonistic mating interactions. Here, ♀ mating rates and ♂ mating harassment were investigated in natural populations of Ischnura elegans. This sp. has a heritable sex-limited polymorphism in ♀♀, where one of the morphs is a ♂ mimic (androchrome). The 3 ♀ morphs differ in mating rates, and these differences are stable across populations and years. However, the degree of premating resistance toward ♂ mating attempts varied across generations and populations. ♂ mating harassment of the ♀ morphs changed in a density-dependent fashion, suggesting that ♂ mate preferences are plastic and vary with the different morph densities. Morph differences in ♂ mating harassment and ♀ fecundity were quantified,

using path analysis and structural equation modelling. Variation was found between the morphs in the fitness consequences of mating, with the fecundity of one of the nonmimetic morphs declining with increasing ♂ mating harassment. However, androchrome ♀♀ had lower overall fecundity, presumably reflecting a cost of ♂ mimicry. Density-dependent ♂ mating harassment on the morphs and fecundity costs of ♂ mimicry are thus likely to contribute to the maintenance of this ♀ polymorphism.

(18780) HANSON, M.A., B.J. PALIK, J.O. CHURCH & A.T. MILLER, 2009. Influence of upland timber harvest on aquatic invertebrate communities in seasonal ponds: efficacy of forested buffers. *Wetlands Ecol. Mngmt* 2009: 13 pp.; – DOI 10.1007/sl1273-009-9167-1. – (First Author: Wetland Wildl. Pop. & Res. Gr., Minnesota Dept Nat. Resour., 102 23rd St. NE, Bemidji, MN 56601, USA).
The study was conducted in Aitkin and Cass co, N central Minnesota (USA). Ponds were assigned to the following treatments: control (uncut forest), full buffer, partial buffer and clearcut. Odon. were among the dominant groups. Invertebrate communities of seasonal ponds in clearcut forests differed from those in similar sites in unharvested uplands, but only after 3-4 yr following tree removal. Partial and full buffer treatments shared community characteristics with both control and clearcut treatments.

(18781) KIANY, M. & K.M. INAEI, 2009. The dragonfly family Libellulidae (Insecta: Odonata: Anisoptera) of Shiraz and its vicinity (Fars province, Iran). *Iran. agric. Res.* 28(1): 65-78. (With Iran. s.). – (Dept Plant Prot., Coll. Agric., Shiraz Univ., Shiraz, Iran).
Records are presented for 13 spp. and a key is appended.

(18782) KIM, D.G., J.M. HWANG, T.J. JOON & Y.J. BAE, 2009. Relationship between temperature and egg development of Nannophya pygmaea Rambur (Odonata: Libellulidae), an endangered dragonfly in Korea. *Korean J. envir. Biol.* 27(3): 292-296. (Korean, with Engl. s.). – (Last Author: Coll. Life Sci. & Biotechnol., Korea Univ., Seoul-136-701, Korea).
8 different temperature conditions were used (17, 20, 22, 25, 28, 30, 33 and 36ºC). Eggs were obtained from ♀♀ inhabiting a small wetland in Mungyeong-si, Gyeongsangbuk-do, Korea, in June 2007. Hatching rates were 2.86, 17.09, 24.32, 39.67, 34.43, 40.57, 44.79, and 1,75% at the above said temperatures, respectively. The nonlinear model of the temperature related to egg development was well fit to the modified Sharpe and DeMichele model. The derived lower developmental threshold temperature for egg hatching was 14.02ºC ($y = 0.005988x-0.084$, $r^2 = 0.99$), and the derived optimal development temperature was 30~35ºC.

(18783) KIM, D.G., T.J. YOON, C.G. OH, J.G. KIM, E.-H. LEE & Y.J. BAE, 2009. Level growth rate of Nannophya pygmaea (Odonata: Libellulidae), an endangered dragonfly in Korea. *Korean J. Limnol.* 42(3): 290-294. (Korean, with Engl. s.). – (Last Author: Coll. Life Sci. & Biotechnol., Korea Univ., Seoul-136-701, Korea).
300 larvae (length 6.20-7.94 mm) were introduced (June 2007) in an artificial green-house habitat, whereupon the length of the individuals was measured at 5 intervals (I-V) and 2 body size groups could be discerned, viz. (mean, in mm): I (24 Aug. 2007): 2.84 and 5.16; II (31 Oct. 2007): 5.96 and 8.02); III (27 March 2008): 5.97 and 7.82; IV (23 May 2008): 7.04 and 8.52; and V (4 Nov. 2008): 5.72 and 7.71. The populations, I-V, were the offspring of the introduced larvae and the offspring grew approx. 3 mm in 470 degree-days. It was established that N. pygmaea larvae require approx. 100 degree-days to grow 0.7 mm in body length.

(18784) KISHIDA, O., G.C. TRUSSELL & K. NISHIMURA, 2009. Top-down effects on antagonistic inducible defense and offense. *Ecology* 90(5): 1217-1226. – (First Author: Cent Ecol. Res., Kyoto Univ., Otsu, Shiga, 520-2113, JA).
Using a simple food chain consisting of a top predator (Aeshna nigroflava larvae), an intermediate predator (salamander Hynobius retardatus larvae), and frog (Rana pirica tadpoles) as prey, it is shown that the presence of dragonfly risk cues substantially modifies the intensity of antagonistic morphological plasticity in both amphibians. In the absence of dragonflies, tadpoles produced bulgier bodies in response to salamanders, and salamanders responded to this defense by enlarging their gape size. However, in the presence of dragonfly risk cues, the expression of both antagonistic traits was significantly reduced because tadpoles and salamanders produced phenotypes that are more effective against dragonfly predators. Thus, the reduced antagonism likely emerged, in part, because the benefits of antagonistic trait expression were outweighed by the potential cost

of increased vulnerability to dragonfly predation. In addition, these results suggest that when all 3 spp. were present, salamander activity levels, which influence the amount of signals required to induce antagonistic traits, were more strongly affected by dragonfly risk cues than were tadpole activity levels. This species-specific difference in activity levels was likely responsible for the reduced tadpole mortality caused by salamanders in the presence vs. absence of dragonfly risk cues. Hence, dragonflies had a positive trait-mediated indirect effect on tadpoles by modifying both the morphological and behavioural traits of salamanders.

(18785) LEGRIS, S. & L. GAVORY, 2009. *Eléments de connaissances préliminaires pour la conservation des populations de l'agrion de mercure Coenagrion mercuriale en Picardie*. Picardie Nature, Amiens. 64 pp. ISBN none. – (Publishers: B.P. 50835, F-80008 Amiens).
Gavory, L. & S. Legris: Statut de l'agrion de mercure Coenagrion mercuriale en Picardie: synthèse des données anciennes et situation en 2005 (pp. 6-28); – Eléments sur l'écologie et l'éthologie de l'agrion de mercure Coenagrion mercuriale en Picardie: description des stations et synthèse des connaissances accumulées en 2005 (pp. 29-43); – Eléments généraux sur l'agrion de mercure Coenagrion mercuriale (pp. 44-52); – Conservation et suivi de l'agrion de mercure Coenagrion mercuriale en Picardie: état des stations connues, prescriptions pour leur conservation et le suivi de l'espèce (p. 53-64).

(18786) MBABAZI, D. et al. [9 joint authors], 2009. Intra-lake stable isotope ratio variation in selected fish species and their possible carbon sources in Lake Kyoga (Uganda): implications for aquatic food web studies. *Afr. J. Ecol.* 2009: 9 pp.; – DOI: 10.1111/j.1365--2028.2009.01163.x – (Natn. Fish. Resour. Res. Inst., P.O. Box 343, Jinja, Uganda).
The (possible) mean contribution of stable isotope C and N (‰) by odon. to 10 fish spp. is stated.

(18787) MÜLLER, J., 2009. Grosses Granatauge Erythromma najas (Odonata, Coenagrionidae) wehrt Angriff des Wasserläufers Gerris najas (Heteroptera, Gerromorpha, Gerridae) erfolgreich ab. *Ent. Nachr. Ber.* 53(3/4): 167-168. (With Engl. s.) – (Frankefelde 3, D-39116 Magdeburg).
A description and photographic documentation of an ovipositing E. najas warding off the G. najas attack.

(18788) PARR, A.J., 2009. The Willow Emerald damselfly Lestes viridis (Vander Linden) in East Anglia. *Atropos* 38: 32-35. – (10 Orchard Way, Barrow, Bury St Edmonds, Suffolk, IP29 5BX, UK).
The 2009 sightings are brought on record and discussed.

(18789) PHOENIX, J., 2009. Herbstschlupf von Ophiogomphus cecilia (Odonata: Gomphidae) an der unteren Elbe in der Tschechischen Republik. *Bull. Lampetra* 6: 30-32. (With Eng. & Czech s's). – (Goethestr. 22, D-01824 Königstein).
A remarkably late O. cecilia emergence is brought on record. On 12-IX-2008, a "fresh" exuviae was found on a willow root at Velké Březno on the lower Elbe (Czech Republic). Since on 2-3 Sept. the water level of the river was high and the site was most likely flooded, the emergence must have taken place after that date. Normally, in the Königstein area, the emergence of this sp. occurs between 26 May and the 1st of July.

(18790) SADEGHI, S. & J. MOHAMMADALIZADEH, 2009. Additions to the Odonata fauna of Iran. *Iran. J. Sci. Technol.* (A)33(4): 355-359. – (First Author: Dept Biol., Coll. Sci., Shiraz Univ., Shiraz, Iran).
The records are presented of 48 spp. from 46 localities across Iran. Paragomphus sinaiticus, and Sympetrum sinaiticum are new to the country.

(18791) SAHA, N., G. ADITYA & G.K. SAHA, 2009. Habitat complexity reduces prey vulnerability: an experimental analysis using aquatic insect predators and immature dipteran prey. *J. Asia-Pac. Ent.* 12: 233-239. – (Last Author: Dept Zool., Univ. Calcutta, Ballygunge Circular Rd, Kolkata-700019, India).
The effects of alternative prey and structural complexity of habitat on the selection of mosquito larvae (Culex quinquefasciatus) by aquatic insect predators were evaluated in the laboratory. The heteropteran adults (Anisops bouvieri, Sphaerodema rusticum, S. annulatum) and odon. larvae (Ceriagrion coromandelianum, Brachydiplax chalybea) selected mosquito larvae based on their abundance relative to chironomid larvae and on the levels of habitat complexity. The effect of one prey sp. on the other was asymmetrical, as indicated through prey selectivity values. Compared to open habitat, the presence of macrophytes reduced the vulnerability of mosquito larvae while the effect was reverse in the presence of

sediments. When both sediment and macrophytes were present in habitats, all the predators except S. annulatum consumed more mosquito larvae than chironomid larvae. The clearance rate, an indicator of predatory efficiency, varied among the predator spp. and habitat types. The results suggest that the outcome of the interactions between insect predators and mosquito immatures was context-dependent and that it was mediated by the presence of alternative controphic spp. and the habitat complexity.

(18792) [SAMWAYS, M.J.] CANNINGS, R.A., 2009. Dragonflies and damselflies of South Africa, by M.J. Samways. *Fla Ent.* 92(2) 404-405. − (R.A. Cannings, Roy. Brit. Colombia Mus., 675 Belleville St., Victoria, BC, V8W 9W2, CA).
A comprehensive and descriptive book review of the volume described in *OA* 17514.

(18793) STRÄTZ, C., 2009. *Erfolgskontrolle der Seebach-Renaturierung im Stadtgebiet von Bamberg: Fachbeitrag Macrozoobenthos*. Büro ökol. Stud., Bayreuth. ii + 28 pp. − (Büro für ökologische Studien, Oberkonnersreuther Str. 6/A, D-95448 Bayreuth).
The results of the restoration (commenced in 2003) of the Seebach in the city area of Bamberg (Germany) are reported. Among these is the re-occurrence of Calopteryx splendens, C. virgo, Gomphus vulgatissimus and Onychogomphus forcipatus. Their status is described in detail.

(18794) VINTCHEVSKI, D. & A. YASIEVITCH, 2009. Comparison of a diet of the Montagu's harrier Circus pygargus L. during breeding season in two distinct plots in the western Belaus. *Studia Materialy Cent. Eduk. przyrod.-lesnej* 3(22): 110-117. (With Pol. s.). − (Authors' postal addresses not stated).
Sympetrum flaveolum and possibly other middle-sized odon. spp. are reported in the diet of the bird.

(18795) WALKER, I., 2009. Emergence of aquatic insects and spider abundance in the Balbina Reservoir (Presidente Figueiredo, Amazonas, Brazil) during the phase of declining eutrophication. *Acta limnol. bras.* 21(2): 199-207. (With Port. s.). − (CPEC, Inst. Nac. Pesquisa Amazonia, Av. André Araújo 2936, Aleixo, C.P. 478, BR-69011-970 Manaus, AM).
The general abundance of Odon. (adult ind./ha) is stated, 7 spp. observed along the Balbina Reservoir are listed, and the Brachymesia herbida abundance in the emergent dead forest of the Reservoir is emphasized.

(18796) WANG, F., Y. HUANG & X.-L. WANG, 2009. The first record of the genus Hylaeothemis with a species from China (Odonata, Libellulidae). *Acta zootax. sin.* 34(2): 391-394. (With Chin. s.). − (Dept Ent., Coll. Agron. & Biotechnol., China Agric. Univ., Beijing-100193, China).
4 ♂ from the province of Yunnan (China), 3-V-2007, are brought on record, described and structural features are illustrated.

(18797) ZHANG, Z.-S., X.-G. LU, Q.-C. WANG & D.-M. ZHENG, 2009. Mercury, cadmium and lead biogeochemistry in the soil-plant-insect system in Huludao city. *Bull. envir. Contam. Toxicol.* 83: 255-259. − (First Author: Key Lab. Wetland Ecol. & Envir., Northeast Inst. Geogr. & Agro Ecol., Chin. Acad.Sci., Changchun, China).
Hg, Cd and Pb concentrations of ashed plant and insect samples were investigated and compared with those of soil to reveal their biochemical processes along food chains in Huludao city, Liaoning prov., China. In a tab., the concentrations of these metals are given for a "dragonfly" (n = 33; no taxonomic name). The highest Hg and Pb concentrations were found in dragonflies, and the highest Cd concentrations in spiders.

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(18798) *BRACHYTRON*. Journal of the Odonatological societies of the Netherlands (NVL) and of Flanders, Belgium (LVV) (ISSN 1386-3460), Vols 12(1/2) (Jan. 2010; Engl.), 13(1/2) (March 2010; Dutch, with Engl. s's). − (Editor: R. Ketelaar, Wilslaan 27, NL-6708 RW Wageningen).
[Vol. 12]: *Editorial* (p. 3); − *Bouwman, J.H., K.-J. Conze, C. Göcking & R. Ketelaar*: The first cross-border dragonfly symposium (pp. 4-5); − *Bouwman, J.H., K.-J. Conze & R. Ketelaar*: The organisation of dragonfly research in the Netherlands and North Rhine-Westphalia (pp. 6-10); − *Göcking, C., T. Hübner & K. Röhr*: Status and conservation of Coenagrion mercuriale in North Rhine-Westphalia (pp. 11-17); − *Groenendijk, D. & J.H. Bouwman*: Occurrence and conservation of Somatochlora arctica in the Netherlands (pp. 18-24); − *de Vries, H.H.*: Species protection plan for Aeshna viridis (pp. 25-31); − *Olthoff, M.*: The dragonflies of the peat bogs and heathlands in western Münsterland (Westphalia, Germany) (pp. 32-37); − *Ketelaar, R.*: Recovery and further protection of rheophilic Odonata in the Neth-

erlands and North Rhine-Westphalia (pp. 38-49); – *Aletsee, M.*: Classification of dystrophic ponds by means of the TWINSPAN algorithm for an ecological characterisation of the Odonata habitats in the Hohe Venn/Hautes Fagnes (pp. 50-59); – *Conze, K.-J. & J.H. Bouwman*: Working with the Habitat Directive: two countries, two approaches (pp. 60-67). – [Vol. 13]: *De Knijf & T. Termaat*: Sympetrum meridionale in Belgium and the Netherlands: identification, distribution and status in northwestern Europe (pp. 4-18); – *Wasscher, M. & K. Goudsmits*: Coenagrion scitulum back in northwestern Europe (pp. 19-25); – *Bouwman, J.*: Two new populations of Somatochlora arctica in Overijssel (pp. 26-31); – *van de Meutter, F.*: Colonisation and habitat preferences of Crocothemis erythraea in De Maten (Genk, Belgium) (pp. 32-40); – *Schrijvershof, P.*: Coenagrion scitulum near Cadzand-Bad in Zeeuws-Vlaanderen, the Netherlands in 2007 (pp. 41-43); – *van Grunsven, R.H.A. & T. Termaat*: Record of young Aeshna mixta at an unusual location (pp. 44-46); – 40 YEARS OF ORGANISED DRAGONFLY RESEARCH IN THE NETHERLANDS: *Ruiter, E.J., R.M.J.C. Kleukers & T.J. Verstrael*: Cooperation for dragonflies (pp. 47-54); – *Veling, K.*: Dragonfly working groups: more than the sum of its parts (pp. 55-64); – *Kranenbarg, B., T. van Vliet, T. Termaat & R. Ketelaar*: Index of almost 40 years of publications of the Netherlands Dragonfly Society and its forerunners (pp. 65-96).

(18799) BROCKHAUS, T., 2010. Eiablage der Arktischen Smaragdlibelle (Somatochlora arctica) in einem von der Torf-Mosaikjungfer (Aeshna juncea) dominierten Lebensraum (Odonata). *Ent. Nachr. Ber.* 54(2): 150-151. – (An der Morgensonne 5, D-09387 Jahnsdorf/Erzgebirge).
A detailed description of S. arctica oviposition at a locality in Erzgebirge (Germany) on 7 Aug. (13:00 h) and 2 Sept. (15:00 h). The odon. assemblage of the site is listed (31 July – 2 Sept. 2009).

(18800) CORBI, J.J., C.G. FROELICH, S. TRIVINHO-STRIXINO & A. DOS SANTOS, 2010. Evaluating the use of predatory insects as bioindicators of metals contamination due to sugarcane cultivation in neotropical streams. *Envir. Monit. Assmt* 2010: 10 pp.; – DOI: 10.1007/s10661-010-1655-5. – (First Author: Depto Biol., Fac. Filos Ciên. Letras,, Univ. São Paulo, BR-14040-900 Ribeirão Preto, SP).
Possible utilisation of adult Belastomatidae (Heteroptera) and larval Libellulidae as bioindicators of metal contamination due to sugarcane cultivation in 13 streams (São Paulo, Brazil) is evaluated for concentrations of Al, Cd, Cr, Cu, Zn, Fe and Mn. Except for Zn, all analysed metals were detected in minor concentrations in Belastomatidae than in Libellulidae, and the viability of utilisation of these 2 taxa as bioindicators of metals is emphasized.

(18801) [CÓRDOBA-AGUILAR, A.] PAULSON, D., 2010. Dragonflies and damselflies: model organisms for ecological and evolutionary research, edited by A. Córdoba-Aguilar. *Anim. Behav.* 80: 345-346. – (1724 NE St., Seattle, WA 98115, USA).
A comprehensive and appreciative book review of the work described in *OA* 17485.

(18802) CRUMRINE, P.W., 2010. Body size, temperature, and seasonal differences in size structure influence the occurrence of cannibalism in larvae of the migratory dragonfly, Anax junius. *Aquat. Ecol.* 44: 761-770. – (Dept Biol. Sci., Rowan Univ., Glassboro, NJ 08028, USA).
The aim of this study was to test the hypotheses that body size and seasonal differences in temperature and size structure influence cannibalism in larval dragonflies. In the first 2 experiments, larvae that were either similar or different in size were paired to examine the potential for intra- and intercohort cannibalism. In the third experiment, size structure of an assemblage of larvae and water temperature were manipulated to explore the seasonal dynamics of cannibalism. Cannibalism was common between individuals that differed in body size by one or more instars. Cannibalism also occurred between individuals similar in size but the rate varied across developmental stages. Results suggest that cannibalism may be most common when water temperatures are warm and late-instar larvae are present at high densities. These results highlight the importance of intra- and intercohort cannibalism as factors that can influence the populations dynamics of generalist predators.

(18803) CRUMRINE, P.W., 2010. Size-structured cannibalism between top predators promotes the survival of intermediate predators in an intraguild predation system. *Jl N. Am. Benthol. Soc.* 29(2): 636-646. – (Dept Biol. Sci., Rowan Univ., Glassboro, NJ 08028, USA).
Individuals in most natural populations of predators vary in size, and size differences among indi-

viduals often result in cannibalism. Cannibalism is an extremely common phenomenon in the animal kingdom, particularly among generalist predators that engage in intraguild predation (IGP). However, few studies have specifically addressed the effects of cannibalism on IGP. The aim of this study was to investigate how trophic and behavioural interactions between 2 size classes of an intraguild (IG) predator influenced the survival and behaviour of IG prey and a shared prey resource. Here, these effects were tested with larval odon. by exposing a shared prey resource (Ischnura verticalis) to the presence or absence of IG prey (Pachydiplax longipennis) and 2 size classes of IG predators (small or large Anax junius) in a 2×2×2 factorial design. Mortality rates of the shared resource in all single-predator treatments were significantly greater than in nonpredator controls, and risk reduction was observed when the shared resource was exposed to combinations of predators. The significant negative effect of large A. junius on P. longipennis survival and activity level was greater than that of small A. junius. Cannibalism occurred between large and small A. junius in size-structured IG predator treatments, and the effects of the size classes were not additive for the survival of IG prey. Cannibalism was not solely responsible for risk reduction in IG prey, and reduced activity level of small A. junius in the presence of larger conspecifics probably had a positive influence on P. longipennis survival. These results demonstrate that cannibalism among IG predators can influence the survival of IG prey and might contribute to coexistence among predators in systems with strong IGP.

(18804) DUXBURY, C., J. HOLLAND & M. PLUCHINO, 2010. Experimental evaluation of the impacts of the invasive catfish Hoplosternum littorale (Hancock, 1828) on aquatic macroinvertebrates. *Aquat. Invasions* 5(1): 97-102. – (First Author: Walt Disney Imagineering, Res. & Development, 1365 Ave of the Stars, Lake Buena Vista, Fla, USA).
E. littoralis is native to S America, it was first recorded in Florida in 1995 and has now dispersed throughout much of the state (USA). It is thought that this fish has had little or no impacts to native fish, but it is unknown if its introduction can cause other ecological impacts, such as alteration of aquatic macroinvertebrate assemblages. A cage experiment was conducted to evaluate the effects of the hople catfish on macroinvertebrates. Results showed that macroinvertebrate abundance and taxa on artificial substrates (MAS) were reduced by up to 50% in the fish treatments. The differences in assemblage structure were primarily influenced by larger number of odon. and fewer numbers of amphipods etc. It is suggested that direct predation could be one explanation of the macroinvertebrate reductions on the fish treatment substrates, but the greater numbers of predatory odon. on the fish MAS could be also due to the circumstance that the catfish may not eat them (none were found in caged fish stomachs) and the larger number of dragonflies could have decreased the overall number of invertebrates.

(18805) FUJIWARA, Y. & S. KOBAYASHI, 2010. A study on the distribution of Mnais costalis Selys in Ehime prefecture. *Bull. Chime prefect. Sci. Mus.* 15: 1-8. (Jap., with Engl. s.). – (Authors' addresses not stated).
In Shikoku island (Japan), the sp. has a limited distribution. In Ehime pref. it was believed to be restricted to the central part of it, but it was now recorded from Imbaru and Saijo, i.e. from E Ehime. More investigations are required in the eastern and northern regions of the prefecture.

(18806) GAUCI, C. & A. SCIBERRAS, 2010. First records of Orthetrum chrysostigma Burmeister, 1839 (Odonata, Libellulidae) from the Maltese islands. *Cent. medit. Naturalist* 5(2): 78-80. – (Second Author: 131, "Arnest", Arcade St., Paola, Malta).
A teneral ♀ is brought on record from a fresh water pond in the Ghadira Nature Reserve (a saline marshland), 12-VI-2010. It has apparently emerged locally and it represents the 18th known odon. sp. in the Maltese fauna.

(18807) HOLOMUZKI, J.R. & D.M. KLARER, 2010. Invasive reed effects on benthic community structure in Lake Erie coastal marshes. *Wetlands Ecol. Mngmt* 18: 219-231. – (First Author: Dept Evol., Ecol. & Organismal Biol., Ohio St. Univ., 1760 University Dr., Mansfield, OH 44906, USA).
8 marshes along Lake Erie's southern shoreline were sampled (Ohio, USA). Multiple regression showed that macroinvertebrate diversity was positively related to Phragmites cover. Ischnura posita, I. verticalis and Anax junius were the dominant odon. spp.

(18808) HOSSIE, T.J. & D.I. MURRAY, 2010. You can't run but you can hide: refuge use in frog tadpoles elicits density-dependent predation by dragonfly lar-

vae. *Oecologia* 163: 395-404. – (Dept Biol., Trent Univ., 1600 West Bank Dr., Peterborough, ON, K9J 7B8, CA).

The potential role of prey refuges in stabilizing predator-prey interactions is of longstanding interest to ecologists, but mechanisms underlying a sigmoidal predator functional response remain to be fully elucidated. Authors have disagreed on whether the stabilizing effect of prey refuges is driven by prey- versus predator-centric mechanisms, but to date few studies have married predator and prey behavioural observations to distinguish between these possibilities. Here, a dragonfly larva-tadpole (Anax junius-Rana pipiens) system was used to study the effect of a structural refuge (leaf litter) on the predator's functional response, and paired this with behavioural observations of both predator and prey. The study confirmed that hyperbolic (type II) functional responses were characteristic of foraging predators when structural cover was low or absent, whereas the functional response was sigmoidal (type III) when prey were provided with sufficient refuge. Prey activity and refuge use were density independent across cover treatments, thereby eliminating a prey-centric mechanism as being the genesis for density-dependent predation. In contrast, the predator's pursuit length, capture success, and handling time were altered by the amount of structure implying that observed shifts in density--dependent predation likely were related to predator hunting efficiency. This study advances current theory by revealing that despite fixed-proportion refuge use by prey, presence of a prey refuge can induce density-dependent predation through its effect on predator hunting strategy. Ultimately, responses of predator foraging decisions in response to changes in prey availability and search efficiency may be more important in producing density-dependent predation than the form of prey refuge use.

(18809) JONGERIUS, S.R. & D. LENTINK, 2010. Structural analysis of a dragonfly wing. *Exp. Mech.* 2010: 12 pp; – DOI: 10.1007/sl1340-010-9411x – (Second Author: Fac. Aerospace Engin., Delft Univ. Technol., NL-2600 GB Delft).

Dragonfly wings are highly corrugated, which increases the stiffness and strength of the wing significantly, and results in a lightweight structure with good aerodynamic performance. How insect wings carry aerodynamic and inertial loads, and how the resonant frequency of the flapping wings is tuned for carrying these loads, is however not fully understood. To study this a 3-dimensional scan of Sympetrum vulgatum fore- and hindwing was made with a micro-CT scanner. The scans contain the complete venation pattern including thickness variations throughout both wings. Subsequently, the forewing architecture was approximated with an efficient 3-dimensional beam and shell model. Then the wing's natural vibration modes and the wing deformation resulting from analytical estimates of 8 load cases containing aerodynamic and inertial loads (using the finite element solver Abaqus) were determined. The inertial loads are 1.5 to 3 times higher than aerodynamic pressure loads and wing deformation is smaller during the downstroke than during the upstroke, due to structural asymmetry. The natural vibration mode analysis revealed that the structural natural frequency of a dragonfly wing in vacuum is 154 Hz, which is approximately 4.8 times higher than the natural flapping frequency of dragonflies in hovering flight (32.3 Hz). This insight in the structural properties of dragonfly wings could inspire the design of more effective wings for insect-sized flapping micro air vehicles: The passive shape of aeroelastically tailored wings inspired by dragonflies can in principle be designed more precisely compared to sail-like wings, which can make the dragonfly-like wings more aerodynamically effective.

(18810) KÉRY, M., B. GARDNER & C. MONNERAT, 2010. Predicting species distributions from checklist data using site-occupancy models. *J. Biogeogr.* 37: 1851-1862. – (First Author: Swiss Ornithol. Inst., CH-6204 Sempach).

The aims of the paper are: (1) to increase awareness of the challenges induced by imperfect detection, which is a fundamental issue in species distribution modelling; (2) to emphasize the value of replicate observations for species distribution modelling; and (3) to show how "cheap" checklist data in faunal/floral databases may be used for the rigorous modelling of distributions by site-occupancy models. The study was conducted in Switzerland and it is based on checklist data collected by volunteers during 1999 and 2000 to analyse the distribution of Aeshna cyanea, a common sp. in that country. Data from repeated visits to 1-ha pixels were used to derive 'detection histories' and site-occupancy models were applied to estimate the 'true' species distribution, i.e. corrected for imperfect detection. A. cyanea distribution was modelled as a function of elevation and year and its detection probability of elevation, year and season.

The best model contained cubic polynomial elevation effects for distribution and quadratic effects of elevation and season for detectability. The site-occupancy model was compared with a conventional distribution model based on a generalized linear model, which assumes perfect detectability (p = 1). The conventional distribution map looked very different from the distribution map obtained using site-occupancy models that accounted for the imperfect detection. The conventional model underestimated the sp. distribution by 60%, and the slope parameters of the occurrence-elevation relationship were also underestimated when assuming p = 1. Elevation was not only an important predictor of A. cyanea occurrence, but also of the detection probability, with a bell-shaped relationship. Furthermore, detectability increased over the season. The average detection probability was estimated at only 0.19 per survey. Conventional sp. distribution models do not model sp. distribution per se but rather the apparent distribution, i.e. an unknown proportion of spp. distributions. That unknown proportion is equivalent to detectability. Imperfect detection in conventional sp. distribution models yields underestimates of the extent of distributions and covariate effects that are biased towards zero. In addition, patterns in detectability will erroneously be ascribed to spp. distributions. In contrast, site-occupancy models applied to replicated detection/non-detection data offer a powerful framework for making inferences about spp. distributions corrected for imperfect detection. The use of 'cheap' checklist data greatly enhances the scope of applications of this useful class of models.

(18811) KORTE, T., 2010. Current and substrate preferences of benthic invertebrates in the rivers of the Hindu Kush-Himalaya region as indicators of hydromorphologica degradation. *Hydrobiologia* 2010: 15 pp.; – DOI: 10.1007/s10750-010-0291-y. – (Dept Appl. Zool./Hydrobiol., Inst. Biol., Univ Duisburg--Essen, Universitätsstr. 5, D-45141 Essen).
The information is presented on benthic invertebrate preferences for substrate and current velocity in the lower Middle Mountains in Bhutan, India and Pakistan, The Shiwaliks in Bhutan, India Nepal and Pakistan, and lowland rivers in the northern Indo--Gangetic plain in Bangladesh, India and Nepal. All the investigated streams are permanent and small to medium in size. "Gomphidae" were collected in 32 samples and were significantly lithophile, occurring on water plants, sand, fine gravel, coarse gravel, small stones, large stones and bedrock.

(18812) GABRIELS, W., K. LOCK, N. DE PAUW & P.L.M. GOETHALS, 2010. Multimetric Macroinvertebrate Index Flanders (MMIF) for biological assessment of rivers and lakes in Flanders (Belgium). *Limnologica* 40: 199-207. – (First Author: Flemish Environment Agency, VMM, A. Van de Maelestraat 96, B-9320 Erembodegem).
In accordance with the requirements of the European Water Framework Directive, the MMIF was developed and tested. Its tolerance scores run from 1 (highly pollution-tolerant taxa) to 10 (highly pollution-sensitive taxa). The odon. are ranging from 6 (Coenagrion, Ischnura, Aeshna, Anax) to 9 (Cordulegaster). With the exception of Calopteryx (8), all other genera have the MMIF score of 7.

(18813) [LÖW (LOEV), F.] ZIEGLER, J., 2010. Vom Wert der Fliegen. *In*: F. Damaschun et al., *Klasse, Ordnung, Art … 200 Jahre Museum für Naturkunde Berlin*, pp. 154-156, Basilisken Presse, Brandenburg. – (Abt. Diptera, Mus. Naturk. Humboldt-Univ., Invalidenstr. 43, D-10115 Berlin).
Contains a note on the initials used by Franz Löw (1829-1889), one of the earlier workers who published on Odon. of Slovenia, incl. on hibernation of Sympecma fusca near Tolmin (1866, *Verh. zool.-bot. Ges. Wien* 16: 943-956).

(18814) MARTENS, A. & C.J. HAZEVOET, 2010. Dragonflies (Insecta, Odonata) of São Vicente, Capo Verde Islands: 10 species on a desert island. *Zoologica caboverdiana* 1(2): 112-115. – (First Author: Dept Biol., Univ. Educ., Bismarckstr. 10, D-76133 Karlsruhe).
The island has no natural and permanent fresh water habitats. 10 spp. are listed, excluding Pseudagrion glaucescens and Brachythemis leucosticta the occurrence of which is considered unconfirmed. An overview of phenological data is also included.

(18815) OTT, J., [Ed.], 2010. *Monitoring climate change with dragonflies*. Pensoft, Sofia-Moscow. vi + 286 pp. Paperback. ISBN 9789546423238. – (Publishers: Geo Miler St. 13/A, BG-1111 Sofia).
Ott, J.: Preface (p. iv); – *McNeely, J.A.*: Monitoring climate change with dragonflies: Foreword (pp. 1-2); – *Settele, J., G. Fanslow, S. Fronzek, S. Klotz, I. Kühn, M. Musche, J. Ott, M.J. Samways, O. Schweiger, J.H. Spangenberg, G.-R. Walther & V. Ham-*

men: Climate change impacts on biodiversity: a short introduction with special emphasis on the ALARM approach for the assessment of multiple risks (pp. 3-29); – *Conze, K.-J., N. Grönhagen, M. Lohr & N. Menke*: Trends in occurrence of thermophilous dragonfly species in North Rhine-Westphalia (NRW) (pp. 31-45); – *Hoffmann, J.*: Do climate changes influence dispersal and population dynamics of dragonflies in the western Peruvian Andes? (pp. 47-72); – *Samways, M.J.*: Impacts of extreme weather and climate change on South African dragonflies (pp. 73-84); – *Samways, M.J. & A.S. Niba*: Climate and elevational range of a South African dragonfly assemblage (pp. 85-107); – *Goffart, P.*: Southern dragonflies expanding in Wallonia (southern Belgium): a consequence of global warming? (pp. 109-126); – *Parr, A.J.*: Monitoring Odonata in Britain and possible insights into climate change (pp. 127-139); – *De Knijf, G. & A. Anselin*: When south goes north: Mediterranean dragonflies (Odonata) conquer Flanders (northern Belgium) (pp. 141-153); – *Termaat, T., V.J. Kalkman & J.H. Bouwman*: Changes in the range of dragonflies in the Netherlands and the possible role of temperature change (pp. 155-173); – *Wildermuth, H.*: Monitoring the effects of conservation actions in agricultural and urbanized landscapes – also useful for assessing climate change? (pp. 175-192); – *Matthews, J.H.*: Anthropogenic climate change impacts on ponds: a thermal mass perspective (pp. 193-209); – *L.A. Krokalo*: Expansion of Crocothemis erythraea in Ukraine (pp. 211-223); – *Beatty, C.D., S. Fraser, F. Pérez-Jvostov & T.N. Sherratt*: Dragonfly and damselfly (Insecta: Odonata) distribution in Ontario, Canada: investigating the influence of climate change (pp. 225-241); – *Oertli, B.*: The local species richness of dragonflies in mountain waterbodies: an indicator of climate warming? (pp. 243-251); – *Ott, J.*: Dragonflies and climatic changes: recent trends in Germany and Europe (pp. 253-286).

(18816) PAIERO, S.M., S.A. MARSHALL, P.D. PRATT & M. BUCK, 2010. Insects of Ojibway prairie, a southern Ontario tallgrass prairie. *In*: D. Shorthouse et al., [Eds], *Arthropods of Canadian grasslands* 1: 199-225, Biol. Surv. Can., ISBN 978--0-9689321-4-8. (With Fr. s.). – (Third Author: 7100 Matchette Rd, LaSalle, ON, N9J 2S3, CA).
The insect fauna of the prairie is described and 44 new Canadian and provincial records are reported. Among these is Archilestes grandis, previously known from eastern USA. Its range has been slowly expanding since the mid-1990s. In Canada it is known only from Ojibway prairie.

(18817) PALACIOS GONZÁLEZ, M.J. et al [20 Authors], 2010. *Catálogo regional de especies amenazadas de Extramadura. Fauna 1. Actualizado con los Libros Rojos de España*. Colección Media Ambiente, Junta de Extramadura. 342 pp. ISBN 978-84-606--4925-0.
The odon. are treated on pp. 28-51. Each sp. is described and sections are included on its status in Extremadura (Spain), distribution, diet, reproduction, phenology, behaviour (incl. the territoriality) and on conservation requirements. Portrait/s, a fig. of peculiar morphological features and a photograph of the habitat are also provided.

(18818) PARR, A.J., 2010. Monitoring of Odonata in Britain and possible insights into climate change. *BioRisk* 5: 127-139. – (10 Orchard Way, Barrow, Bury St Edmunds, Suffolk, IP29 5BX, UK).
The history of recording and monitoring of Odon. in Britain is briefly described. Results are then presented which suggest that the country's odon. fauna is currently in a period of flux, in a manner consistent with the actions of a high-level regulatory factor such as climate change. The ranges of many resident spp. are shifting. Leucorrhinia dubia has recently been lost from southern England, but many spp. are presently expanding their ranges to the N and W, some (such as Aeshna mixta and Anax imperator) with considerable speed. In addition to these changes, a number of "southern" spp. have started to appear in Britain for the very first time. These include Lestes barbarus, Erythromma viridulum (which has now become a locally-common resident in southeast England), Anax parthenope and Crocothemis erythraea. In addition to these distributional changes, some recent trends in flight times are also discussed. Evidence indicates that many spp. are now emerging significantly earlier than in the past, though trends relating to the end of the flight period are less clear cut.

(18819) PARR, A.J., 2010. Records of exotic Odonata in Britain during 2010. *Atropos* 41: 39-41. – (10 Orchard Way, Barrow, Bury St Edmonds, Suffolk, IP29 5BX, UK).
Ischnura senegalensis: 2 ♂, early June, emerged from a fish tank, Darlington, Durham; – 1 ♀ (orange phase, teneral), found indoors, 23-VI, Orpington, Kent; – 1 ♀ (orange phase), seen at a garden pond,

30-VIII, Dortford, Kent. – Crocothemis servilia: 1 ♂, emerged from a tropical fish tank, 16-I, Blackburn, Lancashire; – 1 ♂, emerged from a fish tank, 25-VI, Exeter, Devon. The records are discussed.

(18820) PAULA, M.C. & A.A. FONSECA-GESSNER, 2010. Macroinvertebrates in low-order streams in two fragments of Atlantic Forest in different states of conservation in the state of São Paulo (Brazil). *Braz. J. Biol.* 70(3/Suppl.): 899-909. (With Port. s.). – (Ecol. & Recur. Nat., Univ. Fed. São Carlos, C.P. 676, BR-13565-905 São Carlos, SP).
The larvae pertaining to 14 (identified) odon. gen. were collected in 4 streams.

(18821) PAYNE, J.L., C.R. McCLAIN, A.G. BOYER, J.H. BROWN, S. FINNEGAN, M. KOWALEWSKI, R.A. KRAUSE, Jr, S.K. LYONS, D.W. McSHEA, P.M. NOVACK-GOTTSHALL, F.A. SMITH, P. SPAETH, J.A. STEMPIEN & S.C. WANG, 2010. The evolutionary consequences of oxygenic photosynthesis: a body size perspective. *Photosynth. Res.* 2010: 22 pp.; – DOI 10.1007/s11120--010-9593-1. – (First Author: Dept Geol. & Envir. Sci., Stanford Univ., 450 Serra Mall, Bldg 320, Stanford, CA 94305, USA).
[Verbatim from p. 12, most bibl. references omitted]: Despite widespread awareness of Late Paleozoic gigantism, there have been few attempts to determine whether organisms the size of Carboniferous giants would be prohibited at present-day oxygen levels or whether the magnitude of temporal variation in maximum size within the relevant taxa has been of the magnitude predicted by modelled changes in pO_2. R. Okajima (2008, *Lethaia* 41: 423-430) was the first to examine the link between insect size and oxygen concentration quantitatively through the Phanerozoic, using newly compiled data on the sizes of fossil dragonflies. She found that the variation in maximum size of dragonflies through time has been much greater than predicted by variation in atmospheric oxygen concentrations, assuming respiration via diffusion through tracheae, and assuming that the sizes of Carboniferous dragonflies represent an oxygen-limited maximum size. If oxygen limited maximum body size in the Carboniferous, it has not consistently done so during other periods. Alternatively, if oxygen is limiting in the modern, then anatomical or physiological differences must exist between the Protodonata and Odonata to explain the inability of the Odon. to achieve similarly large sizes. The latter interpretation is suggested by the fact that all of the largest Paleozoic specimens belong to the Protodonata; Paleozoic members of the Odon. exhibit sizes comparable to the largest in the Mesozoic and Cenozoic. Alternatively, the simplifying assumption of oxygen diffusion through tracheae may be inaccurate; there is emerging evidence for active tracheal breathing in insects. Okajima (2008) proposed still another alternative: although variation in oxygen may have contributed to size evolution, maximum size of Mesozoic and Cenozoic dragonflies was limited by ecological competition with flying vertebrates. A further possibility, not examined by Okajima, is that the trend in maximum size of fossils is poorly correlated with the true evolutionary pattern. Temporal variation in the quality of the insect fossil record makes it difficult to determine the extent to which variation in maximum size in the fossil record reflects biological reality versus variation in the quality of available material. For example the Carboniferous contains an unusually extensive record of the coastal marsh environments that may be most likely to house large insects.

(18822) RAMAMURTHY, V.V., M.S. AKHTAR, N.V. PATANKAR, P. MENON, R. KUMAR, S.K. SINGH, S. AYRI, S. PARVEEN & V. MITTAL, 2010. Efficiency of different light sources in light traps in monitoring insect diversity. *Munis Ent. Zool.* 5(1) 109-114. – (Div. Ent., Indian Agric. Res. Inst., New Delhi-110012, India).
Field observations were conducted at weekly intervals in New Delhi (India) on the effect of mercury, black and ultraviolet light sources used in insect catching light traps and under different weather and air temperature (9.3-36.7ºC) conditions. For odon., the mercury light was most efficient, followed by black and UV light. The odon. also showed a positive significant correlation with rainfall, whereas the variation with respect to the average temperature, sunshine hours and average % of relative humidity was not statistically significant. Taxonomically, the taxa are treated on the order level only.

(18823) RESENDE, D.C. & P. DE MARCO, Jr, 2010. First description of reproductive behavior of the Amazonian damselfly Chalcopteryx rutilans (Rambur) (Odonata, Polythoridae) *Revta bras. Ent.* 54(3): 436-440. (With Port. s.). – (First Author: Lab. Bioinform. & Evol., Depto Biol. Geral, Univ. Fed. Viçosa, BR-36570-000 Viçosa, MG).

The research was conducted at a small creek in the Terra Firma Forest, central Amazon (Brazil), using mark-recapture techniques. ♂♂ were resident and territorial, though disputes were rare. Trunks (rotting wood) were important for ♂ persistence at sites, since these are the preferred oviposition locations. The mating system is comparable to the "resource limitation" category of Conrad & Pritchard (*OA* 8532), where ♂♂ cannot control ♀ access to oviposition sites. Therefore ♀ choice becomes important and, apparently, the observed displays (in which ♂♂ flash the coppery hindwing coloration) may be related to the attracting of ♀♀ to the territories, as a lek system.

(18824) RICHARDSON, J.S., Y. ZHANG & L.B. MARCZAK, 2010. Resource subsidies across the land-freshwater interface and responses in recipient communities. *River Res. Applic.* 26: 55-66. – (First Author: Dept Forest Sci., Univ. Brit. Columbia, Vancouver, BC, V6T 1ZA, CA).
Fluxes of resource subsidies, such as terrestrial leaf litter to streams and adult aquatic insects to riparian predators, are examples of important links between adjacent ecosystems. Fish predation on odon. larvae indirectly facilitates terrestrial vegetation reproduction, because insect pollinators are relieved from the predation pressure of dragonfly adults. As J.T. Ngai & D.S. Srivastava (2006, *Science* 314: 963) demonstrated, aquatic communities in epiphytic bromeliads containing zygopterans have lower rates of emergences of adult detritivorous chironomids, tipulids and scirtids. Intraguild predation by fish on invertebrate predators with terrestrial adult stages, such as odon., may indirectly increase terrestrial to aquatic subsidies by relieving terrestrial invertebrates from predation (cf. *OA* 16429).

(18825) ROWAN, B., 2010. Nine years on: revisiting the pond communities of the Lizard peninsula, UK. *Plymouth Student Scientist* 3(2): 40-59. – (c/o Dr D. Bilton, Sch. Marine Sci. & Engin., Univ. Plymouth, Drake Circus, Plymouth, PL4 8AA, UK).
A selection of ponds of various origin (natural depressions, agricultural & conservation based excavations, abandoned mining pits) was sampled in 2000 and again in 2009. The peninsula is classified as a Special Area of Conservation. Lestes sponsa occurred in 2009 but not in 2000. Sympetrum spp. are among the taxa used for SIMPER analysis of between year dissimilarity of pond communities. A list of spp. is not provided.

(18826) ŚNIEGULA, S. & F. JOHANSSON, 2010. Photoperiod affects compensating developmental rate across latitudes in the damselfly Lestes sponsa. *Ecol. Ent.* 35: 149-157. – (First Author: Dept Ecosyst Conserv., Inst. Nature Conserv., Pol. Acad. Sci., Mickiewicza 22, PO-31-120 Krakow).
Although there is a great deal of theoretical and empirical data about the life history responses of time constraints in organisms, little is known about the latitude-compensating mechanism that enables northern populations' developmental rates to compensate for latitude. To investigate the importance of photoperiod on development, offspring of the obligatory univoltine L. sponsa from 2 populations at different latitudes (53ºN and 63ºN) were raised in a common laboratory environment at both northern and southern photoperiods that corresponded to the sites of collection. Egg development time was shorter under northern photoperiod regimes for both populations. However, the northern latitude population showed a higher phenotypic plasticity response to photoperiod compared with the southern latitude population, suggesting a genetic difference in egg development time in response to photoperiod. Larvae from both latitudes expressed shorter larval development time and faster growth rates under northern photoperiod regimes. There was no difference in phenotypic plastic response between northern and southern latitude populations with regard to development time. Data on field collected adults showed that adult sizes decreased with an increase in latitude. This adult size difference was a genetically fixed trait, as the same size difference between populations was also found when larvae were reared in the laboratory. These results suggest phenotypic plasticity responses in life history traits to photoperiod, but also genetic differences between N and S latitude populations in response to photoperiod, which indicates the presence of a latitudinal compensating mechanism that is triggered by a photoperiod.

(18827) SUDO, S., 2010 Micro swimming robots based on small aquatic creatures. *In*: A. Mukherjee, [Ed.], *Biomimetics: learning from nature*. (ISBN 978--953-307-025-4), pp. 343-362, InTech. – (Author's address incomplete: Akita Prefect. Univ., JA).
Technical descriptions of the swimming mechanism of the adult diving beetle, Cybister japonicus, of a diving micro-robot based on its principles, and of the swimming mechanics of a young Sympetrum frequens larva are presented. A younger instar was

selected because it swims actively. In forward swimming of dragonfly larva, only the fore- and middle-legs are active as a thrust generator. Their orbits show almost the same and draw the circle partially of the orbit. The fore- and middle-legs beat almost synchronously. During the power stroke they are stretched and move, whereas the hind legs hardly move. The thrust-generating mechanism is related to the fore- and middle leg motion. The larva expands and contracts the abdomen, to move water during the forward swimming. This change in body length amounts to ca 10%. The legtips move at higher speed during the power stroke, and at lower speed during the recovery stroke. As shown in the present paper, it is possible to construct a micro-robot driving by the wireless energy supply system.

(18828) SZIVÁK, I., C. DEÁK, Z. KÁLMÁN, N. SOÓS, P. MAUCHART, A. LÖKKÖS, G. ROZNER, A. MÓRA & Z. CSABAI, 2010. Contribution to the aquatic macroinvertebrate fauna of the mountains Mecsek, with the first record of Limnius opacus P.J.W.Müller, 1806 in Hungary. *Acta biol. debrecina Oecol. Hung.* 21: 197-222. (With Hung. s.). − (First Author: Dept Gen. & Appl. Ecol., Univ. Pécs, Ifjúság útja 6, HU-7624 Pécs).
Presents records of Calopteryx virgo and Cordulegaster heros; − Hungary.

(18829) TROCKUR, B., J.-P. BOUDOT, V. FICHEFET, P. GOFFART, J. OTT & R. PROESS, 2010. *Fauna & Flora in der Grossregion, 1: Atlas der Libellen. / Faune & flore dans la Grande Région, 1: Atlas des libellules.* Zentrum für Biodokumentation Saarland, Landsweiler-Reden. 201 pp. Hardcover (24.7 × 23.7 cm). ISBN 978-3-938381-31-1. Price: € 24.90 net. Bilingual: Germ./Fr., with Engl. s.). − (Publishers: Am Bergwerk Reden 11, D-66578 Schilling).
The "Grossregion/Grande Région" covers Luxemburg and the provinces of Wallonia (Belgium), Lorraine (France), Rhineland-Palatinate and Saarland (both Germany). Within this territory are known 75 odon. spp. All data (117.053 records) collected in the databases of the 5 partner regions have been put together (updated up to 2006) and maps were constructed, marking the records made prior to 1990 and after that yr. (For Luxemburg, see also *OA* 16487; for Rhineland-Palatinate the database was constructed for the first time now). On the basis of the total number of grid cells (10 × 6', i.e. ca 134 km2 each cell) where a sp. was recorded, a simple analysis of the most common and the rarest spp. was conducted, and the spp. with the biggest increase and the biggest decline during the 2 time spans were compared. The maps also show the odon. "hotspots" (areas with a high number of different spp.) in the "Grossregion", which were identified by summarizing all spp. per grid cell. Range expansions or changes (observed or expected) are described and discussed. A photograph of a ♂ and a ♀ and 2 photographs of the characteristic biotopes are provided for each sp. The cross-border cooperation is emphasized, the experiences made in compiling the Atlas are discussed and suggestions for further cross-border cooperation are presented.

(18830) TUMILOVICH, O.A., 2010. Dozorshchik--imperator. − [Emperor dragonfly] Anax imperator Leach, 1815. *In*: V.P. Dedkov & G.V. Grishanov, [Eds], *Krasnaya kniga Kaliningradskoy oblasti: zhivotnye, rateniya, griby, ekosistemy*, p. 95, Immanuil Kant Russ. St. Univ., Kaliningrad. (Russ.). − (Kaliningrad St. Techn. Univ., Kaliningrad-236000, Russia).
Listing in the Kaliningrad Red Book (Russia), with information on the status of the sp. in the Kaliningrad province, its occurrence and habitats, biology and ecology, and on the measures required for its protection.

(18831) WENDZONKA, J., 2010. The 5th Polish Symposium of Odonatology: "Polish odonatology in the past, present and future", Jeziory, 23-25 October 2009. *Wiad. ent.* 29(2): 133-134. (Pol.). − (Graniczna 17, PO-63-800 Gostyn).
A detailed report on the Symposium, with highlights of the presented papers.

(18832) WONG-MUÑOZ, J., A. CÓRDOBA-AGUILAR, R. CUEVA DEL CASTILLO, M.A. SERRANO-MENESES & J. PAYNE, 2010. Seasonal changes in body size, sexual dimorphism and sex ratio in relation to mating system in an adult odonate community. *Evol. Ecol.* 2010: 17 pp.; − DOI 10.1007/s10682-010-9379-0. − (First Author: Depto Ecol. Evolutiva, Inst. Ecol., UNAM, Ciudad Universitaria, Apdo Postal 70-257, MX-04510 México, DF).
Seasonal environments impose developmental time constraints on insects which can be reflected in body size and sex ratio. By tracking these 2 aspects in recently emerged adults of 10 spp. of an odon. community in a number of lakes, it was investigated here whether (a) body size in both sexes decreased as

the flight season progressed and whether this led to seasonal changes in sexual size dimorphism (SSD); (b) SSD patterns were related to mating systems; (c) biases in sex ratio could be explained by mortality rates associated with the largest sex (e.g. in species with ♂-biased SSD, a ♀-biased sex ratio; in spp. with ♀-biased SSD, a ♂-biased sex ratio). The results indicated that adults in most spp., but not all, tend to reach a smaller body size as the season progressed. However, the opposite pattern was found in a few spp. Predictions about the relation between SSD and mating systems were confirmed: a ♀-biased SSD in nonterritorial spp. and monomorphism for territorial spp. However, predictions of biases in sex ration according to SSD were not met in all spp. Interestingly, changes in body size and SSD along the season were lake-specific in 2 spp. in which these patterns could be examined. These results, although partially supportive of environmental and sexual selection patterns acting on size and sex ratio as documented in other odon. spp., indicate that we are still far from understanding seasonal constrains in these animals.

(18833) WORTHEN, W.B., 2010. Flying dragons: a colorful field experiment in resource partitioning. *Am. Biol. Teach.* 72(7): 432-436. − (Dept Biol., Furman Univ., 3300 Poinsell Hwy, Greenville, SC 29613, USA).
Several common odon. spp. perch at different heights. Using dowels as perches and simple chi-square tests, the pattern of resource partitioning can be described quickly and easily. Additional experiments can examine the effect of interspecific competition on perch selection and the relationships between perching height, body size and wing aerodynamics. The frequency of perch events at different heights is shown for Celithemis eponina, Libellula luctuosa, Pachydiplax longipennis and Perithemis tenera.

(18834) ZHANG, H.-j. et al. [names of joint authors not transliterated], 2010. Distribution and species key of the genus Sympetrum in China. *J. Anhui Agric. Sci.* 38(14): 7386-7388, 7394. (Chin., with Engl. s.). − (Shaanxi Bioresour. Key Lab., Shaanxi Univ. Technol., Hanzhong-723000, China).
35 spp. are treated.

2011

(18835) CORBI, J.J., F.A. DOS SANTOS, R. ZERLIN, A. DOS SANTOS, C.G. FROELICH & S. TRIVINHO-STRIXINO, 2011. Assessment of chromium contamination in the Monte Alegre stream: a case study. *Braz. Archs Biol. Technol.* 54(3): 613-620. − (First Author: Depto Biol., Fac. Filos. Ciênc. Letras, Univ. São Paulo, Ribeirão Preto, SP, Brazil).
The stream is located in the Bueno de Andrade municipality (São Paulo, Brazil). The concentrations of chromium detected in the sediments and in the calopterygid, gomphid and libellulid larvae amounted to: upstream 8.02-10.9 mg kg^{-1} in sediment and to 0.42-0.46 in larvae. Downstream these values were 30.1-32.4 and 0.64-0.72 mg kg^{-1}, respectively.

(18836) DALZOCHIO, M.S., J.M. COSTA & M.A. UCHÕA, 2011. Diversity of Odonata from Serra da Bodoquena, Mato Grosso do Sul state, Brazil. *Revta bras. Ent.* 55(1): 88-94. (With Port. s.). − (Second Author: Depto Ent., Mus. Nac., UFRJ, Quinta da Boa Vista, São Cristovão, BR-20940-040 Rio de Janeiro, RJ).
From 4 lotic systems, 33 spp. are recorded.

(18837) [DIJKSTRA, K.-D.B.], 2011. Grootste ontdekkingsreis in 50 jaar: diep in Congo. − [The greatest discovery mission in 50 years: deep in Congo]. *Wetenschap in Beeld* 2011(7): 46-53. (Dutch). − (c/o Dr K.-D.B. Dijkstra, Naturalis, P.O. Box 9517, NL-2300 RA Leiden).
On the same expedition as in *OA* 18151, with reference to [over] 160 odon. spp. collected by K.-D.B.D.

(18838) DOLNÝ, A., D. BÁRTA, S. LHOTA, RUSDIANTO & P. DROZD, 2011. Dragonflies (Odonata) in the Bornean rain forest as indicators of changes in biodiversity resulting from forest modification and destruction. *Trop. Zool.* 24: 63-86. − (First Author: Dept Biol. & Ecol., Fac. Sci., Univ. Ostrava, Chittussiho 10, CZ-71000 Ostrava).
During 35 days, divided between 2 seasons, the odon. fauna was surveyed at Sungai Main Protection Forest (E Kalimantan, Indonesia) and 88 spp. were recorded. Seasonal differences in species diversity were fairly small. The highest species diversity was observed in intact primary forest: 60 % of all recorded spp. were found there and 32 % of all spp. were exclusive to this habitat. The proportion of biotope specialists decreased along the gradient: intact primary forest, slightly degraded primary forest, secondary forest, heavily degraded forest and non-forest. The ordination obtained from detrended correspondence analysis showed, along the main axis, a gradient in

community similarity corresponding to the degree of forest degradation. The evidence indicates that, within the applied spatial scale, any forest degradation results in fewer spp., with a pronounced change in the species composition, and an overall reduction in taxonomic diversity.

(18839) *IDF-REPORT*. Newsletter of the International Dragonfly Fund. ISSN 1435-3393, Vols 40 (Sept. 2011), 41 (Sept. 2011). – (c/o M. Schorr, Schulstr. 7/B, D-54314 Zerf).
[Vol. 40]: *Kosterin, O.E.*: Odonata of the Cambodian coastal regions: beginning of dry season in 2010 (pp. 1-108); – [Vol. 41]: *Schröter, A.*: Review of the distribution of Somatochlora sahlbergi (Odonata: Corduliidae) (pp. 1-27).

(18840) IGNATAVICIUS, G., M. RAULINAITIS & N. GERDVILIS, 2011. Assessment of the effects of mechanical bottom sludge removal from lakes Didžiulis and Lentvaris (Trakai district) based on macrozoobenthos indicators. *Environmental Engineering* [Proc. 8th Int. Conf.], Vilnius. ISBN 978-9955-28-827-5. – (First Author: Vilnius Univ., Universiteto 3, LT-01513 Vilnius).
In the past, the 2 lakes were heavily polluted by municipal wastewater, which resulted in large volume of bottom sledge, high amounts of biogenic substances and deterioration of aquatic ecosystems. In 2008, mechanical restoration was applied by removing a great volume of the sludge. 5 odon. spp. are recorded and for 3 of these the abundances in 2007, 2008 and 2009 are stated.

(18841) *INTERNATIONAL JOURNAL OF ODONATOLOGY* (ISSN 1388-7890), Vol. 14, No. 1 (dated 1 March 2011, received 16 Aug. 2011).
Haritonov, A. & O. Popova: Spatial displacement of Odonata in south-west Siberia (pp. 1-10); – *Kalkman, V.J. & R.J.T. Villanueva*: A synopsis of the genus Rhinagrion, with description of two new species form the Philippines (Odonata: Megapodagrionidae) (pp. 11-31); – *Reels, G.T.*: Emergence patterns and adult flight season of Anisoptera at a managed wetland site in Hong Kong, southern China (pp. 33-48); – *Conniff, K.L., N.E. van der Poorten & S. Gunasingha*: Description of the female of Mortonagrion ceylonicum Lieftinck, 1971 and amended description of the male (Zygoptera: Coenagrionidae) with notes on habitat, distribution and behaviour (pp. 49-53); – *Zhang, H., V.J. Kalkman & X. Tong*: A synopsis of the genus Philosina, with descriptions of the larvae of P. alba and P. buchi (Odonata: Megapodagrionidae) (pp. 55-68); – *Matushkina, N.A. & P.H. Lambret*: Ovipositor morphology and egg laying behaviour in the dragonfly Lestes macrostigma (Zygoptera: Lestidae) (pp. 69-82); – *Sasamoto, A., N. Yokoi & T. Teramoto*: Description of a new Sinogomphus from northern Laos (Odonata: Chlorogomphidae) (pp. 83-89); – *Pérez-Gutiérrez, L.A. & J.M. Montes-Fontalvo*: Rediscovery of Mesagrion leucorrhinum (Zygoptera: Megapodagrionidae): a "formal" description of female and ultimate stadium of larva with notes on habits (pp. 91-100); – *Martens, A. & K. Grabow*: Early stadium dragonfly larvae (Odonata: Coenagrionidae) as prey of an aquatic plant, Utricularia australis (pp. 101-104).

(18842) KALNINŠ, M., R. BERNARD & I. MIKELSONE, 2011. Protected aquatic insects in Latvia: Nehalennia speciosa (Charpentier, 1840) (Odonata: Coenagrionidae). *Latv. Ent.* 50: 41-54. – (First Author: Nat. Conserv. Agency, Siguldas novads, Baznicas iela 7, LV-2150 Sigulda).
An analysis of N. speciosa distribution, population size, habitat selection and conservation status in Latvia is presented, based on published and all known unpublished data. The distribution is mapped (38 recent localities, mostly in NE and SE parts of the country). Most populations seem to be small.

(18843) LI, J.-K., A. NEL, X.-P. ZHANG, G. FLECK, M.-X. GAO, L. LIN & J. ZHOU, 2011. A third species of the relict Epiophlebiidae discovered in China (Odonata: Epiproctophora). *Syst. Ent.* 2011: 5 pp.; – DOI: 10.1111/j.1365-3113.2011.00610.x. – (Second Author: Entomologie, Mus. Natn. Hist. Nat., 45 rue Buffon, F-75005 Paris).
Epiophlebia sinenesis sp. n. is described and illustrated from 2 adult ♂♂. Holotype ♂: along the Zheng-nan-gou stream (alt. 352-500 m), Shahezi Zhen, Wuchang, Heilongjiang prov., China, 20/21-VI-2010; deposited in Coll. Geogr. Sci., Harbin Normal Univ., Harbin, China. The 3 now known Epiophlebia spp. are keyed.

(18844) *LIBELLULA*. Zeitschrift der Gesellschaft deutschsprachiger Odonatologen, GdO (ISSN 0723-6514), Vol. 30(1/2) (1 Aug. 2011). Mostly Germ., with Engl. s's & Engl. Contents tab.). – (c/o T. Fliedner, Louis-Segelken-Str. 106, D-28717 Bremen).
Olthoff, M., N. Menke & J. Rodenkirchen: Rediscov-

ery of Leucorrhinia caudalis in North Rhine-Westphalia, Germany (Odonata: Libellulidae) (pp. 1-12); – *Gospodinova, H., H.-W. Wünsch & S. Heydrich*: First reproduction record of Epitheca bimaculata in North Rhine-Westphalia, Germany (Odonata, Corduliidae) (pp. 13-18); – *Pix, A.*: A gynandromorph of Cordulegaster bidentata from the Weser Hills, northern Germany (Odonata: Cordulegastridae) (pp. 19-24); – Variation of the anal triangle of Cordulegaster bidentata (Odonata: Cordulegastridae) (pp. 25-32); – *Weihrauch, F., A. Karle-Fendt, J.E. Krach, M. Lohr & R. Seidenbusch*: Coenagrion scitulum in Bavaria, Germany: correction and status quo (Odonata: Coenagrionidae) (pp. 33-42); – *Hunger, H.*: Rediscovery of Coenagrion scitulum in Baden-Württemberg after almost 90 years (Odonata Coenagrionidae) (pp. 43-50); – *Lingenfelder, U.:* Coenagrion scitulum in southwestern Germany and adjacent regions – a current survey (Odonata: Coenagrionidae) (pp. 51-64); – *Festi, A.*: Aeshna subarctica elisabethae, new to the fauna of Italy (Odonata: Aeshnidae) (pp. 65-76); – *Monnerat, C. & R. Hoess*: Odonata from Jordan, the West Bank and Lebanon, collected by Johann Friedrich Klapperich between 1956 and 1969 (pp. 77-88); – *Baierl, E.*: Large Psammodromus, Psammodromus algirus, captures a mating wheel of Orthetrum chrysostigma (Squamata: Lacertidae; Odonata: Libellulidae) (pp. 89-91).

(18845) *ODONATOLOGICAL ABSTRACT SERVICE* (ISSN 1438-0269), Nos 31 (59 pp., June 2011), 32 (60 pp., Sept. 2011), – (Distributor: M. Schorr, Schulstr. 7/B, D-54314 Zerf).
Abstract Nos 9968-10316 and 10317-10678, respectively.

(18846) *ODONATRIX*. Bulletin of the Odonatological Section of the Polish Entomological Society (ISSN 1733-8239), Vol. 7, Nos 1 (31 Jan. 2011), 2 (31 Aug. 2011). (Pol., with Engl. s's). – (c/o Dr P. Buczyński, Dept Zool., UMCS, Akademicka 19, PO-20-033 Lublin).
[No. 1]: *Bernard, R. & G. Tończyk*: New localities of Nehalennia speciosa (Charpentier, 1840) in southeastern Poland (pp. 14-18); – *Holly, M.*: New and rare dragonflies (Odonata) in the Bieszczady National Park recorded in 2009 and 2010 (pp. 19-23); – *Konopko, D.*: New locality of Nehalennia speciosa (Charpentier, 1840) in the Tricity Landscape Park (pp. 24-27); – *Book reviews*, by P. Buczyński & J. Wensonka (pp. 27-32). – [No. 2]: *Dobrzańska, J., S. Filipowicz, A. Sikora & E. Pelnia-Iwanicka*: Dragonflies (Odonata) of chosen oxbow lakes of the Vistula river in Warsaw (pp. 33-40); – *Buczyński, P., P. Mikolajczuk & G. Tończyk*: New records of Coenagrion armatum (Charpentier, 1840) on the southwestern edge of its distribution area (central and eastern Poland) (pp. 41-47); – *Buczyński, P., L. Dawidowicz, G. Wagner & W. Jarska*: Anax ephippiger (Burmeister, 1839) in Polish part of the Lithuanian Lake District (pp. 48-49); – *Matos da Costa, J.*: First records of some dragonfly (Odonata) species in the Narew National Park (pp. 50-51); – *Żurawlew, P.*: Rediscovery of Onychogomphus forcipatus (L., 1758) in an isolated distribution island within the Gnieźnieńskie Lakeland (central-western Poland) (pp. 52-53); – The locality of Sympetrum meridionale (Selys, 1841) in the Sieradz Basin (central Poland) (pp. 54-55); – *Dolata, P.T.*: The site of Leucorrhinia caudalis (Charpentier, 1840) and Bucephala clangula (L, 1758) (Aves: Anseriformes) in the river Noteć valley near Czarnków (northern Wielkopolska) (pp. 55-57); – *Buczyński, P.*: First records of Lestes barbarus (Fabricius, 1798) and Erythromma viridulum (Charpentier, 1840) in islands Wolin and Uznam (pp. 57-58); – Polish and to Poland dedicated odonatological papers, 9: 2010 (pp. 59-64).

(18847) *TOMBO. ACTA ODONATOLOGICA JAPONICA* (ISSN 0495-8314), Vol. 53 (Memorial issue for the late Dr S. Asahina) (15 Apr. 2011). (Engl. & Jap., mostly with Engl. titles). – (c/o S. Wada, 8-18, Nishikida 3-chome, Fukui, 918-8004, JA).
[List of Engl. titles]: *Inoue, K.*: Dr Syoziro Asahina, grandfather of odonatology in Japan (pp. 5-7); – *Ubukata, H.*: Dr Syoziro Asahina's accomplishment and his contribution in odonatology (pp. 13-15); – *Van Tol, J.*: Dr Syoziro Asahina, his importance for our knowledge of the Odonata, his importance for our knowledge of the Odonata of Southeast Asia (pp. 16-17); – *Eda, S., I. Kawashima, A. Sasamoto, Y. Saito & K. Inoue*: A checklist of publications by Dr Syoziro Asahina, 1928-2010 (pp. 38-58); – *JSO Editorial Secretary*: List of the odonate scientific names described by late Dr S. Asahina (pp. 59-66); – *Futahashi, R.*: A revisional study of Japanese dragonflies based on DNA analysis, 1 (pp. 67-74); – *Karube, H.*: Two new species of the family Aeshnidae (Anisoptera) from central Vietnam (pp. 75-80; Cephalaeschna asahinai sp. n., Planaeschna asahinai sp. n.); – Vietnamese Odonata collected in 1992--2003 surveys, 2: Macromiidae and Corduliidae (pp.

81-91; Idionyx asahinai sp. n.); – *Kawashima, I. & I. Tsuji*: An intergeneric tandem formation observed between a male Anax parthenope Julius Brauer and a female Boyeria maclachlani Selys (pp. 91-92); – *Kawashima, I., A. Sasamoto, Q.T. Phan & M.C. Do*: First discovery and description of female and larva of Rhinagrion hainanense Wilson & Reels, 2001 (= R. yokoii Sasamoto, 2003) (Zygoptera: Megapodagrionidae) from Vietnam (pp. 93-99); – *Itoh, S.*: A new record of Sympetrum s. speciosum Oguma, 1915 from Miyago prefecture, the northern Honshu, Japan (pp. 99-100); – *Naraoka, H.*: Reproductive behaviour of Coenagrion terue (Asahina, 1949) (Zygoptera, Coenagrionidae), with special reference to repeated interruptions of the copulation and a long pre-ovipositional tandem linkage (pp. 101-109); – *Kawashima, I.& Y. Suzuki*: An intergeneric tandem formation observed between a male Orthetrum albistylum speciosum (Uhler) and a female Sympetrum frequens (Selys) (p. 110); – *Karube, H., R. Futahashi, T. Odajima, A. Odajima & K. Odajima*: An occurrence of southeastern Asiatic species, Pseudagrion australasiae Selys in Japan: a possible case of accidental introduction (pp. 111-114); – *Ozono, A., R. Futahashi & A. Ozono*: An interspecific hybrid between Anax parthenope julius female and A. panybeus male (pp. 115-118); – *Kitayama, T. & R. Futahashi*: The first record of interspecific hybrid between Anax n. nigrofasciatus Oguma, 1915 and Anax parthenope julius Brauer, 1865 from Okayama prefecture, Honshu, Japan (pp. 119-120).

(18848) VILLANUEVA, R.J.T. & M. SCHORR, 2011. Two new damselfly species from Polillo island, Philippines (Odonata: Platystictidae). *Zootaxa* 3017: 46-50. – (Second Author: Schulstr. 7/B, D-54314 Zerf). Drepanosticta wildermuthi sp. n. (holotype ♂: Pinaglubayan, Polillo isl., Philippines, 27-III-2010) and Sulcosticta vantoli sp. n. (holotype ♂: Tamulaya area, Polillo isl., Philippines, 25-IV-2005) are described, illustrated and compared with D. moorei and S. viticula, respectively.

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(18849) *AGRION, WDA*. Newsletter of the Worldwide Dragonfly Association (ISSN 1476-2552), Vol. 16, No. 1 (Jan. 2012). – (c/o R.W. Reimer, Villa 2, Compound 12, 0th St., Al Ain, Al Mnaizlah, Falaj Hazzaa, United Arab Emirates).
[Selected articles]: *Theischinger, G.*: Surprise rediscovery of Acanthaeschna victoria, a key taxon in dragonfly evolution (Odonata, Aeshnoidea, Telephlebiidae) (pp. 4-9); – *Averill, M.*: Sympetrum faonscolombii in Lanzarote, an example of coping with arid climates (pp. 10-11); – *Guillerma-Ferreira, R.*: Female courtship in Mnesarete lencionii? (p. 14); – *Davidson, S.*: Pantala flavescens an ancient mariner (p. 15); – *Day, L., D. Farrell, E. Gibert, A. Günther, M. Hämäläinen, E. Klimsa, A. Korshunov, O. Kosterin, N. Makbun, A. Pelegrin, U. Röder, R. Ruangrong & N. Vikhrev*: New provincial records of Odonata from Thailand mostly based on photographs (pp. 16-25); – *Wilson, K.D.P.*: Atractocerus sp. (Coleoptera: Lymexylidae) a damselfly-looking beetle (p. 26); – *New books* (pp. 27-29).

(18850) BATES, L.M. & B.D. HALL, 2012. Concentrations of methylmercury in invertebrates from wetlands of the Prairie Pothole Region of North America. *Envir. Pollut.* 160: 153-160. – (Second Author: Dept Biol., Univ. Regina, 3737 Wascana Parkway, Regina, SK, S4S 0A2, CA).
Prairie wetlands may be important sites of mercury (Hg) methylation resulting in elevated methylmercury (MeHg) concentrations in water, sediments and biota. The odon. larvae (Lestidae, Coenagrionidae, Aeshnidae, Libellulidae) were among the organisms examined from the sites located 40 km E from Saskatoon (Canada). Mean MeHg concentrations and mean percent MeHg of total Hg are stated for the order.

(18851) SALUR, A., Ö. DOĞAN & Y. YAĞIZ, 2012. Odonata fauna of Pülümür (Turkey: Tunceli prov.). *Munis Ent. Zool.* 7(1): 359-362. – (Dept Biol., Fac. Arts & Sci., Hitit Univ., TR-19030 Corum).
Records of 24 spp.; – E Anatolia.

(18852) SALUR, A., A. MIROĞLU & B. OKÇU, 2012. Odonata fauna of Tokat province (Turkey). *Munis Ent. Zool.* 7(1): 339-343. – (First Author: Dept Biol., Fac. Arts & Sci., Hitit Univ., TR-19030 Corum).
Records of 30 spp.; – Black Sea Region of Anatolia.

ERRATUM

(18624) The correct authorship of this excellent book is HAWKING, J. & G. THEISCHINGER. The address of the first Author is: Coop. Res. Cent., Freshw. Ecol., P.O. Box 921, Albury, NSW 2640, AU.

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ASANA, J.J. & S. MAKINO, 1935. A comparative study of the chromosomes in the Indian dragonflies. *J. Fac. Sci. Hokkaido Univ*. (VI) 4: 67-86.

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.

The abbreviations of the titles of journals should be strictly in accordance with the World List of Scientific Periodicals.

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