ODONATOLOGICA

JOURNAL
OF
THE
SOCIETAS
INTER-
NATIONALIS
ODONATO-
LOGICA
S.I.O.

MALE HARASSMENT AND FEMALE ENERGETICS
IN THE TERRITORIAL DAMSELFLY
HETAERINA AMERICANA (FABRICIUS)
(ZYGOPTERA: CALOPTERYGIDAE)

A. CÓRDOBA-AGUILAR* and D.M. GONZÁLEZ-TOKMAN
Departamento de Ecología Evolutiva, Instituto de Ecología,
Universidad Nacional Autónoma de México, Apdo. Postal 70-275, Ciudad Universitaria,
MX-04510, Mexico D.F., Mexico

The possible energetic costs due to ♂ harassment in *H. americana* ♀♀ were explored by investigating: (a) changes in thoracic and abdominal fat during ♀ adulthood, (b) the fat budget after each of the 2 matings that ♀♀ engage in during 2 seasons of varying ♂ harassment, (c) the fat imbalance due to ♂ harassment in the thorax (where fat is used mainly for flying) and abdomen (where fat is used to produce eggs), (d) whether re-mating takes longer when harassment is high compared to when harassment is low, and (e) the feeding rate after each mating in both seasons to see whether ♀♀ balance the energetic resources they spend. ♀♀ gained fat resources after emergence but lost fat when they became old. Fat decreased more in the 'high harassment' season than in the 'low harassment' season; in the former, fat was reduced more intensively after a second mating. Thoracic fat decreased to a lower level after the second mating in the 'high harassment' season compared with the 'low harassment' season. When harassment was high, re-mating took longer than when harassment was low. Feeding was similar between seasons. These results suggest substantial energetic costs for ♀♀ due to ♂ harassment.

INTRODUCTION

Current sexual conflict ideas indicate that males and females do not necessarily share the same reproductive interests. The reason is that both sexes differ in how they maximize reproductive success. In the case of males, high mating rates are

* **Corresponding author**: Phone ++ 52 55 56 22 9003; − Fax ++ 52 55 56 22 8995; − acordoba@ecologia.unam.mx

essential while for females a few matings allow them to secure enough sperm for fertilizing all their eggs. Fitness is thus maximized differently as mating rate levels of females are considerably lower to those of males (PARKER, 1970, 1979). This is one reason why males consistently harass females to subdue them to mate. Male harassment however entails a cost for females, including reduced survival and fecundity (reviewed by ARNQVIST & NILSSON, 2000; LESSELLS, 2006). Nevertheless, little is known in relation to the proximate detrimental effects that male harassment bears for females, which may help to explain these negative effects. Available evidence suggests that female resistance to male harassment causes a high energetic expenditure for females (JORMALAINEN, 1998; WATSON et al., 1998; VALERO et al., 2005) and two causal factors are a reduction in feeding rate (EREZ et al., 2005; PLATH, 2008) and a costly energetic behavioural response by females (VALERO et al., 2005). In our view, documenting such causal effects has lagged behind in studies of sexual conflict. As has occurred with many sexual selection studies (see also IRSCHICK et al., 2007), ignoring such functional aspects has impeded our understanding of the mechanisms by which female's condition may be affected by male harassment.

One proximate cost that may be paid when dealing with male harassment is a reduction in fat reserves. After the pre-mature stage, both sexes struggle to find dietary resources which could be directly accumulated or be used to construct fat reserves. Examples of situations in which fat reserves are heavily utilized are male-male aggressive encounters (e.g. LAILVAUX & IRSCHICK, 2006), escape from predators (e.g. MacLEOD et al., 2007), migration (McWILLIAMS et al., 2004), hibernation (e.g. HUMPRHIES et al., 2003) and egg production (e.g. JERVIS et al., 2005. Thus the level of fat reserves is a likely candidate when looking at how females could be using energy. Surprisingly, such an idea appears never to have been tested.

The use of fat reserves has been widely investigated in odonates (dragonflies and damselflies) but, whereas there is good evidence of how fat is used in males (they mostly spend their fat reserves during aerial fights or to defend or obtain a mating territory (reviewed by SUHONEN et al., 2008)), little is known about how females make use of their fat reserves. Besides using fat for producing eggs, females sometimes incur in flying activities whose costs may not be trivial. For example, it is known that males frequently harass females in odonates (e.g. CORDERO, 1999; McMILLAN, 2000; CORDERO RIVERA & ANDRÉS, 2002; KOCH, 2006) which is also the case in other insects (reviewed by ARNQVIST & NILSSON, 2000). There is some evidence suggesting that females incur fitness costs due to male harassment in odonates. Thus GOSDEN & SVENSSON (2007) found that, in a damselfly with polymorphic females, the different female morphs have evolved different egg number allocation strategies to deal with the high levels of male harassment. Despite this knowledge, it is unclear how female energetic reserves become affected by male harassment.

We have here investigated whether male harassment causes a reduction in fat reserves in females, using *Hetaerina americana* as a study subject. In this species males defend riverine territories. Females arrive at these sites to mate and are chased by a territorial male, who takes her to a "communal" oviposition site (RAIHANI et al., 2008). During these visits, females are frequently assaulted by other males that try to dislodge the male in tandem (CÓRDOBA-AGUILAR, 2009a). Male harassment in this species varies during the year, being higher when density is low (from January to April), and lower when density is high (from July to October; CÓRDOBA-AGUILAR, 2009a). There is good experimental evidence indicating that male harassment has fitness and energetic costs for females: high levels of harassment lead to lower survival and fecundity, besides reducing fat thoracic reserves and immune ability of females (CÓRDOBA-AGUILAR, 2009a). However, there are details to be clarified in relation to these costs. One is that the reduction was only documented for the first of the two visits females make to the river for copulating and ovipositing. It is unknown how much energy is spent in each of the two river visits (occasionally, three visits are carried out but this occurs primarily when harassment is low (CÓRDOBA-AGUILAR, 2009a) and whether such costs are variable depending on the level of harassment (e.g. low energetic costs because of a low level of harassment). If females do not replenish fat resources before re-mating (i.e. by acquiring more food between matings), a second visit to the river could dramatically decrease fat reserves. Furthermore, such expenditure would be higher if male harassment is high. Also fat costs were documented only for the thorax region by CÓRDOBA-AGUILAR (2009a). Although this is the place where stored energy is used for flying (MARDEN, 1989), the abdomen may also suffer a negative effect. For example, and according to a scenario of a resource conflict allocation (ROFF, 1992), abdominal fat could be used to compensate an extreme cost in thoracic fat and enable flying to continue (other regions such as legs, head and wings, are not considered as they contain negligible levels of fat; PLAISTOW & SIVA-JOTHY, 1996). In female odonates and compared to males, relatively higher levels of fat are located in the abdomen presumably because this is the site where fat is used for egg construction (AN-HOLT et al., 1991). However, compensating loss of thoracic fat by using that of the abdomen may come with a cost. Females on a second mating may end up with less abdominal fat, which means that fewer resources would be available for egg production. This situation would be harder especially if male harassment is high. How females balance such fat loss is unknown. One other issue is the time interval between matings. One would expect that the interval between matings will be longer in a high harassment situation. This is because females will take longer to recover in terms of resource acquisition to produce a new egg batch and then visit the river to re-mate and oviposit again. Finally, it would be interesting to see how females would replenish such fat expenditure after each mating visit and levels of male harassment. One would expect that feeding rates will be high-

er after the second mating compared with the first and when male harassment is high compared to when this is low.

Our approach in this study is observational, aimed to fulfill the gaps not covered by the experimental evidence previously provided in this species (CÓRDOBA--AGUILAR, 2009a). A manipulative initiative to uncover how male harassment affects female energetics is not needed here as the foundation of this was already established by previous experimental evidence.

First, we documented fat changes during female adulthood to gain a broad idea of how adult females construct and spend their fat reserves. Second, we determined how females spend their energetic reserves according to each of the two visits they usually make to the river and according to two levels of male harassment (as explained before, females may make a third visit and mating but since this only occurs when there is low harassment, there will be no way to compare this for both harassment levels). Third, we investigated how females spend and possibly re-allocate fat resources between thoracic and abdominal stores according to the number of matings and harassment levels. Fourth, we describe and compare how long the time interval is between first and second mating in relation to both seasons. Finally, we provide data of how frequently females feed prior and after each female mating in the high and low harassment seasons.

MATERIAL AND METHODS

FEMALE FAT ACCORDING TO ADULT AGE. − Females were collected with a butterfly net in September and October 2008 in the Amacuzac river (18°32'56" N, 99°16'23" W), in Tehuixtla, Morelos, México, and were kept in ethanol 70% for later analyses. Individuals were measured from the tip of the head to the end of the last abdominal segment with a digital caliper (± 0.1 mm), and were classified into four age classes: the first class, teneral, comprised the youngest, newly emerged females, whose pigmentation patterns in thorax, abdomen and wings had not been fixed yet, and their exoskeleton was still not rigid (N = 20); the second stage comprised young individuals, with the exoskeleton still not rigid, with dorsoventrally flexible, undamaged wings and pigmentation patterns already fixed (N = 21); the third stage comprised mature females with a rigid exoskeleton but no signs of aging (N = 29); the last stage included old females, with inflexible, papery-like and frequently broken wings, with some signs of pruinescence in the abdomen and the thorax (N = 9). However, our age classification was able to predict survival expectancies according to male harassment intensity (CÓRDOBA-AGUILAR, 2009a). Furthermore, this classification has proven to make sense when interpreting real age differences in odonates in general (CORBET, 1999).

VARIATION IN FEMALE FAT ACCORDING TO MATING ORDER AND HARASSMENT SEASON. − We were able to track females that were marked since they were young in a ca. 70 m stretch of the same Amacuzac river in April and July 2000. These months show extremes in male harassment intensity: while harassment is high in April, it is low in July (CÓRDOBA-AGUILAR, 2009a, 2009b). We took advantage of one particular behaviour both adults use throughout their entire life which is the use of communal roosting places (usually bushes and small trees), located close to the river and used when animals are not engaged in sexual activities (GRETHER & SWITZER, 2000). There were two discrete roosting places (ca height 1.0-2.5 m, width 0.5-1.5) at which animals arrived on a daily basis. Every day, we looked for young females that we assumed were virgin, to mark. Similar to the first stage in our female age classification, physical appearance of these animals is that

their exoskeleton has not hardened yet, as judged by being easily bent when gently pressed, which is an indicator that they are virgin (unpub. data). Nevertheless, to see whether this was true, 6 females with this characteristic were captured and their spermatheca and bursa copulatrix were dissected to see whether they had sperm stored in these sites. In none of these cases did females have sperm. Additionally, the sperm storage organ tissues were shrunk (i.e. folded), which is an indicator that they were not yet sexually mature (i.e. CÓRDOBA-AGUILAR, 2003). We marked 158 females in April and 121 in July. Marking was carried out from 1600 to 1800 hrs, by writing an individual three-digit number on the distal portion of the right forewing using a black ink pen. Total handling time for each individual did not last more than three minutes, after which animals were put back where they had been originally collected.

On a daily basis during 25 days in April and July, marked females were recorded both when they were in the communal roosting sites and also while at the river (from 0900-1500 hrs) to record their sexual activities. When a marked female was found at the river, it was observed until it left. With this procedure, we were able to have a lifetime record of two types of sexual activities females engaged in: number of matings and the intensity of male harassment they faced. For the former variable, we paid special attention to whether females mated during their visit. As a measure of harassment, we recorded the number of male approaches that females received in their visits. We recorded how many times a female was approached by any male, since we first detected her until she left the river. Such approaches were carried out either by the same or different males and included behaviour of varying nature (e.g. from chasing her to actually making contact with her). We did not include male-female interactions at the roosting sites as sexual-based approaches are non-existent in such sites (GRETHER & SWITZER, 2000). With our daily recording, we were able to track 14 marked females in April and 18 in July from which mating occurrence and male harassment were recorded. For fat measurements, we collected two sets of females that were independent from those whose mating activity and harassment had been recorded. This second set consisted of females that mated and oviposited for their first time, and females that mated and oviposited for their second time. We assume oviposition events were those followed by copulation as females in this species have never been observed to visit the river and oviposit without an immediately previous mating (CÓRDOBA-AGUILAR, unpub. data). Sample sizes in this female set were: 9 females with one mating and 10 with two matings for April, and 11 females with one mating and 9 females with two matings for July. These females were placed in a paper envelope within a dark, cool (ca 8-10 °C) box to reduce the animal's activity (so that energy expenditure is reduced). For comparing the time elapsed between matings for both seasons, we used the data (in days) of those females whose sexual history (matings and male harassment) was recorded (N = 14 females from April; N = 18 females from July).

FEEDING RATE. — We recorded this by using a subset of the female group whose sexual history (matings and male harassment) was tracked according to season: 10 females from the low harassment season and 13 from the high harassment season. These females were followed to observe their feeding patterns. Focal animals were observed in the roosting places for one hour in the two hours (1600-1800 hrs) that activity in the evening takes place. In these locations and during the afternoon, females mostly engage in feeding activities, which consist of chasing any passing small-sized insect (e.g. Diptera, Ephemeroptera and/or Lepidoptera), trying to capture it, and returning to their original perching leaf or twig (GRETHER & GREY, 1996). *H. americana* usually perches at the tops of emergent tree parts and towards sun rays when preying, and each catching prey flight lasts no more than three seconds. When a prey is caught, this is visibly clear in the mouthparts of the damselfly when it has returned to its perching site (CONTRERAS-GARDUÑO et al., 2009). It is in this perching place where the prey is consumed. These conditions allowed us recording the number of successful prey-catching attempts. This number was related to each female's sexual history. Each female was observed for one hour at three different times in their life: prior to copulation, one day after the first copulation and one day after the second copulation. Thus, each female was observed for a total of three hours. We admit, however, that the number of prey caught is a conservative measure of how

much an animal has eaten, as prey may vary in a number of traits (e.g. size) which may provide differences in nutritional content (GRETHER & GREY, 1996). Also, our recordings are by not means lifetime-based. Our results, thus, have to take these restrictions into account.

FAT MEASUREMENT. − Thoracic and abdominal fat reserves were quantified. The other body parts were separated and, following the protocol of PLAISTOW & SIVA-JOTHY (1996), both thorax and abdomen were placed in a desiccator and fat was extracted via chloroform immersion. Each body region was weighed to the nearest 0.01 mg previous to and after the extraction. Total fat for each region is interpreted as the difference between prior and after weight recording.

STATISTICAL ANALYSES. − For testing differences in the fat load of females of different ages, we carried out a one way analysis of variance with a Tukey post-hoc test in the case of thoracic fat. Since for total, abdominal and relative thoracic/abdominal fat, variances were not homogeneous between females of different ages (Levene $P < 0.05$), we carried out Kruskal-Wallis tests and Tamhane's post-hoc comparisons. Relative differences were used particularly to see how much each region becomes unbalanced in fat in relation to the other region, presumably because in the two regions gain or lose fat at different age stages. Differences in fat load between the high harassment and the low harassment seasons, and between a first and a second mating event were tested using t-tests. Differences in male harassment in April and July were analysed using t-tests and log_{10} transformed data. Time (in days) when matings took place according to season was compared using t-tests.

In order to test for differences in feeding rate during the females' life in the two seasons, we carried out a general linear model with repeated measures, with the number of mating events as a within-subjects factor and the season as a between-subjects factor. The interaction of both factors was included in the model. Multiple comparisons were analysed with Tukey post-hoc tests.

Kolmogorov-Smirnoff and Levene tests were used for testing normality and homogeneity of variances respectively. Results are indicated as mean ± SD unless otherwise indicated. Analyses were carried out using SPSS version 13.0.

RESULTS

FEMALE FAT ACCORDING TO ADULT AGES

Females of different ages did not differ in body size ($F_{3,78} = 0.811$, $P = 0.320$, $N = 79$). There were significant differences between females of different ages in abdominal fat content ($\chi^2 = 17.208$, $P = 0.001$; Fig. 1a) and thoracic fat content ($F_{3,78} = 13.534$, $P < 0.001$; Fig. 1b) and in the proportion of fat allocated to each body part ($\chi^2 = 11.761$, $P = 0.008$; Fig. 1c). Abdominal fat increased from the teneral stage until sexual maturity was reached (Tamhane's $P < 0.001$). Thoracic fat increased and reached its maximum in the young adult stage (Tukey's $P < 0.001$), remaining constant until old age (Tukey comparisons $P < 0.05$). The female's thorax gained in the relative mass of fat from teneral to young adult (Tamhane's $P = 0.034$) but there were no differences with mature females (Tamhane's $P > 0.05$).

VARIATION IN FEMALE FAT ACCORDING TO MATING ORDER
AND HARASSMENT SEASON

In April, harassment was higher ($13.571 ± 9.246$, $N = 14$) than in July ($4.055 ± 0.438$, $N = 18$; t test = 6.009, $P < 0.0001$). There was a difference in total fat for

both seasons (t = -5.355, P < 0.001, d. f. = 25.102, N = 39; t-test was carried out without assuming homogeneous variances: Levene P < 0.001) in which females in the high harassment season had lower fat reserves (2.20 ± 1.03 mg) than females in the low harassment season (3.60 ± 0.48 mg). In the high harassment season, total, abdominal and thoracic fat reserves were significantly lower in females that mated twice than in females that mated only once (Tab. I; Fig. 2a-c). Although most fat was found stored in the abdomen, the proportion in the abdomen increased significantly after a second mating (from 58.6-68.8% after a first mating to 75.0-90.0% after a second mating; Tab. I; Fig. 2d). However, in the low harassment season, total and abdominal fat load did not differ between a first and a second mating (Tab. I; Fig. 2a-b). The proportion of total fat stored in the abdomen in the same season increased after a second mating (from 55.3-71.8% after a first mating to 71.0-96.3% after a second mating; Tab. I; Fig. 2d). This means that, in both harassment seasons, the abdomen gained fat and the thorax lost it after the first mating.

Fig. 1. *Hetaerina americana*, changes in female fat reserves: (a) in abdomen; − (b) in thorax; − throughout adult life. − [Bars in (a) and (b) represent mean ± standard error. Values in (c) are relative. A significant difference is asterisked (*)].
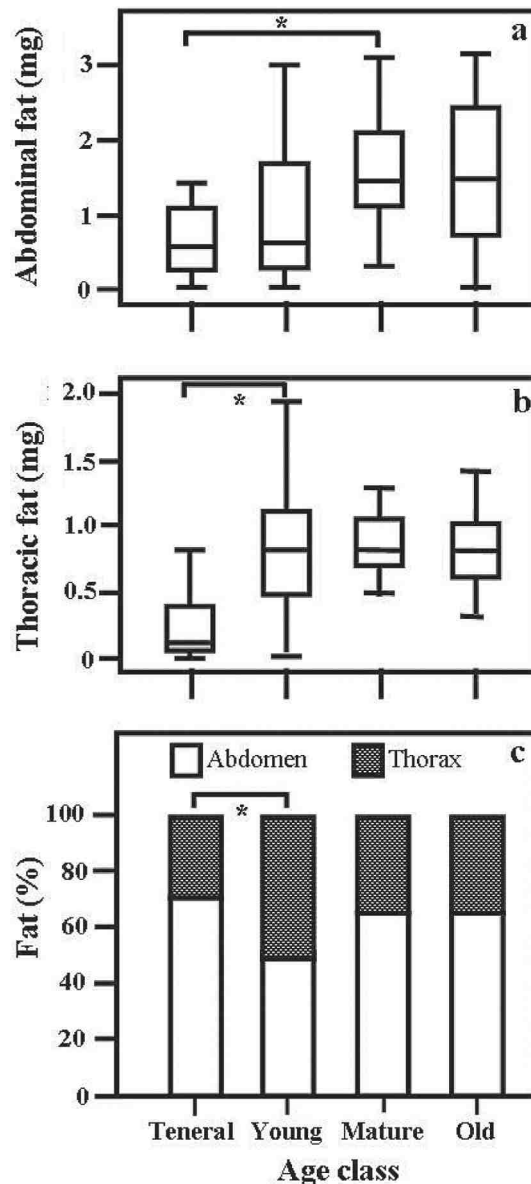
Table I

Differences in fat load between once-mated and twice-mated females in two seasons of different male harassment in *H. americana*

Variable	High harassment (N = 19)	Low harassment (N = 20)
Total fat	t = 17.436, P < 0.001	t = 4.420, P < 0.001
Abdominal fat	t = 11.978, P < 0.001	t = 0.318, P = 0.754
Thoracic fat	t = 19.746, P < 0.001	t = 6.742, P < 0.001
% Thoracic/abdominal fat	t = 11.258, P < 0.001	t = 4.668, P < 0.001

Females that mated once had a higher level of total, abdominal and thoracic fat in the low harassment season than in the high harassment season (Tab. II; Fig. 2a-c), and there was no difference in the proportion of total fat allocated to the abdomen or the thorax between seasons (Tab. II; Fig. 2d). The same occurred with total, abdominal and thoracic fat in females that mated twice (Tab. II; Fig. 2a-c) but the proportion of thoracic fat in such females declined in the high harassment season (Tab. II; Fig. 2d).
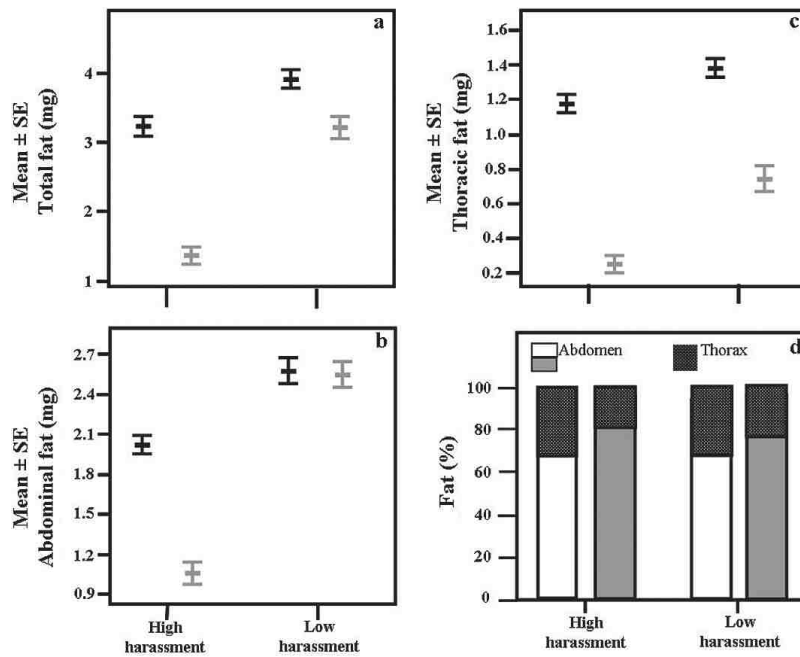
Fig. 2. *Hetaerina americana,* differences in fat load: (a-c) between females that mated once (black bars) and those that mated twice (grey bars) in two seasons of different male harassment; − (d) relative values according to body region. − [Bars represent mean ± standard error].

Table II

Differences in fat load between seasons of high and low male harassment in once-mated and twice-mated females in *H americana*

Variable	Mated once (N = 20)	Mated twice (N = 19)
Total fat	t = -4.743, P < 0.001	t = -15.041, P < 0.001
Abdominal fat	t = 3.830, P = 0.001	t = -13.935, P < 0.001
Thoracic fat	t = -3.023, P = 0.007	t = -6.175, P < 0.001
% Thoracic/abdominal fat	t = -0.543, P = 0.594	t = -1.898, P = 0.075

In both the high and the low harassment seasons, the proportion of fat allocated to the abdomen or thorax differed between females that mated only once and females that mated twice (Tab. II; Fig. 2d). Between seasons, there were no differences in such proportions when females mated once. However, in the high harassment season, relative thoracic fat declined after a second mating (Tabs II, III; Fig. 2d). In the high harassment season, total and abdominal fat loads decreased between a first and a second mating, while they remained constant in the low harassment season. Values of fat according to season and mating events are given in Table III.

TIME INTERVALS BETWEEN MATINGS ACCORDING TO SEASON

Females from different seasons did not differ in days as to when their first mating took place (high harassment: 9.714 ± 1.728, N = 14; low harassment 10.222 ± 2.102, N = 18; *t* test = 0.634, P = 0.531). However, females from the high harassment season took longer to mate for their second time (17.428 ± 1.651, N = 14) compared to females from the low harassment season (14.167 ± 1.653, N = 18; *t* test = 5.338, P < 0.0001).

Table III

Mean ± S. D. values (in mg) of fat load of *H. americana* females in two seasons of different harassment after one or two mating events

Variable	High harassment (N = 19)		Low harassment (N = 20)	
	One mating	Two matings	One mating	Two matings
Total fat	3.23 ± 0.27	1.27 ± 0.22	3.90 ± 0.34	3.22 ± 0.34
Abdominal fat	2.04 ± 0.20	1.04 ± 0.16	2.51 ± 0.31	2.47 ± 0.27
Thoracic fat	1.19 ± 0.13	0.23 ± 0.08	1.39 ± 0.16	0.76 ± 0.26

FEEDING RATE

Feeding rate varied throughout the reproductive life of females (Pillai's trace $F_{2,23} = 57.583$, P < 0.001), increasing after a first mating event ($p < 0.001$) and decreasing again after a second mating event (P < 0.001; Fig. 3). Although the interaction between the season (high/low male harassment) and the number of mating events was significant in the model (Pillai's trace $F_{2,23} = 43.800$, P < 0.001), foraging rates did not vary between high and low harassment seasons ($F_{2,23} = 1.867$, P = 0.186).
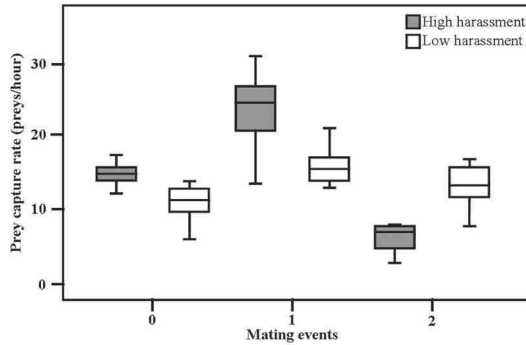
Fig. 3. *Hetaerina americana,* foraging rates of females: (0) before mating; − (1) after one mating event; − (2) after two mating events, in two seasons of male harassment intensity.

DISCUSSION

Our results of ontogenetic changes in fat manufacture suggest that females emerge with relatively little fat but that this is increased and kept constant during most of adulthood. Odonates in general emerge with reduced mass compared to what occurs with fully mature adults (ANHOLT et al., 1991) and/or fat content (DUNHAM, 1993; MARDEN & ROWAN, 2000), possibly because most of the resources acquired in the larval stage are used to manufacture the exoskeleton structure the adult needs (ANHOLT, 2008). This means that, as soon as the adult emerges, a great production of fat needs to be stored during female lifetime considering that, despite the fat expenditure during sexual activities, females still retain high levels of fat. Although previous results had already documented that there is a large difference in mass (and, somehow, fat) in recently emerged vs. fully mature adults (ANHOLT et al., 1991), our work has established that gains in fat reserves may continue through life and are not necessarily stopped if the adult has reached maturity. ANHOLT et al (1991) suggested that gains in abdominal mass are related to increased fecundity but our work sheds light on a more complex scenario. Indeed, fecundity may seem enhanced but, according to our results and at least for the case of *H. americana*, females also accumulate fat to deal with male harassment. Although our approach is partially observational, the experimental-based results previously obtained in this species have clearly indicated that the energetic budget of females becomes impaired when they are

more heavily harassed by males (CÓRDOBA-AGUILAR, 2009a). Of course, there are still uncontrolled variables that may explain our results. For example, one may think that food availability could be different in both seasons and so explain seasonal differences in female fat reserves. However, it does not seem to be the case since females did not show differences in feeding rate in both seasons. Another source indicates that the amount of food adult males consume in different habitats depends more on how much food the animal requires than on prey availability (CONTRERAS-GARDUÑO et al., 2009).

Contrary to our results in relation to age-related changes in fat reserves, a reduction in fat reserves during adulthood was found in another calopterygid, *Mnais costalis* (PLAISTOW & TSUBAKI, 2000). This interspecific difference may be due to distinct levels of sexual harassment and consequent female strategies followed by each species. Although little is known with respect to harassment in *M. costalis,* the fact that *H. americana* males chase females when they fly close by, even leaving their territory (CÓRDOBA-AGUILAR et al., 2009), makes one think that harassment levels in our study species are fairly high (equivalent to what occurs in non-territorial species; ROBERTSON, 1985; SIROT & BROCKMANN, 2001; GOSDEN & SVENSSON, 2007), especially because this behavior is absent in other territorial species (SUHONEN et al., 2008). If food accumulation to construct fat is not a problem in terms of food availability, what else constrains this? It may be hypothesized that *H. americana* females incur in costs by feeding more. One cost is parasitism. Females may get more parasitized as usually their prey bear gregarine oocysts which, once they develop within the damselfly intestinal tract, affect future fat accumulation, an event that has been documented in males of another calopterygid (SIVA-JOTHY & PLAISTOW, 1999). As also occurs in males of other calopterygids, females could also be more exposed to predators while they are foraging (e.g. birds and/or spiders; see REHFELDT, 1992 and SVENSSON & FRIBERG, 2007 respectively). However, gregarines are actually rare (CÓRDOBA-AGUILAR et al., 2006) and predation does not seem common in our study population.

Although energetic costs have been detected for females that deal with male approaches (JORMALAINEN, 1998; WATSON et al., 1998; VALERO et al., 2005), the specific details of how these costs relate to females' sexual history was unknown. According to our results, females have their first mating at the same time in both seasons but then females from the high harassment season take longer to mate again compared to females from the low harassment season. One interpretation is that given the high energetic costs when harassment is high, females take longer to replenish fat reserves and mature eggs. This could explain why females in the low harassment season could sometimes mate for a third time, which does not occur in the high harassment season (CÓRDOBA-AGUILAR, 2009a). In relation to body region, the costs are present especially for fat located in the thorax, as this is the site where energy is used during flight (MARDEN,

1989). One would expect that, according to this, females may become poorer at flying although, despite this, they seemed to prey equally effectively. However, one ultimate cost is a decreased survival in females of the high harassment season, as has been documented (CÓRDOBA-AGUILAR, 2009a). Related to this, the survival costs could be so high that this may prevent females from mating as many times as occurs in other odonate species (CORBET, 1999). *H. americana* females mate usually two and, rarely, three times and such variation is also seasonal: they may mate three times in the low harassment season, and twice in the high harassment season (CÓRDOBA-AGUILAR, 2009a). Such strategy seems to contrast with what occurs in *Calopteryx haemorrhoidalis,* where harassed females mate more frequently than non-harassed females (CORDERO RIVERA & ANDRÉS, 2002). Our hypothesis to explain this pattern is that females engage in a third mating only when they are less energetically exhausted. The number of matings a female engages in has also been related to male harassment levels (ARNQVIST & NILSSON, 2000): the more matings, the lower the female survival. One hypothesis to explain this is the high toxicity of seminal fluids which accumulate if female mate multiply (e.g. CHAPMAN, 1995). Although the existence of such compounds in unknown in odonates, the number of matings, according to our results, can be alternatively explained in terms of how much fat reserves females end up with. It would be interesting to see whether such an explanation also applies to other animals.

Our data suggest a re-allocation of resources between thoracic and abdominal fat. The abdomen has more fat and the thorax less by the second mating compared to the first. Since the abdomen seems to lose more fat than the thorax between matings and harassment levels (Figs 2b and c), females seem to compensate by allocating more fat resources to the abdomen, and this is why they end up with proportionally similar levels of fat in both structures between seasons (Fig. 2d). The increase in fat for the abdomen could take place by re-allocating the fat present in the thorax to the abdomen or by re-allocating the fat built from the gathered food more to the abdomen than the thorax. These possibilities deserve further investigation. Interestingly, a close correlation in fat reserves was observed for both structures for the high harassment season but not for the low harassment season. One explanation is that flying costs in the high harassment season are so high that females need to balance adequately fat resources between body regions. Compensating more fat to the abdomen is adaptive as such fat is used for egg production. Previous results have indicated that females from the low harassment season are able to produce more eggs than in the high harassment season, although eggs from the latter are larger (CÓRDOBA-AGUILAR, 2009a). An increased egg size has been discussed as a female evolutionary response to deal with the cost of a reduction in fecundity (CÓRDOBA-AGUILAR, 2009a). In proximate terms, such reduction in egg number can be explained in relation to the lowered fat levels.

Our results, along with those published recently based on an experimental setting in which male harassment was controlled (CÓRDOBA-AGUILAR, 2009a), indicate an energetic cost for females due to male harassment in which the response variable could be linked to egg production. Although previous authors have shown energetic costs in scenarios of male harassment, the recorded variable (e.g. oxygen consumption) could be linked to a variety of energy-demanding functions which, of course, may be ultimately related to egg production, although the link would not be clear. Fat, an important resource that animals use for a number of functions, is mainly used for egg production in female insects and, in winged insects, for flight. Given the ubiquity of sexual conflict and male harassment, it is likely that our results apply to a large number of other animals.

REFERENCES

ANHOLT, B.R., 2008. Fitness landscapes, mortality schedules, and mating systems. *In*: A. Córdoba-Aguilar, [Ed.], *Dragonflies: model organisms for ecological and evolutionary research*, pp. 167-174, Oxford University Press, Oxford.

ANHOLT, B.R., J. H. MARDEN & D. M. JENKINS, 1991. Patterns of mass gain and sexual dimorphism in dragonflies (Insecta: Odonata). *Can. J. Zool.* 69: 1156-1163.

ARNQVIST, G. & T. NILSSON, 2000. The evolution of polyandry: multiple mating and female fitness in insects. *Anim. Behav.* 60: 145-164.

CHAPMAN, T., 1995. Cost of mating in Drosophila melanogaster females is mediated by male accessory glands products. *Nature* 373: 241.

CONTRERAS-GARDUÑO, J., J. CANALES-LAZCANO, J.G. JIMÉNEZ-CORTÉS, N. JUÁREZ-VALDEZ, H. LANZ-MENDOZA & A. CÓRDOBA-AGUILAR, 2009. Spatial and temporal population differences in male density and condition in the American rubyspot, Hetaerina americana (Insecta: Calopterygidae). *Ecol. Res.* 24: 21-29.

CORBET, P.S., 1999. *Dragonflies: behavior and ecology of Odonata*. Comstock Publishing Associates, Cornell Univ. Press. Ithaca, New York.

CORDERO, A., 1999. Forced copulations and female contact guarding at a high male density in a calopterygid damselfly. *J. Insect Behav.* 12: 27-37.

CORDERO RIVERA, A. & J.A. ANDRÉS, 2002. Male coercion and convenience polyandry in a calopterygid damselfly (Odonata). *J. Insect Sci*. 2: 14. Available online at http://www.insect-science.org/2.14.

CÓRDOBA-AGUILAR, A., 2003. A description of male and female genitalia and reconstruction of copulatory and fertilisation events in Calopteryx haemorrhoidalis (Zygoptera: Calopterygidae). *Odonatologica* 32: 205-221.

CÓRDOBA-AGUILAR, A., 2009a. A female evolutionary response when survival is at risk: male harassment mediates early re-allocation of resources to increase egg number and size. *Behav. Ecol. Sociobiol.* 63: 751-763.

CÓRDOBA-AGUILAR, A., 2009b. Seasonal variation in genital and body size, sperm displace-

ment ability, female mating rate and male harassment in two calopterygid damselflies. *Biol. J. Linn. Soc.* 96: 815-829.

CÓRDOBA-AGUILAR, A., J. CONTRERAS-GARDUÑO, H. PERALTA-VÁZQUEZ, A. LU-NA-GONZÁLEZ, A. I. CAMPA-CÓRDOVA & F. ASCENCIO, 2006. Sexual comparisons in immune ability, survival and parasite intensity in two damselfly species. *J. Insect Physiol.* 52: 861-869.

CÓRDOBA-AGUILAR, A., G. RAIHANI, M. A. SERRANO-MENESES & J. CONTRERAS-GARDUÑO, 2009. The lek mating system of Hetaerina damselflies. *Behaviour* 146: 189-207.

DUNHAM, M., 1993. Changes in mass, fat content, and water content with growth in adult Pachy-diplax longipennis (Odonata: Libellulidae). *Can. J. Zool.* 71: 1470-1474.

EREZ, T., J. M. SCHNEIDER & Y. LUBIN, 2005. Is male cohabitation costly for females of the spider Stegodyphus lineatus (Eresidae)? *Ethology* 11: 693-704.

GOSDEN, T.P. & E. I. SVENSSON, 2007. Female sexual polymorphism and fecundity conse-quences of male mating harassment in the wild. *PLoS ONE* 2:e580 (doi:10.1371/journal.pone.0000580)

GRETHER, G.F. & R.M. GREY, 1996. Novel cost of a sexually selected trait in the rubyspot dam-selfly Hetaerina americana: conspicuousness to prey. *Behav. Ecol.* 7: 465-473.

GRETHER, G.F. & P.V. SWITZER, 2000. Mechanisms for the formation and maintenance of tra-ditional night roost aggregations in a territorial damselfly. *Anim. Behav.* 60: 569-579.

HUMPHRIES, M.W., D. W. THOMAS & D. L. KRAMER, 2003. The role of energy availabili-ty in mammalian hibernation: a cost-benefit approach. *Physiol. Biochem. Zool.* 76: 165-179.

IRSCHICK, D.J., A. HERREL, B. VANHOOYDONCK & R. VAN DAMME, 2007. A functional approach to sexual selection. *Funct. Ecol.* 21: 621-626.

JORMALAINEN, V., 1998. Precopulatory mate guarding in crustaceans: male competitive strategy and intersexual conflict. *Quart. Rev. Biol.* 73: 275-304.

JERVIS, M.A., C. L. BOGGS & P. N. FERNS, 2005. Egg maturation strategy and its associated trade offs: a synthesis focusing on Lepidoptera. *Ecol. Ent.* 30: 359-375.

KOCH, K., 2006. Effects of male harassment on females' oviposition behaviour in Libellulidae (Od-onata). *Int. J. Odonatol.* 9: 71-80.

LAILVAUX, S.P. & D. J. IRSCHICK, 2006. A functional perspective on sexual selection: insights and future prospects. *Anim. Behav.* 72: 263-273.

LESSELLS, C.M., 2006. The evolutionary outcome of sexual conflict. *Phil. Trans. R. Soc. Lond.* (B) 361: 301-317.

MacLEOD, R., J. LIND, J. CLARK & W. CRESWELL, 2007. Mass regulation in response to pre-dation risk can indicate population declines. *Ecology Lett.* 10: 945-955.

MARDEN, J.H., 1989. Body building dragonflies: costs and benefits of maximising flight muscle. *Physiol. Zool.* 62: 505–521.

MARDEN, J.H. & B. ROWAN, 2000. Growth, differential survival, and shifting sex ration of free-living Libellula pulchella (Odonata: Libellulidae) dragonflies during adult maturation. *Ann. ent. Soc. Am.* 93: 452-458.

McMILLAN, V.E., 2000. Post-copulatory behavior in Libellula pulchella Drury (Odonata: Libel-lulidae) and female tactics for avoiding male interference with oviposition. *J. Insect Behav.* 13: 573-583.

McWILLIAMS, S.R., C. GUGLICIMO, B. PIERCE & M. KLAASEN, 2004. Flying, fasting, and feeding in birds during migration: a nutritional and physiological ecology perspective. *J. Avian Biol.* 35: 377-393.

PARKER, G.A., 1970. Sperm competition and its evolutionary consequences in the insects. *Biol. Rev.* 45: 525-568.

PARKER G.A., 1979. Sexual selection and sexual conflict. *In*: M.S. Blum & M.A. Blum, [Eds], *Sexual*

selection and reproductive competition in insects. pp 123-166, Academic Press, New York.

PLAISTOW, S.J. & M.T. SIVA-JOTHY, 1996. Energetic constraints and male mate-securing in the damselfly Calopteryx splendens xanthostoma (Charpentier). *Proc. R. Soc. Lond.* (B) 263: 1233-1239.

PLAISTOW, S.J. & Y. TSUBAKI, 2000. A selective trade-off for territoriality and non-territoriality in the polymorphic damselfly Mnais costalis. *Proc. R. Soc. Lond.* (B) 1447: 969-975.

PLATH, M., 2008. Male mating behaviour and costs of sexual harassment for females in cavernicolous and extremophile populations of Atlantic mollies (Poecilia mexicana). *Behaviour* 145: 73-98.

RAIHANI, G., M.A. SERRANO-MENESES & A. CÓRDOBA-AGUILAR, 2008. Male mating tactics in the American rubyspot damselfly: territoriality, non-territoriality and switching behaviour. *Anim. Behav.* 75: 1851-1860.

REHFELDT, G.E., 1992. Impact of predation by spiders in a territorial damselfly (Odonata: Calopterygidae). *Oecologia* 89: 550-556.

ROBERTSON, H.M., 1985. Female dimorphism and mating behaviour in a damselfly, Ischnura ramburi: females mimicking males. *Anim. Behav.* 33: 805-809.

ROFF, D.A., 1992. *The evolution of life histories: theory and analysis*. Chapman & Hall, New York.

SIROT, L.K. & H.J. BROCKMANN, 2001. Costs of sexual interactions to females in Rambur's forktail damselfly, Ischnura ramburi (Zygoptera: Coenagrionidae). *Anim. Behav.* 61: 415-424.

SIVA-JOTHY, M.T. & S.J. PLAISTOW, 1999. A fitness cots of eugregarine parasitism in a damselfly. *Ecol. Ent.* 24: 465-470.

SUHONEN, J., M. J. RANTALA & J. HONKAVAARA, 2008. Territoriality in odonates. *In*: A. Córdoba-Aguilar, [Ed.], *Dragonflies and damselflies: model organisms for ecological and evolutionary research*. pp. 203-218, Oxford Univ. Press, Oxford.

SVENSSON, E.I. & M. FRIBERG, 2007. Selective predation on wing morphology in sympatric damselflies. *Am. Nat.* 170: 101-112.

VALERO, A., R. HUDSON, E. A. LUNA & C. MACÍAS-GARCÍA, 2005. A cost worth paying: energetically expensive interactions with males protect females from intrasexual aggression. *Behav. Ecol. Sociobiol.* 59: 262-269.

WATSON, P.J., R.R. STALLMANN & G. ARNQVIST, 1998. Sexual conflict and the energetic costs of mating and mate choice in water striders. *Am. Nat.* 151: 46-58.

THE EFFECT OF ECOLOGICAL DETERMINANTS
ON THE DISPERSAL ABILITIES
OF CENTRAL EUROPEAN DRAGONFLIES (ODONATA)

F. HARABIŠ[1] and A. DOLNÝ[2]

[1] Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences,
CZ-165 21 Prague 6, Czech Republic; − harabis.f@gmail.com
[2] Department of Biology and Ecology, Faculty of Science, University of Ostrava,
CZ-710 00 Slezská Ostrava, Czech Republic; − ales.dolny@osu.cz

Individual species dispersal ability deserves special attention mainly because of negative impact of human induced changes on freshwater ecosystems. This study is focused on Central European dragonflies, because there is a high concentration of very experienced odonatologists in this region. It is more difficult to estimate dispersal ability of distant taxa than closely related spp. This study supports the widespread awareness of limited dispersal abilities of habitat generalists. Although there are a variety of life-history groups between both suborders, the majority of spp. with limited dispersal abilities are from the suborder Zygoptera. Mediterranean elements, often referred to as those expanding due to global warming, embody higher dispersal abilities than Siberian elements. Lentic spp. may benefit from the stable conditions of standing waters in comparison to lotic ones, although this preference is not so strong according to authors' analysis.

INTRODUCTION

Dispersal indicates the diffuse movement of individuals from birth place or home district into new territory, which brings both benefits and risks. From the evolutionary point of view, dispersal determines the level of gene flow between populations, and affects local adaptation, speciation and evolution of living processes. From the ecological perspective, dispersal affects the population dynamics and persistence, community structure, distribution and abundance of species (CLOBERT et al., 2001). The main benefit of high dispersal ability for organisms is that it reduces the risk of extinction of habitat, competition between closely related individuals and the risk of inbreeding (DIECKMANN et al., 1999). The

main disadvantage may be the substantial cost of dispersal (e.g. high mortality of dispersing individuals). Comprehensive information about dispersal ability could be a very powerful tool for effective management of endangered species, especially with regard to a negative anthropogenic impact on landscape (KADOYA et al., 2009; SAHLEN et al., 2004; THOMAS, 2000).

Despite the considerable ecological importance of dispersal and the use of sophisticated research methods, there is only very rudimentary knowledge about the dispersal ability of many freshwater invertebrate species (BOHONAK & JENKINS, 2003), including odonates. Dragonflies are a very useful group for the application of new advanced research methods. The individual marking of dragonfly adults is easy and this is the main requirement for the use of mark--release-recapture methods (MRR). Individual marking in combination with the right statistics represents a very useful tool for population dynamics modelling (CORDERO RIVERA & STOKS, 2008; BESNARD et al., 2007). However, we only have very general information about dragonfly dispersal abilities after several decades of the application of this method (CONRAD et al., 1999, 2002; McCAULEY, 2006). The main problem of MRR application results from the fact that the maximal dispersal rate occurs within the immature (teneral) individuals, dispersal ability being higher in females than males in most cases (CORBET, 1999).

There are also very promising new methods, enabling the measurement of the dispersal ability of water invertebrates, such as stable isotope marking (BRIERS et al., 2004; HUNGER et al., 2001; MacNEALE et al., 2005; PAYNE et al., 2002) and telemetry (HARDERSEN et al., 2007; WIKELSKI et al., 2006). New techniques in genetics enable us to find markers, which allow us to identify even small variations in genetic information. Thus gene flow monitoring, with a combination of MRR methodology, could be an effective tool for management of endangered dragonflies (PURSE et al., 2003; WATTS et al., 2005, 2007). The information obtained on the basis of MRR shows that the estimated dispersal abilities of dragonflies are undervalued compared to the information acquired from gene flow monitoring. BOHONAK & RODERICK (2001) pointed out that gene flow cannot be objectively interchanged with dispersal ability estimation. The monitored elements of gene flow are not of individuals but of whole generations. If spatial isolation has not produced a local adaptation, it is supposed that the gene flow has not been interrupted. Not every individual transmits its genetic information to the next generation (for a review see BOHONAK & JENKINS, 2003).

There is much inconsistency with regard to the recognition of dispersal patterns and the dispersal ability of dragonflies. Therefore, the main question is how good is our awareness of dragonfly dispersal ability and what are the main ecological factors affecting the dispersal ability of particular taxa. The main goal of this study is not to present new methods of dispersal ability monitoring, but to summarize critically the effect of significant ecological factors on dragonfly dispersal ability with unconventional ingress.

MATERIAL AND METHODS

To describe the relative dispersal ability of dragonfly species, we adopted the method described in (COWLEY et al., 2001). We sent a questionnaire (n = 83) to experienced odonatologists in central Europe and asked them to classify a "dispersal ability index" (1-4) for each dragonfly species (n = 71). In the questionnaire, value 1 indicates that a given dragonfly species embodies minimal dispersal ability and value 4 means that the species has maximal dispersal ability. We also give an option NA – I cannot classify. This ranking reflects the proportion of replies that classified a species as of more, less, or equal dispersal ability than every other species. Altogether, 24 questionnaires were returned and used for the analysis.

The habitat specificity and water type preference of each species was classified according to its niche breadth – the number of occupied habitat types (only autochthonous occurrences were recorded) among the 18 potential habitat types. The 18 potential natural and man-made freshwater dragonfly habitats included all main freshwater biotope types from central Europe. The classification for analysis of the faunistic elements was modified from DÉVAI et al. (1976). We used the male wingspan (mm) taken from DIJKSTRA & LEWINGTON (2006), as a measure of dragonfly body size.

STATISTICAL ANALYSIS. – The Quasibinomial model with control for overdispersion, lognormal distribution was used for the general analysis. We used the generalized linear model (GLM) to test the influence of selected factors on dispersal ability (R DEVELOPMENT CORE TEAM, 2009). The dispersal ability was always the dependent value. Possible interactions among the factors were also tested but no significant interaction was found. Because a complete phylogeny of Czech dragonflies is not available, we developed a phylogenetic tree based on hierarchical taxonomy.

The phylogenic levels used for the analysis were: suborder, superfamily, family, subfamily, tribe, genus and species. The phylogenic relationships for these analyses were taken from SCHORR et al. (2009). The lengths of particular tree branches were modeled according to GRAFEN (1989). Subsequent phylogenic correction was made using the generalized least squares (GLS) method (MARTINS & HANSEN, 1997); this specifies the variance-covariance matrix of residuals based on phylogenetic relatedness among species. The Brownian motion model was used to create a matrix (R DEVELOPMENT CORE TEAM, 2009).

RESULTS

The phylogenetic relationship did not affect the significance of all factors according to our analysis (Tabs I, II). It was more difficult to identify the dispersal ability of species with 'average' dispersal ability (for example *Calopteryx* spp.), while

Table I

Factors significantly influencing the dispersal ability of dragonfly species based on an analysis that was not controlled for phylogeny

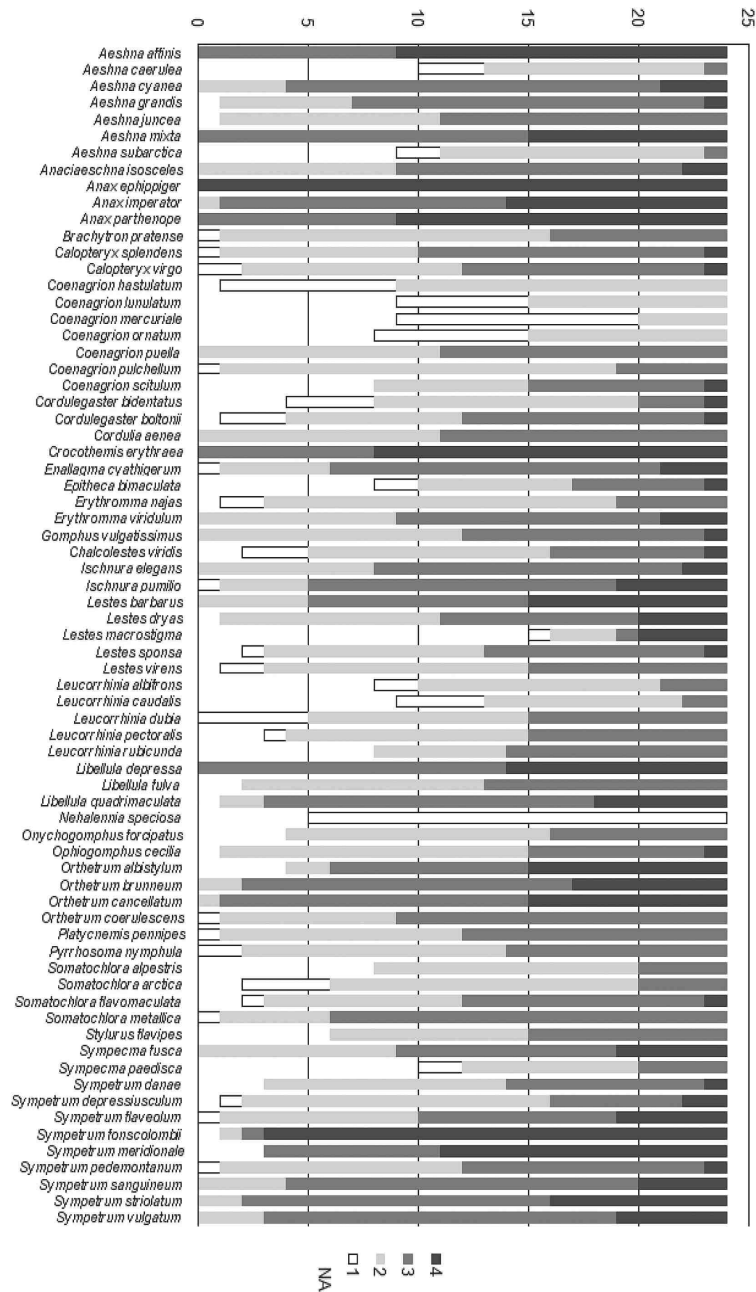| Factor	Df	Deviance	Resid.	Df Resid.	Dev. F	Pr (>F)
NULL			67	20.41		
Biotope specificity	1	3.28	66	17.14	21.87	< 0.001
Suborder	1	3.19	65	13.95	21.29	< 0.001
Faunistic element	6	4.95	58	9.00	4.72	< 0.001
Water type	1	0.47	57	8.53	3.14	0.080
Wingspan	1	0.14	56	8.39	0.95	0.338

F. Harabiš & A. Dolný

Fig. 1. Dispersal ability estimation of Central European dragonfly species [empty column: cannot be estimated; − rates of dispersal ability: 1: minimum, − 4: maximum].

it was easier to distinguish the species with very limited dispersal ability (e.g. *Nehalennia speciosa*). This was also demonstrated in our analysis (Fig. 1).

Table II

Factors significantly influencing the dispersal ability of dragonfly species based on an analysis controlled for phylogeny (with generalized least squares)

Factor	Df	F	Pr (>F)
Intercept	1	43.94	< 0.001
Biotope specificity	1	10.54	0.002
Suborder	1	16.95	< 0.001
Faunistic element	6	5.76	< 0.001
Water type	1	7.08	0.010
Wingspan	1	0.48	0.493

However, higher habitat specificity had a significantly negative effect ($p < 0.001$) on the dispersal abilities of individual dragonfly species (Fig. 2).

The main problem was to distinguish the dispersal ability of distantly related species. However, potential dispersal abilities can be considerably different within suborders (Fig. 3). Although there are various life-histories represented in both suborders, the majority of species with low dispersal ability are from the suborder Zygoptera.

Some Mediterranean and Mediterranean-afrotropic thermophilic species, which have apparently recently been spreading as a consequence of global warming in central Europe, were characterized by very high dispersal ability (Fig. 4). The question is whether really only those species with an extraordinary dispersal ability are infiltrating central Europe or whether their dispersal abilities were overestimated.

Water type preference was classified as a nearly significant factor according to our analysis ($P = 0.08$). Considerably more difficult was to set the relative abilities for species whose linkage to the specific biotope does not exist, and also for lotic species, whose dispersal is facilitated with movement along the water courses (Fig. 5). Lotic species' dispersal ability estimation seemed to be more complicated than lentic (e.g. Cordulegastridae, Gomphidae and Calopterygidae).
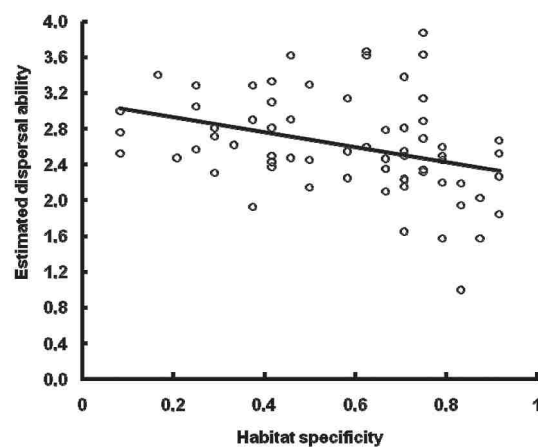

Fig. 2. The relationship between estimated dispersal ability and the habitat specificity of dragonflies.

DISCUSSION

Maximum dispersal ability is beneficial from the evolutionary view, especially for
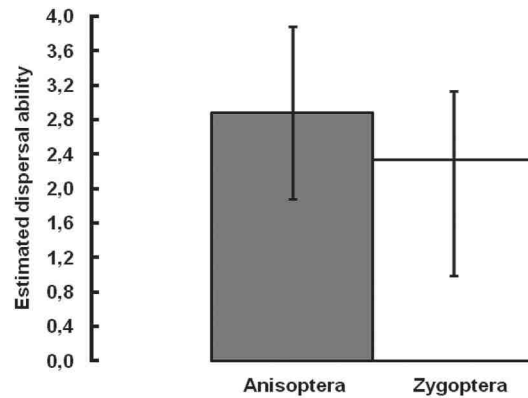
Fig. 3. Mean estimated dispersal ability of dragonflies: inter-suborder differences.

those species occurring in ephemeral biotopes, because it mitigates the risks adherent to biotope downfall, lowers impact of intra-specific competition and effectively protects against inbreeding (BLOCK et al., 2005; HOF et al., 2006). On the other hand, the long-term existence of primary (native) populations is closely dependent on the return of teneral individuals back to the patch where their larval development occurred (HASTINGS & BOTSFORD, 2006). Real dispersal ability therefore results from the incidence of two tendencies – maximal dispersal and staying in the locality with suitable conditions. These tendencies can be the reason why the real values of dispersal ability markedly lag behind the potential abilities of individual species (cost risks are to high). Habitat specialists have evolutionary considerably lower dispersal ability than habitat generalists, the species with larger ecological valence (CLOBERT et al., 2001; McCAULEY, 2006). Most of the specialists have a strategy of lower dispersal, because long-distance dispersal is related to higher energetic costs and mortality risk. This mechanism known as trade-off

Fig. 4. Estimated dispersal ability of central European dragonfly species according to the faunistic elements classification. (Different colours of bars distinguish Mediterranean and Siberian elements).

shows that it is impossible to fully profit from both strategies (TRAVIS & DYTHAM, 1999).

Several studies focused on main threat to dragonfly species pointed out the increasing habitat isolation of narrowly specialized species as the proximate cause of being endangered (BERNARD & WILDERM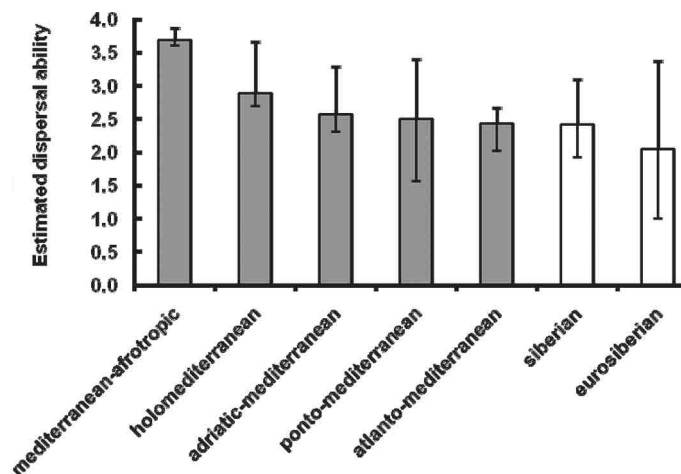UTH, 2005; WATTS et al., 2004). Limited dispersal abilities are often the relevant cause of why several species of dragonfly become endangered. However, it is also important to set an average distance which could be insurmountable for most of a single generation of individuals. Even a small variation in dispersal ability could provide an adaptive advantage, especially in the context of anthropogenic environment changes (DEVICTOR et al., 2008; THOMAS, 2000).

The main problem seems to be able to distinguish the dispersal abilities of species within individual suborders (distantly related taxa) rather than of closely related species. The species from both suborders represent wholly different life histories (CORBET, 1999), whereas there are also major differences within the suborder Anisoptera (CORBET & MAY, 2008). Distinct morphological and physiological differences occur between suborders and also between species within the Anisoptera, especially metabolism and the wing structure, the latter producing different flight abilities not only between the two suborders but within the Anisoptera (CORBET, 1999; MARDEN, 2008). Flight activity is frequently related to dragonfly dispersal ability. Energy-saving dragonflies often referred to as 'perchers' can be characterized by lower activity rate. Dragonflies referred to as 'fliers' feature greater activity rate at the cost of high energy (CORBET & MAY, 2008). Therefore, paradoxically the species with relatively lower activity rate may feature considerable higher dispersal ability. There are a few indirect proofs for this hypothesis. The fact that, within pioneer species, in which good dispersal ability is an essentials adaptation, both suborders / strategies are represented equally (for example *Ischnura pumilio* and *Libellula depressa*).

Species, which we can include in the Mediterranean species group, showed markedly extraordinary dispersal ability according to the estimation of odonatologists (Fig. 4). This may be surprising to a certain extent because the zoogeographical relationship should not directly determined dispersal ability. We can find habitat generalists and specialists, pioneer species and typical climax habitat
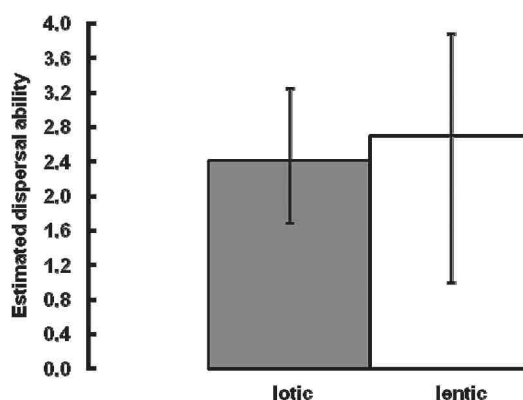

Fig. 5. Mean estimated dispersal ability of dragonflies: water type preference.

species, r and K strategists side by side in all zoogeographical regions.

Lotic environment enables easier dispersal along water courses. However both, lotic and lentic species are able to translocate for considerably large distances along the water courses, often for many kilometres (CORBET, 1999). Lentic habitats (spatially isolated patches) provide more stable environment for larval development and overwintering (HOF et al., 2006) and can be functionally interconnected within metapopulations via dispersal (BLOCK et al., 2005).

REFERENCES

BERNARD, R. & H. WILDERMUTH, 2005. Nehalennia speciosa (Charpentier, 1840) in Europe: a case of a vanishing relict (Zygoptera: Coenagrionidae). *Odonatologica* 34: 335-378.
BESNARD, A., S. PIRY, K. BERTHIER, J.-D. LEBRETON & R. STREIFF, 2007. Modeling survival and mark loss in molting animals: recapture, dead recoveries, and exuvia recoveries. *Ecology* 88: 289-295.
BLOCK, M.D., S. GEENEN, K. JORDAENS, T. BACKELJAU & R. STOKS, 2005. Spatiotemporal allozyme variation in the damselfly, Lestes viridis (Odonata: Zygoptera): gene flow among permanent and temporary ponds. *Genetica* 124: 137-144.
BOHONAK, A.J. & D.G. JENKINS, 2003. Ecological and evolutionary significance of dispersal by freshwater invertebrates, *Ecol. Lett.* 6: 783-796.
BOHONAK, A.J. & G.K. RODERICK, 2001. Dispersal of invertebrates among temporary ponds: are genetic estimates accurate? *Israel. J. Zool.* 47: 367-386.
BRIERS, R.A., J.H.R. GEE, H.M. CARISS & R. GEOGHEGAN, 2004. Inter-population dispersal by adult stoneflies detected by stable isotope enrichment. *Freshwater Biol*. 49: 425-431.
CLOBERT, J., E. DANCHIN, A.A. DHONDT & J. NICHOLS, 2001. *Dispersal: causes, consequences and mechanisms of dispersal at the individual, population and community level*. Oxford Univ. Press, Oxford.
CONRAD, K.F., K.H. WILLSON, I.F. HARVEY, C.J. THOMAS & T.N. SHERRATT, 1999. Dispersal characteristics of seven odonate species in an agricultural landscape. *Ecography* 22: 524-531.
CONRAD, K.F., K.H. WILLSON, K. WHITFIELD, I.F. HARVEY, C.J. THOMAS & T.N. SHERRATT, 2002. Characteristics of dispersing Ischnura elegans and Coenagrion puella (Odonata): age, sex, size, morph and ectoparasitism. *Ecography* 25: 439-445.
CORBET, P.S., 1999. *Dragonflies: behaviour and ecology of Odonata*. Harley Books, Colchester.
CORBET, P.S. & M. MAY, 2008. Fliers and perchers among Odonata: dichotomy or multidimensional continuum? A provisional reappraisal. *Int. J. Odonatol*. 11: 155-172.
CORDERO RIVERA, A. & R. STOKS, 2008. Mark-recapture studies and demography. *In*: A. Córdoba Aguilar, [Ed.], *Dragonflies and damselflies: model organisms for ecological and evolutionary research*, pp. 7-20. Oxford Univ. Press, Oxford.
COWLEY, M.J.R., C.D. THOMAS, D.B. ROY, R.J. WILSON, J.L. LEON-CORTES, D. GUTIER-

REZ, C.R. BULMAN, R.M. QUINN, D. MOSS & K.J. GASTON, 2001. Density-distribution relationships in British butterflies. 1. The effect of mobility and spatial scale. *J. Anim. Ecol.* 70: 410-425.

DÉVAI, G., G. BODNÁRNÉ PÁLOSI & P. BENEDEK, 1976. An analysis of the faunistic records of dragonflies (Odonata) in Hungary. *Acta biol. Debrecina* 13: 9-92. [Hung., with Engl. s.].

DEVICTOR, V., R. JULLIARD & F. JIGUET, 2008. Distribution of specialist and generalist species along spatial gradients of habitat disturbance and fragmentation. *Oikos* 117: 507-514.

DIECKMANN, U., B. O'HARA & W. WEISSER, 1999. The evolutionary ecology of dispersal. *Trends Ecol. Evol.* 14: 88-90.

DIJKSTRA, K.-D.B. & R. LEWINGTON, 2006. *Field guide to the dragonflies of Britain and Europe*. British Wildlife Publishing, Gillingham.

GRAFEN, A., 1989. The phylogenetic regression. *Phil. Trans. R. Soc.* (B) 326: 119-157.

HARDERSEN, S., 2007. Telemetry of Anisoptera after emergence: first results (Odonata). *Int. J. Odonatol.* 10: 189-202.

HASTINGS, A. & L.W. BOTSFORD, 2006. Persistence of spatial populations depends on returning home. *Proc. natn. Acad. Sci. USA* 103: 6067-6072.

HOF, C., M. BRÄNDLE & R. BRANDL, 2006. Lentic odonates have larger and more northern ranges than lotic species. *J. Biogeogr.* 33: 63-70.

HUNGER, H. & W. RÖSKE, 2001. Short-range dispersal of the southern damselfly (Coenagrion mercuriale) defined experimentally using UV fluorescent ink. *Z. Ökol. NatSchutz* 9: 181-187.

KADOYA, T., S. SUDA & I. WASHITANI, 2009. Dragonfly crisis in Japan: a likely consequence of recent agricultural habitat degradation. *Biol. Conserv.* 142: 1899-1905.

MacNEALE, K.H., B.L. PECKARSKY & G.E. LIKENS, 2005. Stable isotopes identify dispersal patterns of stonefly populations living along stream corridors. *Freshw. Biol.* 50: 1117-1130.

MARDEN, J.H., 2008. Dragonfly flight performance: a model system for biomechanics, physiological genetics, and animal competitive behaviour. *In*: A. Córdoba Aguilar, [Ed.], *Dragonflies and damselflies: model organisms for ecological and evolutionary research*, pp. 261-274. Oxford Univ. Press, Oxford.

MARTINS, E.P. & T.F. HANSEN, 1997. Phylogenies and the comparative method: a general approach to incorporating phylogenetic information into the analysis of interspecific data. *Am. Nat.* 149: 646-667.

McCAULEY, S.J., 2006. The effects of dispersal and recruitment limitation on community structure of odonates in artificial ponds. *Ecography* 29: 585-595.

PAYNE, J.C. & J.E. DUNLEY, 2002. Use of an elemental marker, rubidium, to study dispersal of aquatic insects. *Jl. N. Am. benthol. Soc.* 21: 715-727.

PURSE, B.V., G.W. HOPKINS, K.J. DAY & D.J. THOMPSON, 2003. Dispersal characteristics and management of a rare damselfly. *J. appl. Ecol.* 40: 716-728.

R DEVELOPMENT CORE TEAM, 2009. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. Available from URL: *http://www.R-project.org*.

SAHLEN, G., R. BERNARD, A.C. RIVERA, R. KETELAAR & F. SUHLING, F., 2004. Critical species of Odonata in Europe. *Int. J. Odonatol.* 7: 385-398.

SCHORR, M., M. LINDEBOOM & D. PAULSON, 2009. *World Odonata list*. Tacoma, WA: Slater Museum of Natural History, University of Puget Sound. *http://www.ups.edu/x6140.xml*.

THOMAS, C.D., 2000. Dispersal and extinction in fragmented landscapes. *Proc. R. Soc. Lond.* (B) 267: 139-145.

TRAVIS, J.M.J. & C. DYTHAM, C., 1999. Habitat persistence, habitat availability and the evolution of dispersal. *Proc. R. Soc. Lond.* (B) 266: 723-728.

WIKELSKI, M., D. MOSKOWITZ, J.S. ADELMAN, J. COCHRAN, D.S. WILCOVE & M.L. MAY, 2006. Simple rules guide dragonfly migration. *Biol. Lett.* 2: 325-329.

WATTS, P.C., S.J. KEMP, I.J. SACCHERI & D.J. THOMPSON, 2005. Conservation implications of genetic variation between spatially and temporally distinct colonies of the endangered damselfly Coenagrion mercuriale. *Ecol. Ent.* 30: 541-547.

WATTS, P.C., F. ROUSSET, I.J. SACCHERI, R. LEBLOIS, S.J. KEMP & D.J. THOMPSON, 2007. Compatible genetic and ecological estimates of dispersal rates in insect. *Mol. Ecol.* 16: 737-751.

AUSTROTEPUIBASIS GEN. NOV.
WITH DESCRIPTIONS OF THREE NEW SPECIES
FROM BRAZIL
(ZYGOPTERA: COENAGRIONIDAE)

A.B.M. MACHADO[1] and F.A.A. LENCIONI[2]

[1] Departamento de Zoologia, Instituto de Ciências Biológicas,
Universidade Federal de Minas Gerais, Caixa Postal 486, BR-31270-901, Belo Horizonte,
Minas Gerais, Brazil; − angelo@icb.ufmg.br
[2] Rua Aníbal, 216, Jardim Coleginho, BR-12310-780, Jacareí, São Paulo, Brazil;
− odonata@zygoptera.bio.br

Austrotepuibasis is described along with 3 new spp., viz.: *A. alvarengai* sp. n. (holotype ♂: Mato Grosso, SINOP, X-1970), *A. demarmelsi* sp. n. (holotype ♂: Pará, Fordlândia, II-1957), and *A. manolisi* sp. n. (holotype ♂: Mato Grosso, Alta Floreta, Cristalino Jungle Lodge, Rio Cristalino, 10-IX-2006). The new genus is close to *Tepuibasis* De Marmels, 2007 with which it shares the presence of an articulated ventrobasal lobe on cercus and differs mainly by the absence of the spiny auricle-like processes in penis, absence of dorsal cleft on ♀ tergum of S10 and other structural and colour characters. Whereas *Tepuibasis* is endemic to the high Pantepui region of Venezuela, *Austrotepuibasis* occurs in low altitude Amazon region of the Tapajós-Xingu prov. in Brazil.

INTRODUCTION

During a study of the *Telebasis* specimens of our collections (LENCIONI, 2010, MACHADO, 2010) we came across three new species of coenagrionids initially regarded as *Telebasis* and later recognized as belonging to *Tepuibasis.* A closer analysis of the new species revealed that, in fact, they belong to a new genus here named *Austrotepuibasis.* By the presence of an articulated ventrobasal lobe in cercus this genus belongs in *Teinobasini* tribe TILLYARD (1917) as redefined by DE MARMELS (2007). This tribe was so far represented in Brazil only by one species of *Nehalennia* and one of *Bromeliagrion.* The new genus will be described herein together with the three species *A. alvarengai* sp. n.*, A. demarmelsi* sp. n. and *A. manolisi* sp. n.

AUSTROTEPUIBASIS GEN. NOV.

TYPE SPECIES: *Austrotepuibasis demarmelsi* sp. nov.

E t y m o l o g y. − *Austrotepuibasis* from Latin *australis* = austral, from south, *basis* from Latin base, pedestal. A suffix used to name several genera of coenagrionids. Name refers to the fact that the distribution area of *Austrotepuibasis* is much southern than that of its closest genus *Tepuibasis.*
DISTRIBUTION: Brazil, States of Pará and Mato Grosso.

GENERIC CHARACTERIZATION

H e a d. − Black above, a pale diagonal band between lateral ocelli and antennae base, postocular spots absent. Frons angulated. Occipital lobe not bulging posteriorly.

T h o r a x. − Female mesokatepisternum without tubercle at dorsal end; mesanapleural suture straight dorsally, metatibial spurs about as long as intervening spaces; spines on distal half of metafemur not longer than width of femur, supplementary tooth of tarsal claw well-developed, wings weakly flavescent or hyaline. Petiolation ceasing distal to Ac in Fw (60%) in Hw (80%). Two cells between quadrangle and the vein descending from subnodus in HW.

A b d o m e n (male). − Proximal segments red (or orange), intermediary segments brown (or dark brown) distal segments red or reddish brown. Penis longer than wide, inner and terminal folds of moderate size, apical border of apical lobe moderately bifid and with a pair of long terminal filaments; lateral borders of apical penis segment with proximal and a distal lateral lobe both provided with a chitinized process (tooth, claw or spine). No spiny auricle-like process. Male cercus in medio-dorsal view spoon-shape with a chitinized ventral tooth, having a small articulated baso-medial lobe. Paraprocts longer than cercus, acuminate, with chitinized tip. Female tergum of S10 entire, vulvar spine absent, ovipositor slightly surpassing end of S10.
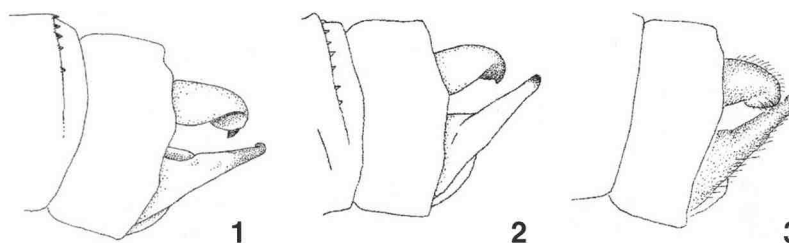
Figs 1-3. *Austrotepuibasis* male abdominal segment 10 with caudal appendages, lateral view in holotypes of: (1) *A. alvarengai*; − (2) *A. demarmelsi*; − (3) *A. manolisi*.

DIAGNOSIS

Austrotepuibasis has the general appearance of *Telebasis* especially of the largest species as *aurea, garleppi* and *gigantea*. It differs from *Telebasis* mainly by having an articulated ventrobasal lobe in cercus a character it shares with *Bromeliagrion*, *Tepuibasis*is and one species of *Nehalennia*.

The closer genus is *Tepuibasis* from which *Austrotepuibasis* differs by the characters shown in Table I. Out of these, perhaps the most important is the spiny auricle-like process at the apical penis segment absent in *Austrotepuibasis* and regarded by DE MARMELS (2007) as a key character of *Tepuibasis*. Special reference should also be made to the presence in the penis of *Austrotepuibasis* of a pair of long terminal filaments and two pairs of lateral lobes with chitinized process both absent in *Tepuibasis*. The morphological differences pointed out above show that although close to *Tepuibasis, Austrotepuibasis* is distinct from it. Biogeography, ecology and evolution confirm this fact.

AUSTROTEPUIBASIS ALVARENGAI SP. NOV.
Figures 1, 4, 7, 10, 13

M a t e r i a l . − **Holotype** ♂: Brazil, Mato Grosso State, SINOP (13º15'42.6" S / 56º15 2.69" W, elevation 372 m) X-1970, M. Alvarenga leg. (in forest), 2 ♂ **paratypes** same data as holotype. Holotype and paratypes deposited in A.B.M. Machado collection.

Table I
Characters separating *Tepuibasis* from *Austrotepuibasis*

Characters	*Tepuibasis*	*Austrotepuibasis*
Frons	Obtusely angled to rounded	Angulated
Spine auricle-like process at the apical penis segment	Present*	Absent
Lateral border of the apical penis segment	With no lateral lobes	With two pairs of lateral lobes with chitinized processes
Pair of long terminal penis filaments	Absent**	Present, very long
Petiolation	Ceasing at Ac	Ceasing distal to Ac in Fw (60%) and Hw (80%)
Median process at distal margin of S10 in male	Present***	Absent
Color of male abdomen	Uniform	Proximal and apical segments orange or reddish; middle segments brown or dark brown
Female tergum of S10	Deeply cleft	Entire

* vestigial in *T. neblinae*; ** present in *T. fulva* but short; *** absent in *T. rubicunda*.
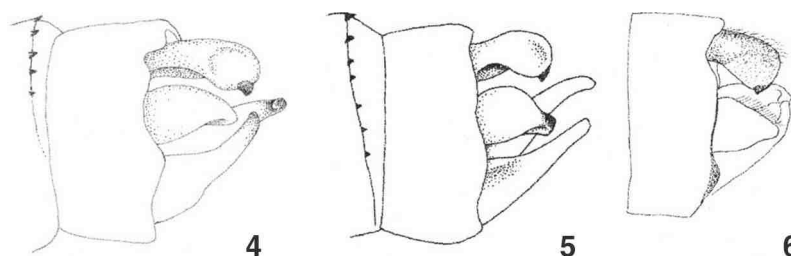
Figs 4-6. *Austrotepuibasis* male abdominal segment 10 with caudal appendages, dorso-medial view in holotypes of (4) *A. alvarengai*; − (5) *A. demarmelsi*; − (6) *A. manolisi*.

E t y m o l o g y. − Named *alvarengai* (noun in genitive case) in honour of the entomologist Cel. Moacir A l v a r e n g a who collected the species and also in recognition to his enormous contribution to the odonatological studies of senior author by gift of valuable Odonata specimens.

MALE (**holotype**). − H e a d. − Labium yellow, genae, base of mandible light blue. Anteclypeus, postclypeus and antefrons dark brown; epicranium black with diagonal band between lateral ocelli and antennae orange brown; rear of red yellowish.

T h o r a x. − Prothorax. Pronotum black with the following reddish orange marking: A C-shaped stripe at the median and posterior parts of medium lobe; borders of hind lobe and at the anterior part of anterior lobe. Propleuron yellowish orange. Pterothorax with middorsal carina and medial 0.70 of mesepisternum black, remainder light brown; mesepimeron light brown; metapleuron orange yellow with a dark brown stripe at hind border of metepisternum. A comma-shaped black marking at the top of the humeral and metapleural sutures. Wings weakly flavescent, pterostigma reddish brown surmounting 1 cell. Px in Fw 15 in Hw 14, R3 arising near Px 6 in Fw PX 7 in Hw. Anal vein separating from the wings margin at a distance distal from Ac that equals 1/2 its length in both wings.
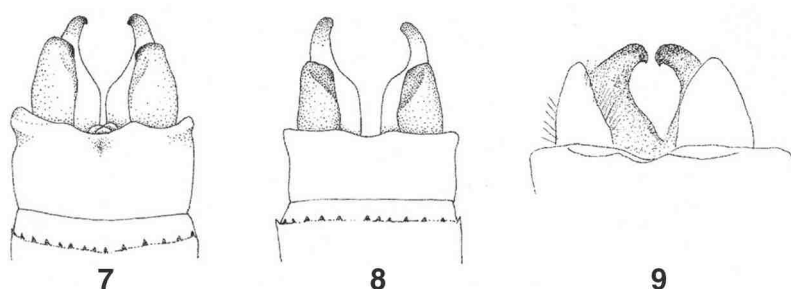
Figs 7-9. *Austrotepuibasis* male abdominal segment 10 with caudal appendages, dorsal view in holotypes of (7) *A. alvarengai*; − (8) *A. demarmelsi*; − (9) *A. manolisi*.

A b d o m e n. − S1 orange yellow, S2 yellowish orange, S3 orange, S4-S5 brownish red, S6-S7 dark brown, S8-S10 red with apex brown.

STRUCTURAL CHARACTERS. − Hind prothoracic lobe smoothly rounded, penis longer than wide with terminal and inner folds of moderate sizes. Distal penis segment (Fig. 13) with two pairs of lateral lobes the distal one provided with small claw-shaped strongly chitinized process, the proximal one with a small spine-shaped strongly chitinized process. Terminal filaments of apical penis segment long, subparallel at proximal 2/3 then strongly divaricate. S10 in dorsal view (Fig. 7) with vertical cleft occupying its distal 1/4. Cercus shorter than S10, much shorter than paraproct in lateral view with a disto-ventral tooth, in medio-dorsal view (Fig. 4) with an apical tooth and a rounded plane surface occupying about half its length. In dorso-medial view with small articulated ventrobasal digitiform lobe (Fig. 10) with apex not chitinized. Paraproct acuminate with chitinized tip.

M e a s u r e m e n t s (mm). − Abdomen 33.8; Hw 21.6.

VARIATION IN PARATYPES. − In one of the paratypes S8-S9 is brownish red and S10 reddish brown and appendages dark brown to black. In a paratype the anterior part of mesepimeron is dark brown. Anal vein separating from the wing margin at a distance distal from Ac that equals its length.

DISTRIBUTION. − Brazil, Mato Grosso State.

REMARKS. − Table II shows that *A. alvarengai* can be easily separated from the other two species by the cercal and penis structure. The presence of a small cleft at tergum of S10 is an unique character of *A. alvarengai*.

AUSTROTEPUIBASIS DEMARMELSI SP. NOV.
Figures 2, 5, 8, 11, 14, 16, 18

M a t e r i a l. − **Holotype** ♂, **allotype** ♀: Brazil, Pará State, Fordlândia (3º51'19.8" S / 55º28'59.99" W, elevation 150-200 m) II-1957 Machado & Pereira leg (in humid forest). 10 ♂ paratypes, same data as holotype. Holotype, allotype and 10 paratypes deposited in A.B.M. Machado collection.

E t y m o l o g y. − Named *demarmelsi* (noun in genitive case) in honour of our good friend Jürg D e M a r m e l s in recognition for his outstanding contribution to the knowledge of neotropical Odonata.
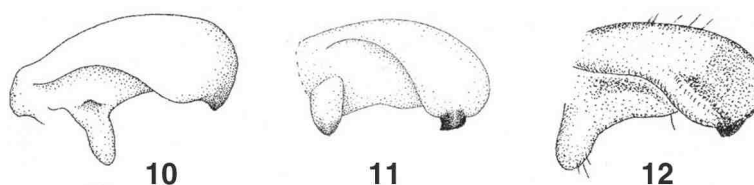
Figs 10-12. Articulated ventrobasal lobe of cercus, dorso-medial view in: (10) *Austrotepuibasis alvarengai*, paratype; − (11) *A. demarmelsi*, paratype; − (12) *A. manolisi*, holotype.
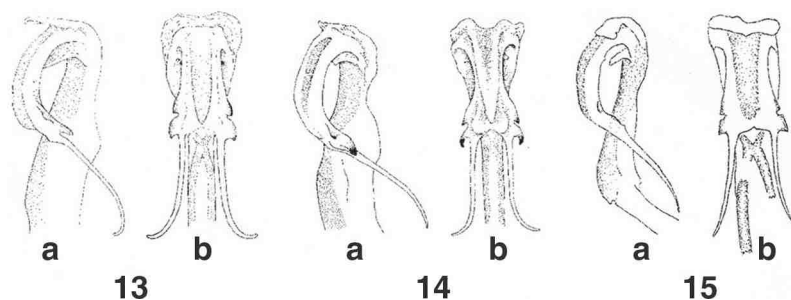
Figs 13-15. Penis of *Austrotepuibasis* in lateral (a) and ecal (b) views: (13) *A. alvarengai*, paratype; −
(14) *A. demarmelsi*, paratype; − (15) *A. manolisi*, holotype.

MALE (**Holotype**). − H e a d. − Labium yellow, genae and base of mandible
light blue, labrum orange white with bluish areas and a postero-medial black dot,
anteclypeus and antefrons dark brown, upper part of head black with diagonal
band between lateral ocellus and antennae base orange brown; rear of head or-
ange yellow.

T h o r a x. − Prothorax with anterior lobe and borders of median and hind
lobes of pronotum brownish orange, remainder of pronotum matte black; pro-
pleuron whitish yellow. Pterothorax with middorsal carina and medial 0.70 of
mesepisternum black, remainder brown. Mesepimeron yellowish brown with a
black stripe occupying its medial 3/4. Metepisternum brown except at its lower
1/4 that is yellow. Metepimeron yellow. Legs brownish yellow. Wings flavescent,
pterostigma light brown surmounting one cell (Fig. 18). .Px in Fw 14, in Hw 15,
R3 arising near Px 8 in both wings. Anal vein separating from the wing margin
at a distance distal to Ac that equals its length.

A b d o m e n. − (Fig 18) S1-2 orange S3 brownish orange; S4-5 brown; S6-8
dorsally dark brown, ventrolaterally brownish red; S9-S10 and paraprocts red-
dish brown; cercus dark brown.

STRUCTURAL CHARACTERS. − Hind prothoracic lobe smoothly rounded;
Penis longer than wide with terminal and inner folds of moderate sizes, lateral
border of apical segment with a pair of very long terminal filaments (Fig. 14)
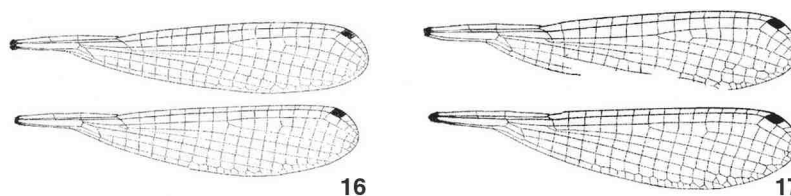
Figs 16-17. Wings: (16) *Austrotepuibasis demarmelsi*, paratype; (17) *A. manolisi*, holotype.

in ectal view parallel at proximal 2/3, then divaricating; apical segment with two pairs of lateral lobes with chitinized process the distal one claw-shaped and large, the proximal one, small and spine-shaped (Fig. 14), cercus shorter than S10, and paraproct, in lateral view with a distoventral tooth (Fig. 2), in medio-dorsal view (Fig. 5) with an apical tooth, with a rounded planar surface occupying an area less than half cercal length. In dorso-medial view with a small articulated ventrobasal lobe, shaped like half a banana with the apex chitinized (Fig. 11). Paraproct acuminate with a chitinized tip (Fig. 5).

M e a s u r e m e n t s (mm). − Abdomen 31.3; Hw 19.0.

FEMALE (allotype). − H e a d. − Similar to that of male except for orange yellow labrum surrounded by bluish white.

T h o r a x. − As in male. Wings flavescent, Px in Fw 15, in Hw 16. R3 arising near Px 8 in Fw near Px 7 in Hw. Anal vein separating from wing margin slightly distal to Ac in Fw and at distance distal to Ac that equals 1/2 and 1.5 its length; pterostigma light brown, surmounting one cell.

A b d o m e n. − S1 yellowish; S2-3 dorsally brown, laterally orange yellow; S4-6 dorsally dark brown laterally reddish brown; S7-10 dorsally matte black, laterally orange; ovipositor yellowish orange; cercus brown.

STRUCTURAL CHAR-ACTERS. − Hind lobe of prothorax smoothly rounded, with median lateral lobes not distinguishable. Distal part of tergum of S10 entire, vulvar spine absent, ovipositor slightly surpassing end of S10.

M e a s u r e m e n t s (mm).

Figs 18-19. *Austrotepuibasis* alive, supposedly: (18) *A. demarmelsi*; − (19) *A. manolisi*. − [Photos by Johan van't Bosch].

− Abdomen 32.0; Hw 23.2.

VARIATION IN PARATYPES. − In four male paratypes the labrum is bluish yellow. In most male paratypes the flavescent colour of the wings is more intense than in the holotype. Venation in males: Px in Fw 14 (20%), 15 (30%), 16 (50%), in Hw 13 (12.5%), 14 (37.5%), 15 (37.5%), 16 (12.5%), R3 arising near Px 6 (10%), 7 (30%), 8 (60%), in Fw Px 6 (20%), 7 (40%), 8 (40%) in Hw. Anal vein separating from wing margin at Ac (40%) or at a distance distal from Ac that equals (40%) or is 1.5 (20%) its length in Fw, in Hw at Ac (20%) equal to Ac (40%) and 1.5 (40%) of its length.

M e a s u r e m e n t s (mm). − Abdomen 31.2-34.9 (mean 32.5); Hw 18.7-23.1 (mean 21.6).

DISTRIBUTION. − Brazil, Pará State.

REMARKS. − *A. demarmelsi* is closer to *A. alvarengai* than to *A. manolisi.* The characters separating these three species are shown in Table II.

Table II

Diagnostic characters separating the three *Austrotepuibasis* species

Character	A. alvarengai	A. demarmelsi	A. manolisi
Mesepimeron	Yellowish	Yellowish brown with black central stripe	Entirely dark brown
Metepisternum	Gray with lower 1/4 yellow	Brown with lower 1/4 yellow	Bluish
Metapleural suture	With dark brown stripe	Without stripe	With dark brown stripe
Wings	Hyaline	Flavescent	Hyaline
Terminal filaments of penis, in ectal view	Subparallel at proximal 2/3, then strongly divaricate	Subparallel at proximal 2/3, then strongly divaricate	Divaricate from the basis
Chitinized process of distal lateral lobe of penis	Small and claw--shaped	Large and claw--shaped	Tooth-shaped
Cercus in lateral view	With disto-ventral tooth	With a disto-ventral tooth	Without visible disto-ventral tooth
S10 in dorsal view	With a small vertical cleft at distal 1/4	With no cleft	With no cleft
Dark brown area in abdomen	Occupying S6-S7	Occupying S4-S8	Occupying S6-S7
Terminal and inner fold of penis	Very well-developed (Fig. 13)	Poorly developed (Fig. 14)	Poorly developed (Fig. 15)
Cercus in lateral view with a disto-ventral tooth	Subcylindric (Fig.7) with disto-medial chitinized area	Subcylindric (Fig. 8) with disto-medial chitinized area	Conic (Fig. 9) with no chitinized area
Apex of paraproct in dorsal view	Slightly convergent	Slightly convergent	Strongly convergent

AUSTROTEPUIBASIS MANOLISI SP. NOV.
Figures 3, 6, 9, 12, 15, 17, 19

M a t e r i a l. − **Holotype** ♂: Brazil, Mato Grosso State, Alta Floresta - Cristalino Jungle Lodge - Rio Cristalino (9º35'41" S / 55º55'53" W). 10-IX-2006, Tim Manolis leg. Holotype deposited in F.A.A. Lencioni collection under number 4322.

E t y m o l o g y. − Named *manolisi* (noun in the genitive case) in honour of Dr Timothy D. M a n o l i s, a dragonfly and bird lover, who collected the holotype and allowed us to described it.

MALE (holotype). − H e a d. − Labium pale ochre; labrum anteclypeus and genae light blue; postclypeus, frons, antennifer, scape, distal half of pedicel (flagella missing) and epicranium metallic black with following pale areas: antefrons, diagonal band extending from lateral ocellus to base of antenna, a very narrow occipital bar, rear of head and proximal half of pedicel.

T h o r a x. − Prothorax metallic black, becoming browner laterally. Pterothorax (Fig. 19) with middorsal carina black, medial 0.70 of mesepisternum metallic black, remainder of mesepisternum dark brown, mesepimeron and mesinfraepisternum dark brown, metepisternum bluish, a brown stripe covering all metapleural suture, metepimeron and base of coxae pale ochre. Legs ochre with wash of brown on posterior margins of femora, tibial spurs longer than interval between them, tarsi pale, dark at extremities, armature black. Wings hyaline, Px Fw 15 (left)/14 (right); Px Hw 15 (left)/14 (right); RP2 originating just before Px 7 in Fw, just before Px 6 in Hw; pterostigma reddish brown, rhomboidal, surmounting one cell (Fig. 17).

A b d o m e n. − (Fig. 19) S1-3 and S8-10 red dorsally, paler ventrally, S4-7 dark brown dorsally pale ventrally; apical annulus in S3-S6 dark brown. Cerci orange, paraprocts orange with black tip.

STRUCTURAL CHARACTERS. − Penis (Fig. 15) longer than wide, lateral borders of apical segment with a pair of very long terminal filaments, in ectal view strongly divaricate from base, each filament long as base of apical segment, two lateral lobes strongly chitinized; inner fold extending ca 0.10 length of basal segment. Cercus in lateral view (Fig. 3) mitten-shaped, posterior margin rounded; expanded ventral margin more or less linear, slightly shorter than paraproct; cercus in medio-dorsal view (Fig. 6) spoon-shaped with a small chitinized tooth; in dorsal view (Fig. 9) conical; in dorso-medial view with a small articulate ventrobasal lobe, oval-shaped (Fig. 12). Paraproct acuminate with tips directed medially (Fig. 6).

M e a s u r e m e n t s (mm). − Abdomen 34, Hw 22.

DISTRIBUTION. − Brazil, Mato Grosso State.

REMARKS. − The number of pictures of this species taken by Johan van´t Bosch and others (Fig. 19) in the vicinity of the type locality shows that the species appears to be quite common in the region. The characters separating *A. manolisi* from *A. alvarengai* and *A. demarmelsi* are shown in Table II.

CONSIDERATIONS ON BIOGEOGRAPHY,
ECOLOGY AND EVOLUTION

Biogeographically and ecologically *Austrotepuibasis* is much different from *Tepuibasis*. *Tepuibasis* is endemic to the high altitudes (900-2600 m) of the mountain systems of the Guyana shield of Venezuela (Fig. 20) known as Pantepui that belongs in the Guyana province of MORRONE (2001), *Austrotepuibasis* occurred in the low altitude (150-372 m) Amazon forest of the States of Pará and Mato Grosso (Brazil) that belongs in Morrone´s Tapajós-Xingu province. The vegetation of the Guyana province is composed of savannah, alternating with humid forest whereas the Tapajós-Xingu province is dominated by humid and gallery forests (MORRONE, 2001). *A. demarmelsi* and *A. alvarengai* were collected in humid forest whereas most species of *Tepuibasis* were collected in areas of open vegetation. Manolis (in litt.) described the habitat of *A. manolisi* as follows (slightly rearranged): "This species is fairly common along the steep, rocky trail up to the top of a large, exposed, rock dome ("Serra") and on a small rock outcrop close to the Rio Cristalino Lodge. Both places are sparsely vegetated with small rivulets. Tandem pairs were seen and no doubt oviposit in these rivulets."

The distances between the southernmost collecting site of *Tepuibasis* and the one of *Austrotepuibasis* is about 1169 Km. According to DE MARMELS (2007) the genus *Tepuibasis* arose from *Teinobasini* ancestors located in South American craton. Some of these ancestors where elevated to high altitudes with the rise of
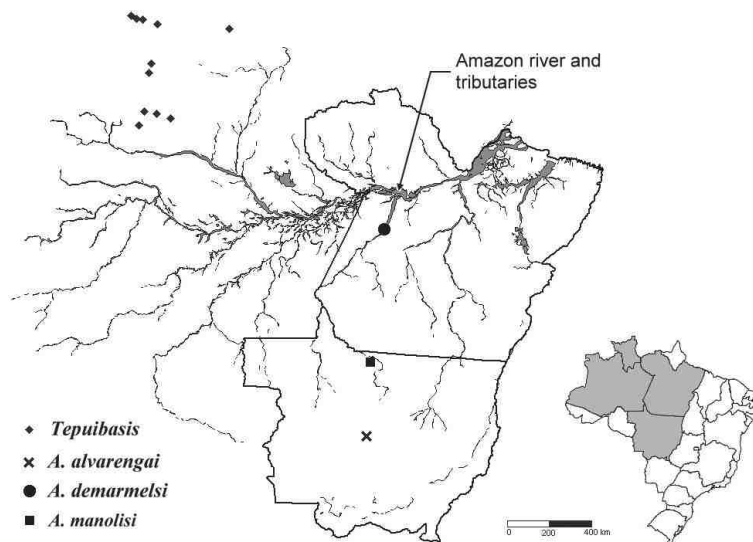
Fig. 20. Distribution of the known *Austrotepuibasis* and *Tepuibasis* species.

the Guyana shield, became isolated from the lowland populations, and progressively adapted to high altitude conditions and evolved into *Tepuibasis*. It is reasonable to believe that *Austrotepuibasis* also evolved from Teinobasini ancestors. It seems to be a genus of the Brazilian shield that became separated from the Guyana shield about Eocene/Miocene when the Amazon river opened its way to East, between the two shields. So it may be reasonable to consider the two genera (*Tepuibasis* and *Austrotepuibasis*) as sister taxa, that evolved from a common ancestor which was present on both shields which became split by the breakthrough of the Amazon river remained in the low altitude and progressively adapted to ecological conditions of the Amazon forest. The Amazon river which separates the two genera is a clear barrier that possibly helped to maintain the two populations separated but, without doubt, the great difference in altitudes was a key factor in the taxogenesis of *Austrotepuibasis* and *Tepuibasis*.

REFERENCES

De MARMELS, J., 2007. Tepuibasis gen. nov. from the Pantepui region of Venezuela, with descriptions of four new species, and with biogeographic, phylogenetic and taxonomic considerations on the *Tepuibasinae* (Zygoptera: Coenagrionidae). *Odonatologica* 36(2): 117-146.

LENCIONI, F.A.A., 2010. Telebasis luizae sp. nov. from Brazil (Zygoptera: Coenagrionidae). *Odonatologica* 39(1): 71-74.

MACHADO, A.B.M. 2010. Seven new species of Telebasis from Brazil (Odonata: Coenagrionidae). *Zootaxa* 2384: 53-64.

MORRONE, J.J. 2001. *Biogeografia de América Latina y el Caribe M & T*. Manuales & Tesis. SEA, vol. 3 Zaragoza.

TILLYARD, R.J. 1917. *The biology of dragonflies (Odonata or Paraneuroptera)*. Cambridge Univ. Press, Cambridge, UK.

SHORT COMMUNICATIONS

REDESCRIPTION OF MALE
COENAGRIOCNEMIS REUNIENSE (FRASER, 1957),
WITH NOTES ON THE MESOSTIGMAL PLATE
AND KEY TO MALES OF THE GENUS
(ZYGOPTERA: COENAGRIONIDAE) *

S. COUTEYEN[1] and M. PAPAZIAN[2]

Association Réunionnaise d'Ecologie (AreE), 188 Chemin Nid-Joli,
F-97430 Le Tampon, La Réunion, France
[1] UMR PVBMT (Peuplements végétaux et bio-agresseurs en milieu tropical)
Université de la Réunion, Faculté des sciences et technologies,
15 Avenue René-Cassin, BP 7151, F-97715 Saint-Denis cedex, France
scouteyen@ecologie.re
[2] Le Constellation Bât. A, 72 Avenue des Caillols, F-13012 Marseille, France
mpapazian@ecologie.re

Coenagriocnemis Fraser, 1949, an endemic genus to the Mascarene Archipelago (Indian Ocean), is currently represented by 4 spp. After examination of its ♂ anal appendages, *C. reuniense* ♂ an endemic sp. to La Réunion, is redescribed. The mesostigmal plate, which has a very unusual structure, is illustrated and commented upon. A key to the *Coenagriocnemis* ♂ ♂ is provided.

INTRODUCTION

The genus *Coenagriocnemis* Fraser, 1949 ranks among the smallest African genera of the Coenagrionidae, with four currently known species which inhabit two islands of the Mascarene Archipelago: Mauritius and La Réunion, E of Madagascar, in the Indian Ocean.

The main systematic studies on the genus have been carried out by FRASER

(1949, 1950, 1957) and by PINHEY (1962, 1976). FRASER (1949) erected simultaneously the genera *Coenagriocnemis* and *Coenargiocnemis*, the generitypes being, respectively *Agrion rufipes* Rambur, 1842 and *Agrion insulare* Selys, 1876, both coming from Mauritius. Observing an intergradation in at least some of the characters of the two species, PINHEY (1962) considered them as being congeneric, and *Coenargiocnemis* falls in synonymy with *Coenagriocnemis* which has page priority.

The genus *Coenagriocnemis* is characterized by the following features: (i) postocular spots present; – (ii) the anal vein leaving the posterior margin of wing proximal to the level of the cubito-anal crossvein; – (iii) the forewing quadrilateral clearly elongated distally, with the costal side much shorter than half of the posterior side; – (iv) the arculus closed proximally or opposite the second antenodal crossvein; – (v) the R4+5 vein starting just before or almost at subnodus; – (vi) the cubito-anal crossvein located about midway between the antenodal crossveins; – (vii) 12 to 19 postnodal crossveins; – (viii) the cerci sharply curved downwards in the male; – and (ix) the vulvar spine absent in the female.

The four species are: *C. reuniense* (Fraser, 1957), endemic to La Réunion; *C. insulare* (Selys, 1872), *C. ramburi* Fraser, 1950 and *C. rufipes* (Rambur, 1842) all three endemic to Mauritius.

During our studies on the Odonata of La Réunion we were able to examine several hundreds of *C. reuniense* specimens. This brought to light a mistake in FRASER's (1957) description of its male anal appendages. He described and illustrated the cerci of *C. reuniense* as having a robust dorsal spine, the apex of which with two or three stiff bristles (Figs1-2). This spine does not exist. In fact, it is just a thick tuft of bristles, more or less dense, which trims dorsally the cerci (Figs 3-4). FRASER (loc.cit.) has examined four males from Hell-Bourg, La Montagne Saint-Denis and Bélouve (from where the type and the allotype come). Such a mistake, after having examined several specimens, seems surprising, except perhaps, if we consider that the specimens had been in contact with some liquid, agglomerating the bristles and giving the illusion of a spine, under insufficient enlargement.

REDESCRIPTION OF MALE
COENAGRIOCNEMIS REUNIENSE (FRASER, 1957)
Figures 1-6

M a t e r i a l. – 10 ♂: France, La Réunion: Saint-Paul, Etang de Saint-Paul, 15-III-1998 (alt. 0 m); Saint-Benoît, Riv. Bras Chansons, 8-I-2005 (alt. 1700 m).

H e a d. – Labium yellowish; lower half of labrum yellow, upper half bright black; anteclypeus black with two yellowish and small lateral spots; postclypeus black, gena yellow; antefrons yellow with a black central part; postfrons, vertex

and occiput black; insconspicuous postocular spots, rather brownish.

T h o r a x. – Prothorax black, anterior lobe slightly lighter; posterior lobe rounded, formed by two plates, the posterior one very thin. Pterothorax: dorsum black; sides blue; size of the antehumeral stripe very variable, sometimes entire, sometimes reduced in two small spots; humeral and metapleural sutures widely underlined by black.

Legs black, inner face of femora greyish.

Wings hyaline; Px forewing 15 to 19; Px hindwing 14 to 17; R4+5 rising clearly before subnodus; arculus opposite to 2nd Ax; Ac located halfway between the two antenodals or slightly closer to the 2nd; anal vein leaving the margin of the wing before Ac, at a distance as much as the length of Ac.

A b d o m e n. – Mainly black, segment 1 blue with a basal mediodorsal black spot; segment 2 blue with a variable-sized U-shaped black spot; segments 4 to 7 black; segments 8 to 10 blue. Anal appendages: cerci stout, hardly curved downwards, with dorsally a thick tuft of bristles near the base; paraprocts very small, laterally barely conspicuous.

M e a s u r e m e n t s (mm). – Total body length (with appendages) 36-42, abdomen 32-38, forewing 21-26.
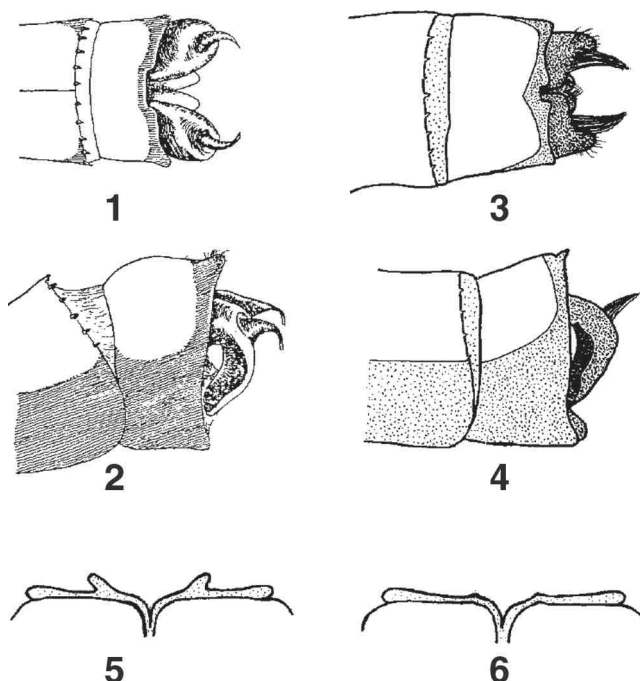
Figs 1-6. *Coenagriocnemis reuniense*: (1-2), male, tip of abdomen, dorsal and lateral views; from FRASER, 1957; – (3-4) same; new description; – (5) male, mesostigmal plate; – (6) same female.

DISCUSSION

C. insulare (male) is large, robust. Abdomen 36-37 mm; hindwing 24-25 mm. Px: forewing 18-19, hindwing 16-17. The tenth abdominal segment is narrowly and deeply notched, with two prominent tubercles on the distal margin. The paraprocts are almost as long as the cerci.

C. rufipes (male) is small and skinny. Abdomen 30-31mm; hindwing 18 mm. Px: forewing 14 at most, hindwing 12. The tenth abdominal segment little-notched, with two little-marked tubercles on the distal margin. The paraprocts are very short.

C. ramburi (male) is large and robust. Abdomen 40 mm; hindwing 23 mm. Px: forewing 17-18, hindwing 15-16. The tenth abdominal segment is widely and deeply notched, with two cone-shaped and little-prominent tubercles. The paraprocts are very short.

C. rufipes is characterized by its small size, few Px, a small notch and little-prominent tubercles of the distal margin of the tenth abdominal segment. *C. insulare* differs in cerci carrying dorsally a strong bump, and in paraprocts well expanded, while *C. reuniense* is distinguished by cerci curved ventrally but not interiorly like in the other species, and similar to *C. insulare* and *C. ramburi* in size. *C. ramburi* resembles *C. insulare* in its large size and in short and robust legs, but also *C. rufipes* in the shape of anal appendages. The status of *C. ramburi* has remained unsettled since the description of the species (FRASER, 1950; PINHEY, 1962).

The genus *Coenagriocnemis* is composed of forest species which colonize the same type of environments: shady rocky lotic waters in both islands, Mauritius and La Réunion. *C. reuniense* and *C. insularis* are fond of small forest streams, *C. rufipes* frequents also wider rivers with aquatic vegetation. Males of *C. reuniense* and *C. rufipes* take up position closely to the water, on stones, possibly on plants, while *C. insularis* males perch on leaves, high above the water (MARTENS, 2001). Regarding the mountain forest streams of la Réunion, *C. reuniense* oviposits mainly in mosses and algae.

MESOSTIGMAL REGION IN *COENAGRIOCNEMIS* MALES

PINHEY (1976) called attention to a very particular morphological element in *Coenagriocnemis* (mainly in *C. insulare* and *C. rufipes*): the mesostigmal plate is more developed in the males than in the females and has a specific feature: a pair of lateral tubercles rather broad like in the females and a pair of more pointed dorsal tubercles, missing in the females. The function of the mesostigmal region in the males is not obvious. PINHEY (loc.cit.) suggested an «inexplicable anomaly». MAY (2002), in a phylogenetic and taxonomic study on *Enallagma* and the related taxa, noting also that the mesostigmal region is more developed in the males than in the females (mainly in *Africallagma*), hypothesized that this struc-

ture may serve to prevent intrasexual tandem pairing. In *C. reuniense* male, the lateral tubercles are inconspicuous, barely prominent like in the female; the dorsal tubercles, developed much more than the laterals, are long and cone-shaped (Figs 5-6).

KEY TO *COENAGRIOCNEMIS* MALES

1 Small and slender species. Notch and tubercles of the 10th abdominal segment poorly marked. Abdomen ≤ 30 mm; hindwing ≤ 20 mm; forewing Px ≤ 14 .... ***rufipes***
− Large and robust species. Notch and tubercles of the 10th abdominal segment very marked. Abdomen ≥ 32mm; hindwing ≥ 21 mm; forewing Px ≥ 15 2
2 Paraprocts almost as long as the cerci .... ***insulare***
− Paraprocts very short 3
3 Abdominal segments 1 to 3 with apical blue rings, dorsally interrupted on the segments 2 and 3. Without dorsal thick tuft of bristles on the cerci .... ***ramburi***
− Abdominal segments 1 and 2 mainly blue, segment 3 with a basal pair of small blue spots. With a dorsal thick tuft of bristles on the cerci .... ***reuniense***

CONCLUSION

The variations in extent of antehumeral stripe and in the size of *C. reuniense* are not random variations (COUTEYEN, 2006); they are ecological features and represent currently the subject of a detailed research. A genetic analysis is underway in an attempt to clarify the composition of the genus *Coenagriocnemis*, on the taxonomic position of *C. ramburi*, and the colonization and speciation in these Indian Ocean islands.

REFERENCES

COUTEYEN, S., 2006. Evolution de la taille de Coenagriocnemis reuniensis Fraser, 1957, en fonction de l'altitude à l'île de la Réunion (Odonata, Coenagrionidae). *Bull. Soc. ent. Fr.* 111(4): 439-444.
FRASER, F.C., 1949. The Zygoptera of Mauritius. *Trans. R. ent. Soc. Lond.* 100: 135-146.
FRASER, F.C., 1950. The Odonata of Mauritius, suborder Anisoptera, and the description of a new species of Zygoptera. *Proc. R. ent. Soc. Lond.* (B) 19: 70-77.
FRASER, F.C., 1957. Odonata and Neuroptera of Reunion. *Mém. Inst. scient. Madagascar* (E) 8: 15-28.
MARTENS, A., 2001. Oviposition of Agriocnemis reuniensis (Fraser) in volcanic rock as adaptation to the extreme running water habitat (Zygoptera: Coenagrionidae). *Odonatologica* 30(1): 103-109.
MAY, M.L., 2002. Phylogeny and taxonomy of the damselfly genus Enallagma and related taxa (Odo-

nata: Zygoptera: Coenagrionidae). *Syst. Ent.* 27: 387-408.

PINHEY, E.C.G., 1962. Some notes on the dragonflies (Odonata) from Mauritius. *Proc. R. ent. Soc. Lond.* (B) 31: 115-121.

PINHEY, E.C.G., 1976. Further notes on the Odonata of Mauritius. *Arnoldia Rhodesia* 8(9): 1-6.

REDESCRIPTION OF THE LARVA OF
ARGIA CONCINNA (RAMBUR),
WITH THE DESCRIPTION OF THAT OF
A. TELESFORDI MEURGEY FROM THE WEST INDIES
(ZYGOPTERA: COENAGRIONIDAE)

F. MEURGEY

Muséum d'Histoire Naturelle, 12 rue Voltaire, F-44000 Nantes, France
Francois.Meurgey@mairie-nantes.fr

The last instar larva of *A. concinna* is redescribed, based on specimens from Guadeloupe, and that of *A. telesfordi* is described and illustrated for the first time, based on specimens from Saint Vincent in the Lesser Antilles. Notes on their ecology and larval habitat are provided.

INTRODUCTION

Argia is a widespread neotropical genus of some 111 known species. Currently, two species have been recorded from the West Indies (MEURGEY, 2009), both known only from the Lesser Antilles. The larva of *A. concinna* was originally described from Dominica (DONNELLY, 1970). Here its final instar is redescribed, based on specimens from Guadeloupe. *A. telesfordi* larva is here described and illustrated for the first time, and some additional notes on their ecology are provided.

ARGIA CONCINNA (RAMBUR)
Figures 1-9

M a t e r i a l (101♂, 66♀). − GUADELOUPE: 10♂, 7♀, stream near Route des Mamelles, Petit-Bourg 590 ft, N 17°89'29,4'' / W 64°10'64,9'', 27-IV-2003; − 3♂, 1♀, stream at Sofaïa, Sainte Rose 1082 ft, N 17°89'36'' / W 32'00'', 2-V-2003; − 6♂, 4♀, Grand Carbet river, Capesterre-Belle-Eau 1961 ft, N 17°74'25,7'' / W 64°50'08'', 5-V-2003; − 1♂, 2♀, Galion river, Saint Claude 1049 ft, N 17°70'10,6'' / W 63°98'42'', 8-V-2003; − 12♂, 9♀, Corrosol river, Petit-Bourg 836 ft, N 17°88'38,0'' / W 64°02'12'',

29-III-2004; − 1♂, 1♀, Canal Dongo, Vauchelet, Capesterre-Belle-Eau 1115 ft, N 17°72'32,4" / W 64°77'47", 27-I-2006; − 1♂, 1♀, stream at Sofaïa, Sainte-Rose 1082 ft, N 17°89'36" / W 32'00", 1-II-2006; − 4♂, 6♀, Grand Rivière de Vieux-Habitants, Vieux-Habitants 127 ft, N 17°75'65,9" / W 63°33'40", 3-II-2006; − 3♂, 4♀, ravine Boudoute, Trois-Rivières 2250 ft, N 17°71'74,7" / W 64°44'92", 6-VI-2007; − 1♂, 2♀, ravine à Vache, Saint-Claude 3182 ft, N 17°73'23,2" / W 64°23'47", 8-VI-2007; − 4♂, 5♀, Rivière Madelonnette, Sainte-Rose 967 ft, N 17°95'72,4" / W 63°82'16", 18-VI-2007; − 6♂, 2♀, Rivière Janikeete, Sainte-Rose 770 ft, N 17°94'91" / W 63°23'47", 18-VI-2007. − All material collected by F. Meurgey.

DESCRIPTION. – H e a d. − Trapezoidal, widest at eye level, larger than prothorax (Fig. 1) and almost ½ times as wide as long. Occipital margin strongly concave. Hind corners protruding posteriorly, margins without noticeable setae. Uncleft prementum prominent, 2.6 mm long and 1.7 mm wide at its widest point, extending posteriorly a little beyond bases of procoxae, strongly convex and finely serrated at front margin, without premental setae (only a few scattered setae in
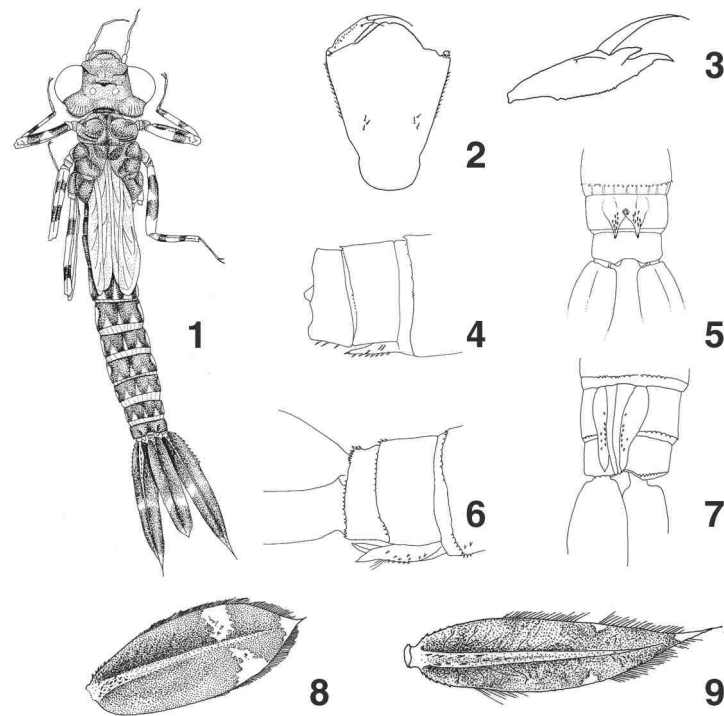
Figs 1-9. *Argia concinna,* last larval instar: (1) general aspect, dorsal view; − (2) prementum, dorsal view; − (3) left palpal lobe, dorsal view; − (4) male gonapophyses, lateral view; − (5) male gonapophyses, ventral view; − (6) female gonapophyses, lateral view; − (7) female gonapophyses, ventral view; − (8) central lamella, lateral view; − (9) lateral lamella, lateral view.

two groups toward base) (Fig. 2). Lateral margins of prementum with 16-18 setae in about distal half. Palpal lobe with 1 setae; movable hook slender, curved, and longer than palpal setae. Distal margin of palpal lobe with a short truncate medial serrated lobe and a long hook-shaped basal lobe (Fig. 3). Antenna 7-segmented, ringed with black and white on segments 2, third segment the longest.

T h o r a x. – Pronotum quadrangular. Pterothorax marked with black spots on each side. Translucent wing pads parallel, the inner ones reaching the abdominal segment four. White legs each with two dark bands on femora and tibiae.

A b d o m e n. – Cylindrical, dark with a longitudinal whitish stripe extending from abdominal segment 1-8, enlarged on 9; laterally bordered with black and white spots. Male gonapophyses as in Figures 4-5. Female gonapophyses reaching at least the distal end of segment 10 and outer ones denticulate (Figs 6-7). Caudal lamellae lanceolate, planate, except for the midrib, with the apex extending into a finely acute point. Central lamella (Fig. 8) about three times as long as its maximum width, inflated in dorsal view, broad in lateral view, pointed at apex and usually dark in colour with a distinct transverse white band near the apex and apex white. Dorsal carina with 20-22 setae and ventral carina with approximately 14-17 setae. Lateral lamella (Fig. 9) about four times as its maximum width long as wide, about as long as segments 5-10, inflated in dorsal view, elongate and pointed in lateral view, usually dark with an interrupted white band near the apex and white tip. Dorsal carina with approximately 11-13 setae, ventral carina with approximately 26-28 setae.

M e a s u r e m e n t s (mm; females N = 33, males N = 12). – Total length without caudal lamellae, females and males: 12.1-13.9. Inner wing pads, females and males: 4.0-4.5; abdomen length without caudal lamellae, females and males: 8.0-8.7; central caudal lamellae, females and males: 3.4-3.8; lateral caudal lamellae, females and males: 4.4-4.6.

ARGIA TELESFORDI MEURGEY
Figures 10-18

M a t e r i a l (9♂, 4♀). – GRENADA: St George Parish, Annandale Falls, Annandale Estate, Willis, 600 ft, 3-V-2009; – SAINT VINCENT: Charlotte parish, South Rivers, Three Rivers, Colonarie River, 9-V-2010. All material collected by F. Meurgey and is deposited in the Nantes Museum of Natural History (France).

DESCRIPTION. – H e a d. – Trapezoidal, widest at eye level, larger than prothorax (Fig. 10) and almost twice as wide as long. Hind corners protruding posteriorly, margins without noticeable setae. Uncleft prementum prominent, 2.0 mm long and 0.9-1.0 mm wide at its widest point, reaching posteriorly the bases of procoxae, strongly convex and finely serrated at front margin, without premental setae (Fig. 11). Lateral margins of prementum with 18-23 setae in about distal 2/3 and 4-6 setae at base of palpal lobes. Palpal lobe with 1 seta; movable hook slender, curved, and longer than palpal setae. Distal margin of palpal lobe

with a short truncate serrated lobe, and a short sinuous hook-shaped basal lobe (Fig. 12). Antenna seven segmented white on all the segments, third segment the longest.

T h o r a x. – Pronotum quadrangular. Pterothorax marked with black spots on each side. Translucent wing pads parallel, the inner ones reaching the end of abdominal segment four. White legs each with one dark band on femora.

A b d o m e n. – Cylindrical, pale with a longitudinal whitish stripe extending from abdominal segment 1-8, enlarged on 9. Male gonapophyses as in Figures 13-14. Female gonapophyses surpassing distal end of segment 10 and outer ones denticulate (Figs 15-16). Caudal lamellae lanceolate, planate, except for the mid-rib, with the apex extending into an acute point. Central lamella (Fig. 17) about three times as long as its maximum width, a bit inflated in basal 1/3 in dorsal view,
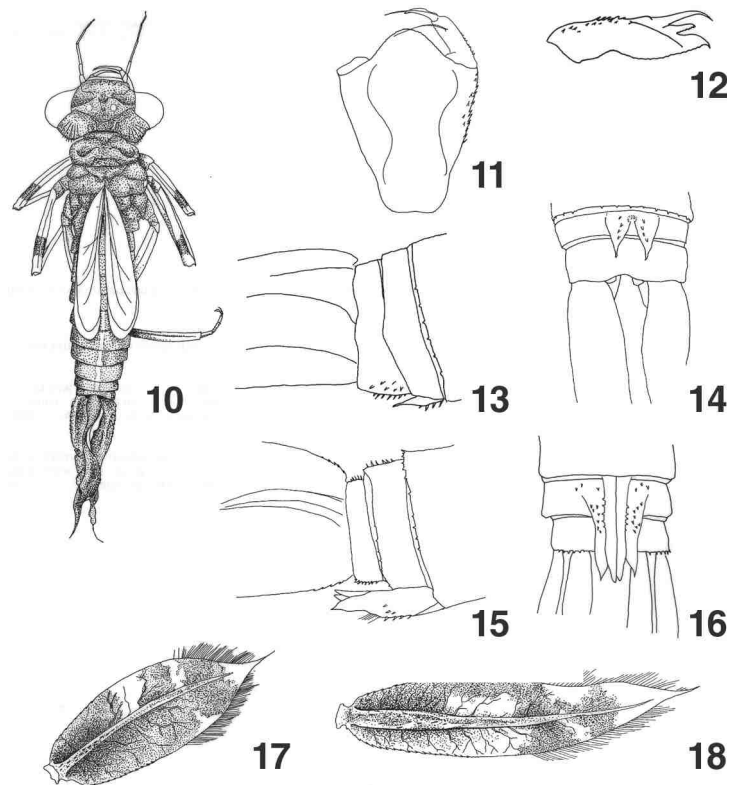
Figs 10-18. *Argia telesfordi,* last larval instar: (10) general aspect, dorsal view; − (11) prementum, dorsal view; − (12) left palpal lobe, dorsal view; − (13) male gonapophyses, lateral view; − (14) male gonapophyses ventral view; − (15) female gonapophyses, lateral view; − (16) female gonapophyses, ventral view; − (17) central lamella, lateral view; − (18) lateral lamella, lateral view.

broad an acutely pointed at tip, usually dark with variable white areas. Dorsal carina with 30-32 setae and ventral carina with approximately 10-12 setae. Lateral lamella (Fig. 18) about five times as long as its maximum width, about as long as segments 2-10, a bit inflated in basal half in dorsal view, elongate and acutely pointed in lateral view, usually shadowed with black and with variable white areas. Dorsal carina with approximately 16-18 setae, ventral carina with approximately 21-24 setae.

M e a s u r e m e n t s (mm; females N = 4, males N = 9). – Total length without caudal lamellae, females and males: 8.5-9.0. Inner wing pads, females and males: 3.9-4.0; abdomen length without caudal lamellae, females and males: 4.9-5.0; central caudal lamellae, females and males: 2.8-3.1; lateral caudal lamellae, females and males: 3.0-3.2.

DISCUSSION

Like the adults, both *Argia concinna* and *A. telesfordi* larvae are similar in general appearance. *A. telesfordi* differs from *A. concinna* by the following set of characters (those of *A. concinna* in brackets): total length reaching at least 9 mm (total length surpassing 13 mm); palpal seta very long, as long as movable hook (considerably shorter); female gonapophyses extending beyond segment 10 (reaching the edge of segment 10). *A. telesfordi* is an uncommon species in Grenada and St. Vincent, occurring at an altitude between sea level and approximately 700 m. It lives in slower areas of fast flowing mountain streams and small rivers. It is also found near stagnant water such as lakes, meadows, and seepages. It differs from *A. concinna* which is predominantly found in fast flowing, shady montane rivers. Larvae were found hidden under roots and near the muddy bottom of small tribs at two sites on different rivers. Companion species of *A. telesfordi* are *Dythemis multipunctata* (St. Vincent), *Brechmorhoga grenadensis* (in Grenada), and sometimes *Erythrodiplax fusca* in both countries.

REFERENCES

CLARKE, A.H., 1904. Notes on insects of Barbados, St Vincent, the Grenadines and Grenada. *Psyche* 11: 114-117.
DONNELLY, T.W., 1970. The Odonata of Dominica British West Indies, *Smithson. Contr. Zool.* 37: 1-20.

GARRISSON, R.W., 1994. A synopsis of the genus Argia of the United States with keys and description of new species, Argia sabino, A. leonore and A. pima (Odonata: Coenagrionidae). *Trans. Am. ent. Soc.* 120(4): 287-368.

MEURGEY, F., 2009. Redescription of Argia concinna (Rambur) with a description of Argia telesfordi spec. nov. from the West Indies (Zygoptera; Coenagrionidae). *Zootaxa* 2272: 45-62.

RAMBUR, M.P., 1842. *Histoire naturelle des insectes névroptères*. Roret, Paris.

SELYS-LONGCHAMPS (de) E., 1865. Synopsis des agrionines, Argia. *Bull. Acad. r. Belg.* 20: 375-417.

STARMÜHLNER, F. & Y. THEREZIEN, 1982. Résultats de la mission hydrobiologique austro-française de 1979 aux îles de la Guadeloupe, de la Dominique et de la Martinique (Petites Antilles). 2. Etude générale de la Dominique et de la Martinique. *Revue Hydrobiol. trop.* 15(4): 325-345.

A STUDY OF THE GENUS *COELICCIA* KIRBY, 1890 FROM SHAANXI (CHINA), WITH THE DESCRIPTION OF *C. WILSONI* ZHANG & YANG SPEC. NOV. (ZYGOPTERA: PLATYCNEMIDIDAE)

H.-J. ZHANG* and K.-K. HUO
Shaanxi Bio-Resource Key Laboratory, Shaanxi University of Technology,
Hanzhong-723000, China
* hjzhang663@sohu.com

The new sp. is described and illustrated. Holotype ♂ and allotype ♀: China, Shaanxi prov., Nanzheng co., alt. 1200 m a.s.l., 28-VII-2006; deposited in the Shaanxi Bio-Resource Key Laboratory, Shaanxi University of Technology, Hanzhong, China. Figs of the penile structure and the dorsum of the ♂ caudal appendages of *C. sexmaculata* Wang are also provided.

INTRODUCTION

Coeliccia Kirby is the most species-rich genus of Platycnemididae, with some 62 described species (VAN TOL, 2009; SCHORR et al., 2009; XU, 2006). It is confined to the subtropical and tropical zones of Asia. Fourteen species are known mainly from southern China, and two, *C. sexmaculata* Wang and *C. wilsoni* sp. nov., occur in Shaanxi province. All specimens of these two taxa have thus far been collected from the subtropical zone in southern parts of Shaanxi and Sichuan provinces. *C. sexmaculata* is distributed also in Henan.

MATERIAL AND METHODS

The studied specimens originate from southern parts of Shaanxi and Sichuan provinces. After a treatment with 70% alcohol, the penis was sought out gently with a dissecting needle and studied under Olympus Zoom Stereo Microscope.

Diagnostic characters were illustrated with the aid of a camera lucida. Figures are not to scale. Wing terminology follows TILLYARD & FRASER (1938), and genital terminology FRASER (1940).

COELICCIA SEXMACULATA WANG, 1994
Figures 1-3

Coeliccia sexmaculata Wang, 1994: 82-84, figs 1-5. Type locality: Luanchuan co.,
Henan prov., China.

M a t e r i a l. – Shaanxi prov.: 3 ♂, Liuba co., 15-VII-1983; – 2 ♀, Ningqiang co., 20-VII-1987;
– 6 ♂, 4 ♀, Zhenba co., 10-VII-1987; – 19 ♂, 3 ♀, Nanzheng co., 15-VII-1987; – Sichuan prov.:
1 ♂, 1 ♀, Tongjiang co., 20-VII-1987.

DISTRIBUTION. – China (Henan, Shaanxi and Sichuan provinces).

REMARKS. – The species was described from Luanchuan county, Henan prov-
ince, 111º5´E, 33º8´N, 900-1200 m a.s.l. (WANG, 1994), and it is here reported
for the first time from Shaanxi and Sichuan provinces. In the original, rather poor
description, the penile organ was not illustrated. The here presented figures of
penis and caudal appendages are based on a paratype, kindly provided by Mr
Zhi-guo W a n g.

The terminal lobe of the penis in *C. sexmaculata* is rectangular, with rising apical
margins, whereas that in *C. didyma* (Sel., 1863) is more widely divided (ASAHINA,
1984a, 1984b, figs 4-5). The structure of the penile organ in *C. sexmaculata* is
similar to that in *C. mingxiensis* Xu from Fujian (XU, 2006), though its terminal
lobe in the latter species is slightly trapezium-shaped and the ribbon-like apical
margins are longer.

COELICCIA WILSONI ZHANG & YANG SPEC. NOV.
Figures 4-9

M a t e r i a l. – **Holotype** ♂ and **allotype** ♀: Shaanxi prov., Nanzheng co., Fucheng village (107º15´E,
32º28´N, alt. 1200 m a.s.l.), 26-VII-2006, Z.-d. Yang leg.; deposited in Shaanxi Bio-Resource Key
Laboratory, Shaanxi University of Technology, Hanzhong, China. – **Paratypes**: 1 ♂, Shaanxi prov.,
Nanzheng co., Beiba village (107º10´E, 32º28´N, alt. 1100 m a.s.l.), 26-VII-1988, Y.-y. Jia leg.; – 1
♂, Sichuan prov., Tongjiang co., Kongshanba village (107º22´E, 32º28´N, alt. 1300 m a.s.l.), 2-VIII-
2006; – 1 ♂, Sichuan prov., Tongjiang co., Miaoba village (107º20´E, 31º28´N, alt. 1350 m a.s.l.),
5-VIII-1006, Z.-d. Yang leg.

E t y m o l o g y. – We are pleased to name this damselfly in honour of Keith D.P. W i l s o n, who
is helping us greatly in our Odonata research.

MALE. – H e a d (Fig. 4). – Labium middle lobe yellow, and lateral lobes black.
Labrum black. Anteclypeus yellow, with regular semicircular brown spots below
border at both sides. Postclypeus black with triangular yellow spots on border
at both sides. Mandible and gena yellow, joined with triangular yellow spots on
border at both sides of postclypeus. Frons black, with a lunate yellow spot behind
middle oculus and a triangular yellow spot at outside of lateral oculus. Occiput
black with a curved long yellow stripe on side. The antenna brown-black, with

each segment apically light yellow.

T h o r a x (Fig. 4). − Prothorax black with yellow stripes on lower margins, and mid-lobe of prothorax with a globular yellow spot at sides. Dorsum of synthorax black extending beyond mesopleural suture, with a pair of yellow antehumeral markings tapering towards the wing bases and extending over ca half the length of the mesepisternum. Synthorax yellow laterally, metapleural sutures with complete black stripes, a wide approximately triangular brown spot below metepimeron. Ventral surface of synthorax yellow.
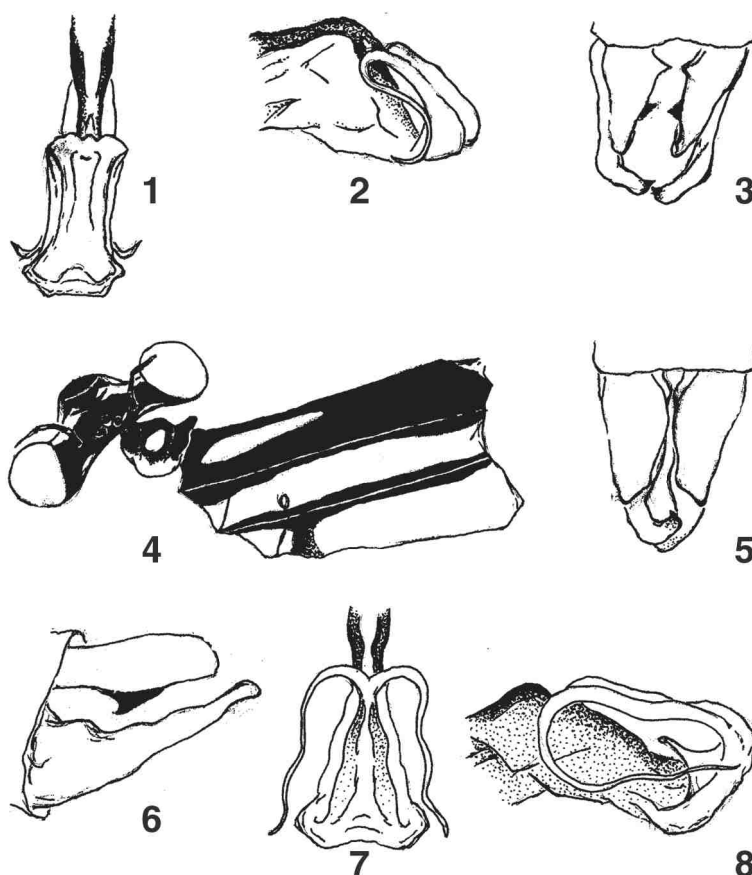
Figs 1-8. Structural characters of two *Coeliccia* species, males. Figs 1-3: *C. sexmaculata* Wang (paratype, Mt Laojunshan, Henan prov., China, 17-VII-1986), Figs 4-8: *C. wilsoni* sp. n.: (1) penile organ, dorsal view; − (2) same, lateral view; − (3) caudal appendages, dorsal view; − (4) head and thorax, lateral view; − (5) caudal appendages, dorsal view; − (6) same, lateral view; − (7) penile organ, dorsal view; − (8) same, lateral view.
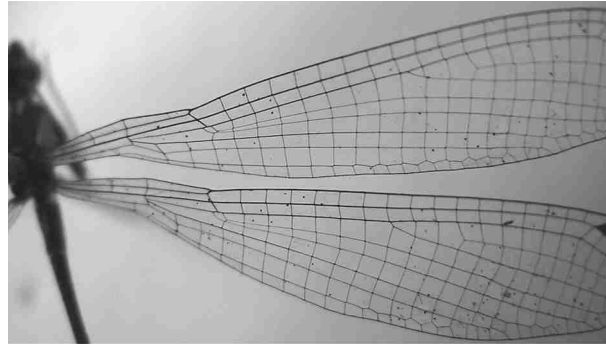
Fig. 9. *Coeliccia wilsoni* sp. n., male: right wings.

Legs black; tarsi, claws, outside surfaces of femora and tibiae with spines black, the rest yellow.

Wings hyaline, with 16.5-18 postnodals in forewing, 14.5-17 in hindwing. Pterostigma blackish brown, bordered with yellow, diamond-shaped, covering 1.5-2 cells.

There are two remarkable venational characters of *C. wilsoni* sp. n., viz.: (1) The costal vein protrudes, especially at the second antenodal, and it forms a convex curve, and (2) IR3 does not arise from the subnodus, but it arises from R2, i.e. more apically, and it approaches R4.

A b d o m e n. − Segment 1 yellow with regular terminal black ring, and an inverted triangular black spot in middle of dorsum. Segment 2 laterally yellow and dorsum black with mid-dorsal yellow stripe which extends over basal two-thirds of length of segment 2. Abdominal segments 3 to7 black with a yellow stripe in each side, the stripe expanding and forming a semicircular-shaped spot at apex, its basal margin with a semi-lunar yellow spot on sides of dorsal mid-ridge. Segment 8 with basal two-thirds black and apex one-third blue, with yellow stripe at sides. Abdominal segments 9 and10 blue with black sides, the black extending over about one-third the width of the segment.

Anal appendages (Figs 5-6). − In dorsal view, the superiors blue and the inferiors yellow. Superior anal appendages nearly triangular, broad with apical margins oblique. Inferior anal appendages strongly incurved and hook-shaped, apex with black teeth. In lateral view, the superiors and the inferiors are yellow, with irregular black cloud-shaped spot. Superiors blunt apically, with a black ventral tooth at mid-length. Inferiors about foot-shaped, slightly bulging basally, and expanding at apex.

Penile organ (Figs 7-8). − Terminal lobe of penile organ is approximately triangular, the apex divided into two slender whips. In lateral view, the terminal lobe of penile organ with a triangular tongue-shaped projection, the top of which is incurved.

M e a s u r e m e n t s (mm). − Abdomen + appendages length 35-37, hindwing 22-25.

FEMALE. − As the male except where noted.

H e a d. − Labium and labrum all yellow. Vertex with an irregular yellow marking formed from a spot behind median ocellus, joining with a triangular yellow spot outside of lateral ocellus, and continuing as a stripe to compound eye.

T h o r a x. − Prothorax black, yellow on sides, and mid-lobe of prothorax with a broad yellow stripe connecting round yellow spots of mid-lobe of prothorax on sides, but is not connecting with pale colour on sides of prothorax; posterior pronotal lobe with a central obtuse black tongue-shaped swelling. Synthorax similar to male. Dorsum of synthorax black, yellow on side, with slender and complete yellow antehumeral stripes. A complete black stripe on metapleural suture, with the upper two-thirds rather wide, but the lower one-third slender. No brown spot below metepimeron.

Wings. − Forewing 17.5 postnodals, 15.5 in hindwing.

Abdomen. − Segments 1 and 2 similar to male. Segments 3 to 8 black with a yellow stripe on each side, the stripe expanding and forming semicircular-shaped spot at apex, the stripes and spots wider than in male. Semi-lunar spots on sides of dorsum of segments 3 to 7 blue and smaller than in male. Segment 8 dorsally with basal two-thirds black and apical one-third yellow which expands on the side. Segment 9 black, with wavy-shaped yellow stripe at apex, expanding on side. Segment 10 black. Cerci black. Ovipositor black, yellow at tip, and longer than segment 10 of abdomen.

M e a s u r e m e n t s (mm). − Abdomen length 36; hindwing 25.

DIFFERENTIAL DIAGNOSIS. − *Coeliccia* was divided into three groups based on venational details by LAIDLAW (1932). Group 1 (*bimaculata*): IR3 arises from sN, R4 proximal to it. Group 2 (*didyma*): IR3 arises distally to sN, R4 proximal to it. Group 3 (*membranipes*): IR3 arises distal to sN, R4 from it. However, IR3 of *C. wilsoni* sp. nov. arises from R2, nor from IR3. The character of *C. wilsoni* sp. nov. is different from its congeners. Other species known from China belong to the Group 2 (*didyma*). The body size and marks of *C. wilsoni* sp. nov. are similar to *C. ryukyuensis* Asahina from Japan, but can be separated from it by the following points:

(1) Mid-lobe of prothorax of the new species, in male and female, with round yellow spots on sides, which are absent in *C. ryukyuensis*.

(2) Dorsum of synthorax with two spindly yellow stripes, but *C. ryukyuensis* with blue cudgel-shaped stripes which have same thickness.

(3) *C. wilsoni* sp. nov. with approximately triangular brown spot below metepimeron, but *C. ryukyuensis* none.

(4) Segment 9 to 10 of abdomen of the new species blue in male and black in female with broad yellow stripe at apex of segment 9, but *C. ryukyuensis* all yellow.

(5) Anal appendages distinctly different. In dorsal view, though superior anal appendages wide and broad in both, but a little inflated basally, no protuberant teeth in *C. wilsoni* sp. nov. No protuberant hook-shaped teeth in middle of inferior anal appendages.

(6) The shape of structure of penile organ more distinctly different. In the dorsal view, terminal lobe of penile organ is approximately triangular, the apex with

two slender whips (Figs 7-8), but *C. ryukyuensis* pincher-shaped, apex wider than base, and lacking a whip (ASAHINA, 1951, figs.13-14).

REFERENCES

ASAHINA, S., 1951. New dragonflies from the northeastern Asia (Odonata). *Kontyu* 19(1): 15-22.

ASAHINA, S., 1984a. A list of the Odonata recorded from Thailand, 6: Platycnemididae, genus Coeliccia. *Tombo* 27(1/4): 2-20.

ASAHINA, S., 1984b. Assamese and Burmese Coeliccia species in the collection of Dr. Erich Schmidt (Odonata: Platycnemididae). *Shikoku ent. Soc.* 16(4): 1-9.

HAMADA, K. & K. INOUE, 1985. *The dragonflies of Japan in colour*. Kodansha, Tokyo. − [Jap., with Engl. title]

LAIDLAW, F.F., 1932. A revision of the genus Coeliccia (Odonata: Platycnemididae). *Rec. Indian Mus.* 34: 7-42, pls 1-3 excl.

MATSUKI, K. & J.C. LIEN, 1984. The platycnemidid fauna of Taiwan (Odonata). *Cho-Cho* 7(7): 41-49.

SCHORR, M., M. LINDEBOOM & D. PAULSON, 2009. World list of Odonata. *http://www.ups. edu/media/SlaterMuseum/WorldOdonataList.pdf*.

VAN TOL, J., 2009. Catalogue of the Odonata of the World. Version1.3, August 2008. *In*: F.A. Bisby et al., [Eds], *Species 2000 & ITIS Catalogue of Life: 2009 Annual checklist*. CD-ROM. – Species 2000, Reading.

WANG, Z.-g., 1994. A new species of Coeliccia (Odonata: Platycnemidae) from China. *Entomotaxonomia* 16(2): 82-84.

XU, Q.-h., 2006. Coeliccia mingxiensis sp. nov. from Fujian, China (Odonata: Platycnemididae). *Int. J. Odonatol*. 9(2): 250-254.

DESCRIPTIONS OF *BOYERIA KARUBEI* YOKOI AND *PERIAESCHNA F. FLINTI* ASAHINA LARVAE FROM CHINA (ANISOPTERA: AESHNIDAE)

H.-M. ZHANG[1] and X.-L. TONG*
Department of Entomology, College of Natural Resources and Environment,
South China Agricultural University, Guangzhou-510642, China
[1] zhanghaomiao6988@gmail.com

The final stage larvae of the 2 spp. are for the first time described and illustrated based on laboratory reared specimens. The reared adults are also illustrated and discussed. Some biological notes are provided.

INTRODUCTION

The aeshnids are among the largest and most conspicuous dragonflies, they have been collected extensively and their adult stages are quite well known. The majority of aeshnid larvae, such as *Anax* species, usually live in the lentic habitat. Some of these, particularly *Anax* species, are also used as food in southwestern China, Laos and Thailand. The larval stages of many Asian species have been described (e.g. FRASER, 1943; YOON & DONG, 1990; see also references in DUDGEON, 1999). The Japanese species are best known; the illustrated monograph by ISHIDA (1996) is a useful work for identifying Asian aeshnid larvae. Although NEEDHAM (1930) has figured *Cephalaeschna* and *Planaeschna* larvae from China and MATSUKI (1987) described four *Anax* larvae from Taiwan, the knowledge on larval stages of Aeshnidae in China is still limited and taxonomic problems remain.

Here, we provide the first descriptions of Chinese *Boyeria karubei* Yokoi and *Periaeschna f. flinti* Asahina larvae, based on laboratory reared specimens. These are forest dwelling species, occurring in forest streams, an usual habitat for aeshnids. Similarly as in *Planaeschna* and *Cephalaeschna* species, *Boyeria* and

* **Corresponding author**: xtong@scau.edu.cn

Periaeschna larvae are hard to find, and most species in these genera are endemic to China. The larvae possess an elongated abdomen with smooth body and long flat prementum, and can be easily distinguished from other Anisoptera by the following combination of characters: (1) head broad usually wider than thorax; (2) antennae filiform, 7-segmented; (3) labium flat and fork shaped with smooth surface, promentum long, median lobe prominent, movable hook sharp, palpal setae and premental setae absent; (4) wing buds parallel; and (5) legs with smooth surface, tarsi 3-segmented.

During 2008-2009, we collected numerous larvae from the mountainous streams in southern and southwestern China. They were then taken to the laboratory for rearing. After six to eight months, some of them emerged successfully. The adults and their exuviae were kept for further identification. All examined specimens are deposited in the Collection of Aquatic Insects and Soil Animals, Department of Entomology, South China Agricultural University, Guangzhou, China.
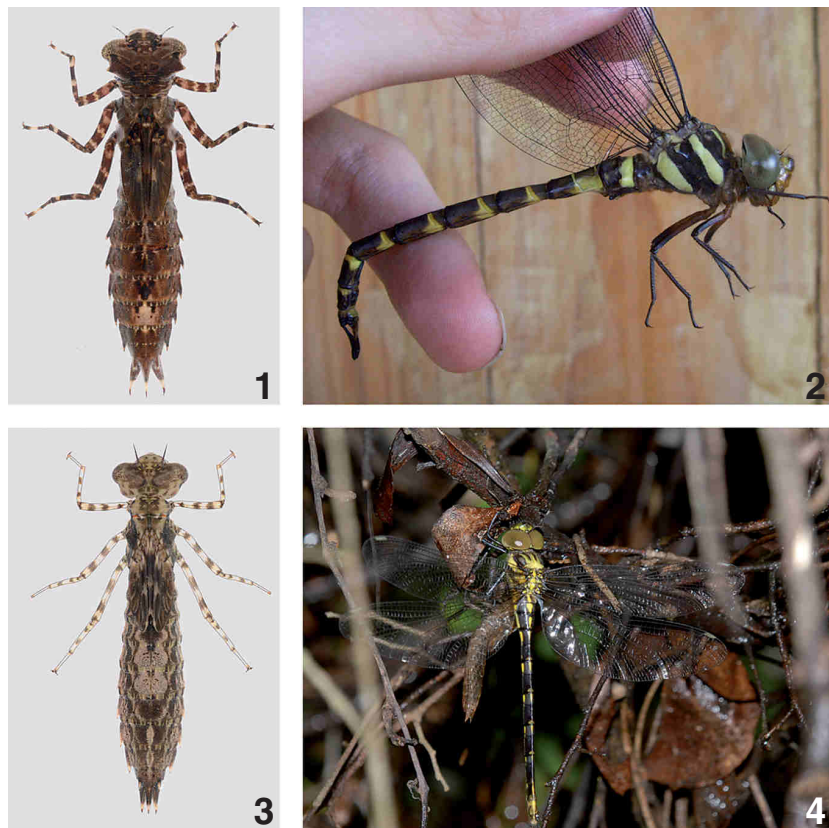
Figs 1-4. *Boyeria karubei* (Figs 1-2) and *Periaeschna f. flinti* (Figs 3-4): (1) final stage larva; − (2) teneral male; − (3) final stage larva; − (4) teneral female with its exuviae.

BOYERIA KARUBEI YOKOI, 2002
Figures 1-2, 5-18

M a t e r i a l. − 1 ♂ and 2 ♀ final stage larvae, 31-III-2008, Diaoluoshan, Hainan, China. Haomiao Zhang leg.; − 1 ♂ and its exuviae, Zhangjiang River, Guizhou, China, same collector; − 1 ♀, 26-VII-2008, Maolan Reserve, Guizhou, China, same collector.

DIAGNOSIS. − Large sized larva, with horn-shaped prominences on the posterior corners of occiput and thorax (Fig. 1). Body length: male 45.5 mm, female 41.0 mm; maximum head width 9.2 mm; length of hind femur 6.0 mm, length of hindwing bud 9.5 mm. Lateral spines present on S5-S9.

H e a d. − Dark brown without conspicuous spots. Posterior corner of occiput with a prominent horn on each side (Fig. 5). Labrum, anteclypeus and postclypeus brownish yellow in colour. Antefrons and ocellar triangle brown. Labium elongate. Promentum long and broad, approximately 1.5 times as long as broad, median lobe prominent, with a pair of small teeth on its distal margin, movable hook sharp, darkened to the apex in colour (Figs 7-8). Antennae filiform, 7-segmented (Fig. 9). Length ratio of segments as follows: 0.31: 0.31: 0.50: 0.22: 0.25: 0.16: 0.25.
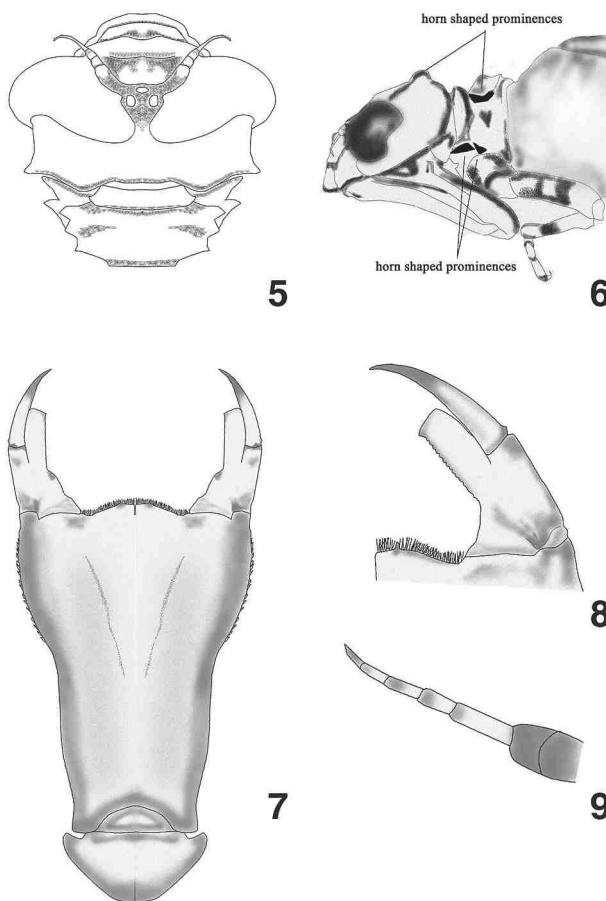
Figs 5-9. *Boyeria karubei*, larva: (5) head and prothorax, dorsal view; − (6) same, lateral view; − (7) labium, ventral view; − (8) movable hook; − (9) antenna.
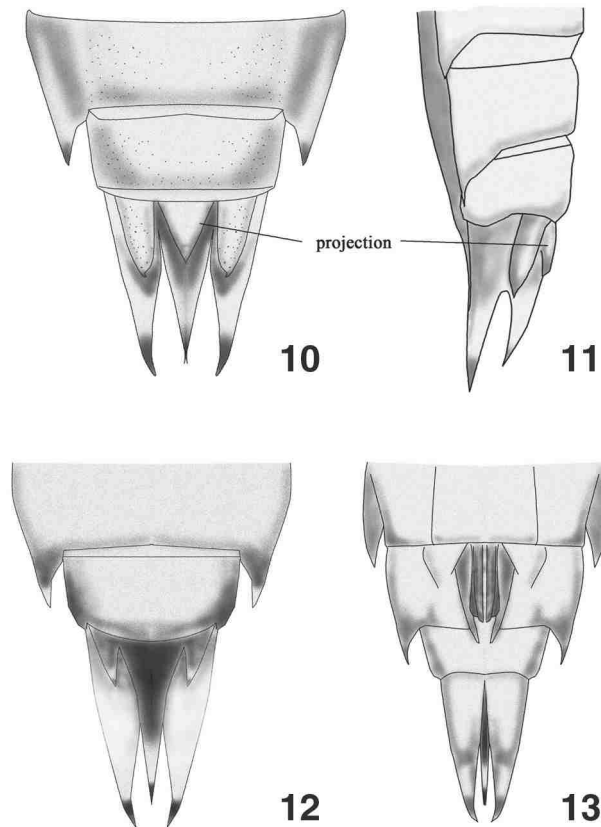
Figs 10-13. *Boyeria karubei*, larva, distal abdominal segments and caudal appendages: (10) male, dorsal view; − (11) male, lateral view; − (12) female, dorsal view; − (11) female, ventral view.

Thorax. − Dark brown. Pronotum with a pair of horn-shaped prominences on each side. Sides of prothorax with a pair of horn-shaped prominences approaching the front legs (Fig. 6). Synthorax brown, with four small horn-shaped prominences approaching the wing buds. Legs brown with black spots, tarsi 3-segmented. Wing buds parallel, hindwing buds approaching the middle of S4. Wing buds with yellow spots on the fore margin.

Abdomen. − Brown, with large, conspicuous black spots on S5-S7, and a rounded white spot on S8. Lateral spines present on S5-S9, dorsal hook absent. The distal segments and caudal appendages are shown in Figures 10-13. Male larvae with a projection on epiproct. Ovipositor of female larva reaching to the hind margin of S9.

BIOLOGICAL NOTES. − *B. karubei* larvae often climb in submerged aquatic weed or roots of riparian vegetation. Having a streamlined shape and keen eyesight, they actively stalk their prey, consuming any moving creature smaller than themselves, even their own kind. The larvae often mimic a twig which renders them cryptic in their usual habitat of leaf litter or submerged weeds, and they usually withdraw their legs and feign death when disturbed. Adults (Fig. 2) are active in gloomy forest canopies, and females have been observed to ovipositing during cloudy afternoons. In South China the flight period lasts from June to October.

REMARKS. − The genus *Boyeria* is widely distributed from the Mediterranean

to East Asia. Two
species of the genus
are known to occur
in China: *B. sinen-sis* Asahina and *B.
karubei.* ASAHINA
(1978) described *B.
sinensis* from a single
male collected from
Sichuan, China.
Since then no new
information on
this species has be-
come available, and
the female and the
larva remain un-
known. *B. karubei,*
originally described
by YOKOI (2002)
from central Laos,
was recently reported
from Guangdong and
Guangxi by WILSON
& XU (2008). Its lar-
va is similar to that of
*Tetracanthagyna wa-
terhousei* McLachlan,
which also has horn-
-shaped prominenc-
es on the posterior
corners of occiput.
However, *B. yokoii*
can easily be separated
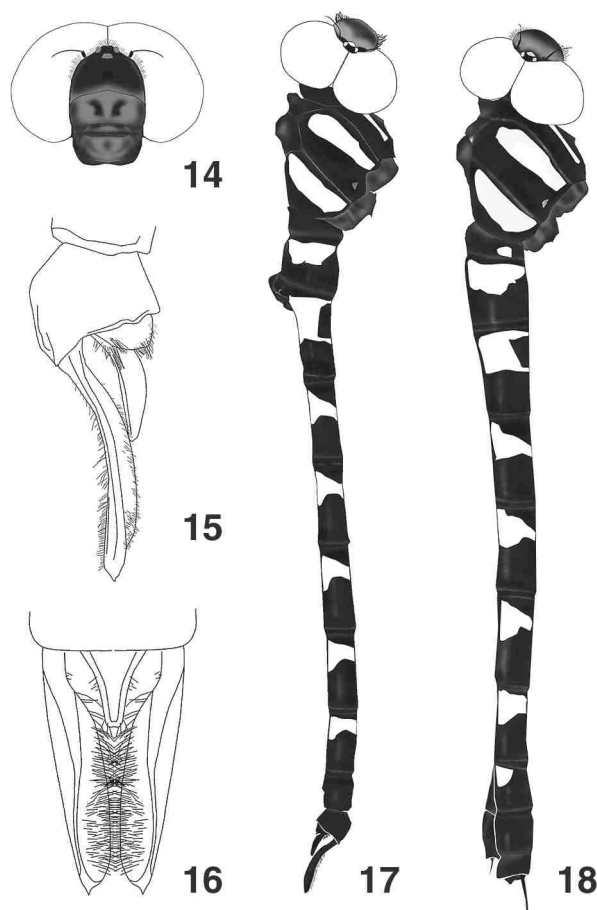
Figs 14-18. *Boyeria karubei*, adult: (14) male, head, frontal view; −
(15) male, thorax and abdomen, lateral view; − (16) female, same,
lateral view; − (17) male, caudal appendages, lateral view; − (18)
same, dorsal view.

from *T. waterhousei* by relatively shorter abdomen and the extremely pointed ap-
pendages, whereas *T. waterhousei* has taper-shaped prominences on dorsum of
distal segment, and its appendages are shorter and less developed.

YOKOI (2002) made a comparison between the adult *B. maclachlani* (Selys)
from Japan, *B. sinensis* and *B. karubei* and he noticed that the colour of head
and antealar carina in *B. karubei* (Figs 14, 17-18) differs from *B. maclachlani*. The
lack of subbasal ventral tubercle and a more pointed apex in superior appendages
(Figs 15-16) separates *karubei* from *sinensis*. WILSON & XU (2008) wrote:
"It is apparent there are clear structural differences to separate *sinensis* from

maclachlani but there are no overt structural differences to distinguish *karubei* from *maclachlani*."

DISTRIBUTION. − China (Guangdong, Guangxi, Hainan and Guizhou) and Laos.
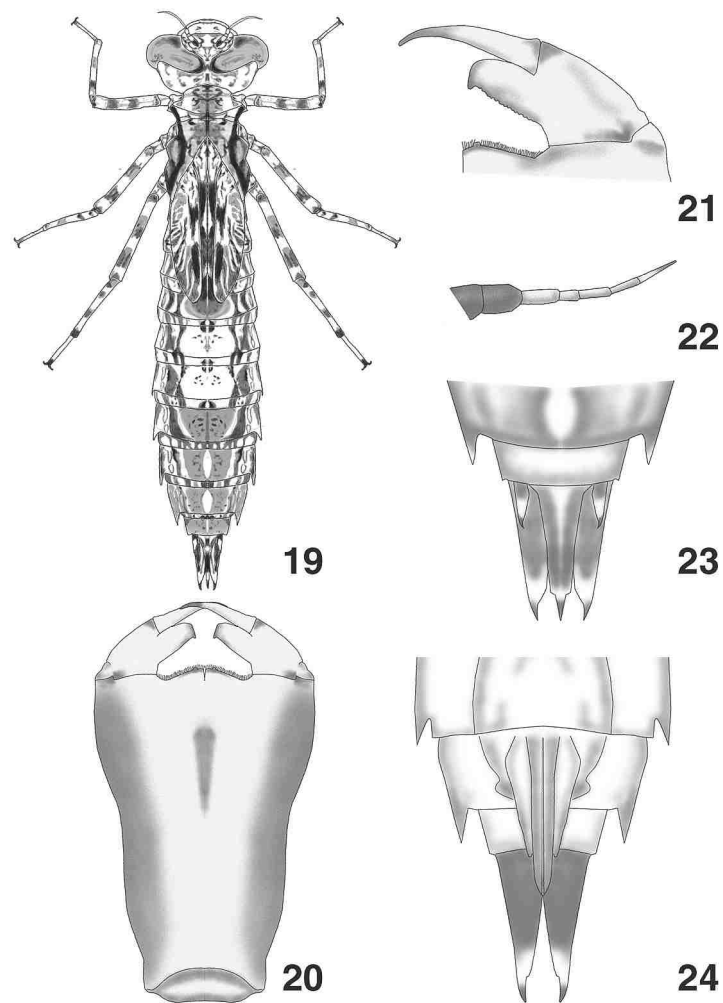
Figs 19-24. *Periaeschna f. flinti*, larva: (19) male, final instar, dorsal view; − (20) labium, ventral view; − (21) movable hook; − (22) antenna; − (23) female, distal abdominal segments and caudal appendages, dorsal view; − (24) same, ventral view.

PERIAESCHNA F. FLINTI ASAHINA, 1978
Figures 3-4, 19-31

M a t e r i a l. − 1 ♂, 1 ♀ and their exuviae, 15-VI-2008, Lishui, Zhejiang, China, Haomiao Zhang leg.; − 1 ♀ final stage larva, same data but 22-VI-2008; − 1 ♂, 1 ♀, same data; − 1 ♂, 9-VII-2008, Xiangzhigou, Guizhou, China, same collector; − 1 ♂, 25-VII-2008, Maolan Reserve, Guizhou, China, same collector.

DIAGNOSIS. − Small sized larva (Fig. 19). Body length: female 31.5 mm; maximum head width 6.5 mm; length of hind femur 5.5 mm, length of hindwing bud 6.0 mm. Lateral spines present on S6-S9.

H e a d. − Brownish yellow, without conspicuous spots. Labrum, anteclypeus, postclypeus, antefrons and ocellar triangle brownish yellow in ground colour. Labrum and anteclypeus with a small rounded black spot in the centre, postclypeus with a pair of black spots in the centre. Eyes black. Posterior corner of occiput rounded. Hind margin of occiput with three irregular black spots each side. Labium flat and elongate, Promentum long and broad, approximately 1.5 times as long as broad, median lobe prominent, with a pair of small teeth on its distal margin, movable hook sharp, darkened to the apex (Figs 20-21). Antennae filiform, 7-segmented (Fig. 22). Length ratio of segments as follows: 0.19: 0.28: 0.28: 0.16: 0.16: 0.16: 0.28.

T h o r a x. − Brownish yellow. Sides of prothorax with a pair of horn-shaped prominences approaching the front legs. Synthorax brownish yellow, with an oblique black stripe across mesepisternum and mesipimeron, extending along the antealar to the hindwing bud. Legs brownish yellow with dark brown spots, tarsi 3-segmented. Wing buds parallel, hindwing buds approaching the middle of S4. Wing buds with yellow spots on the fore margin.

A b d o m e n. − Brown, with large conspicuous black spots on S1-S4, and big conspicuous yellow spots on S5-S6. S8-S9 with oval yellow spots along the dorsal carina. Lateral spines present on S6-S9, dorsal hook absent. The distal segments and caudal appendages are shown in Figures 23-24. Ovipositor of female larva reaching to 1/3 of the length of paraproct.

NOTES ON BIOLOGY. − *Periaeschna* larvae frequently occupy the riffle areas of mountainous forest streams. Due to their habitat requirements it is not easy to rear them under laboratory conditions. Therefore they are poorly known and their descriptions are inadequate. *P. f. flinti* larvae usually occur in the headwater streams with shade riparian vegetation, but have also been found in the paddy fields ditches. These are active, spindle-shaped predators and have a remarkable jet propulsion system for escaping when disturbed. Adults are active in gloomy forest canopies. The flight period in southern China lasts from May to August.

REMARKS. − The genus *Periaeschna* is widely distributed in southern and south-eastern Asia and in China. Four species were recorded from China, viz.: *P. f. flinti*, *P. magdalena* Martin, *P. zhangzhouensis* Xu and *P. gerrhon* (Wilson) (ASAHINA, 1978; WILSON, 2005; WILSON & REELS, 2001; WILSON & XU, 2008; XU,

2007). The larva of *P. f. flinti* is easily distinguished from the Chinese congeners by the much smaller body size and maculation patterns. Larvae of some *Cephalaeschna* species also possess large spots, but have a relatively broader frons which is usually more than 1/2 of the head width. Female larvae of both *Cephalaeschna* and *Periaeschna* have a long ovipositor, but the ovipositor in the former is more developed. For example, larvae of *C. patrorum* Needham, possess a much longer ovipositor than *P. f. flinti*, reaching to 1/2 of the length of paraproct (JIANG & ZHANG, 2008). *P. flinti assamensis* Asahina occurs in Assam (ASAHINA, 1981).

DISTRIBUTION. − China (Guangdong, Fujian, Jiangxi, Sichuan, Zhejiang and Guizhou).
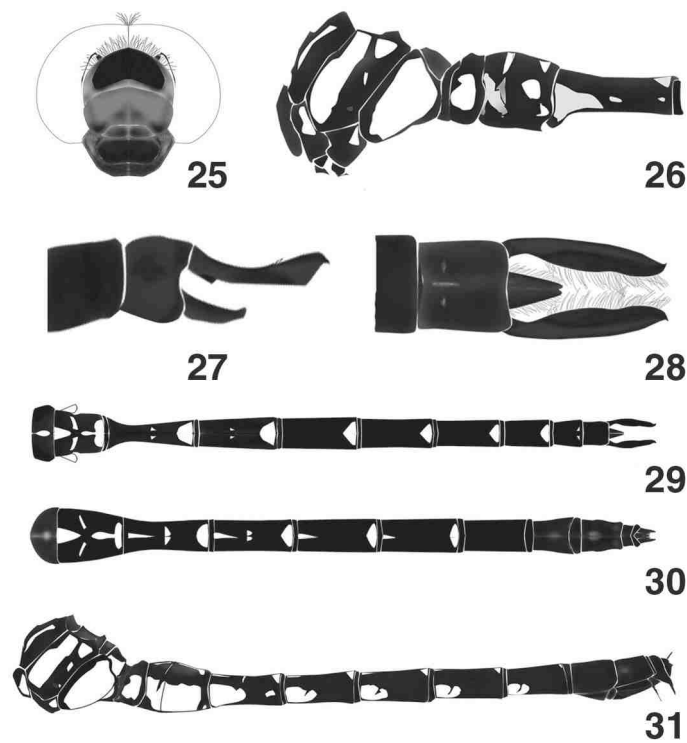
Figs 25-31. *Periaeschna f. flinti*, adult: (25) male, head, frontal view; − (26) male, thorax and basal abdominal segments, lateral view; − (27) male, caudal appendages, lateral view; − (28) same, dorsal view; − (29) male, abdomen, dorsal view; − (30) female, abdomen, dorsal view; − (31) female, thorax and abdomen, lateral view.

ACKNOWLEDGEMENTS

REFERENCES

ASAHINA, S., 1974. Diagnostic notes on the ultimate instar larvae of some Anax species. *Tombo* 17: 10-16. − [Jap., with Engl. s.]

ASAHINA, S., 1978. Notes Chinese Odonata, 7. Further studies on the Graham Collection preserved in the U.S. National Museum of Natural History, suborder Anisoptera. *Kontyū* 46(2): 234-252.

ASAHINA, S., 1981. A revision of the Himalayan dragonflies of the genus Cephalaeschna and its allies (Odonata, Aeschnidae), 2. *Bull. natn. Sci. Mus. Tokyo* (A) 7(2): 57-77.

DUDGEON, D., 1999. *Tropical Asian stream: zoobenthos, ecology and conservation*. Hong Kong Univ. Press, Hong Kong.

FRASER, F.C., 1943. New oriental Odonata larvae. *Proc. R. ent. Soc. Lond.* (B) 12: 81-93.

ISHIDA, K., 1996. *Monograph of Odonata larvae in Japan.* Hokkaido Univ. Press, Sapporo. − [Jap., with Engl. title]

JIANG, Y.-H. & H.-M. ZHANG, 2008. Descriptions of the full-grown Cephalaeschna patrorum Needham and Planaeschna shanxiensis Zhu & Zhang larvae from China. (Anisoptera: Aeshnidae). *Odonatologica* 37(3): 273-277.

MATSUKI, K., 1987. Descriptions of the larvae of four species of the genus Anax in Taiwan (Odonata: Aeshnidae). *Tombo* 30: 25-32. − [Jap., with Engl. s.]

NEEDHAM, J.G., 1930. A manual of the dragonflies of China: a monographic study of the Chinese Odonata. *Zoologia sin.* (A) 11(1): 345 + 11 pp., 20 pls incl.

WILSON, K.D.P., 2005. Odonata of Guangxi Zhuang Autonomous Region, China, 2: Anisoptera. *Int. J. Odonatol.* 8(1): 107-168.

WILSON, K.D.P. & G.T. REELS, 2001. Odonata of Hainan, China. *Odonatologica* 30(2): 145-208.

WILSON, K.D.P. & Z.-F. XU, 2008. Aeshnidae of Guangdong and Hong Kong (China), with the descriptions of three new Planaeschna species (Anisoptera). *Odonatologica* 37(4): 329-360.

XU, Q.-H., 2007. Periaeschna zhangzhouensis spec. nov. from Fujian, China (Anisoptera: Aeshnidae). *Odonatologica* 36(3): 315-318.

YOKOI, N., 2002. Description of a new Boyeria species from central Laos (Anisoptera: Aeshnidae). *Tombo* 45: 12-14.

YOON, I.B. & S.K. DONG, 1990. Systematic study of the dragonfly (Odonata) larva from Korea, 1: superfamily Aeshnoidea. *Korean J. Ent.* 20: 55-81.

ODONATOLOGICAL ABSTRACTS

2002

(18175)   BORISOV, S.N., 2002 Altitudinal diffusion of dragonflies (Odonata) in the Pamir-Alai. *Sibir. ekol. Zh.* 6: 685-696. (Russ., with Engl. s.). — (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

For 53 (out of 57) spp., the ranges and optima of altitudinal distribution are presented. Distinguished are: mountainous spp. (13), lowland spp. (10), those with optima in the mountains (16), or plains (11), whereas 3 spp. are obligatory migrants, with vaguely expressed optima. The odon. vertical distribution is conditioned by climatic conditions and by the availability of appropriate breeding habitats. With the development of irrigation systems, the patterns of odon. vertical distribution in the Pamir-Alai (and generally in southern central Asia) have radically changed. Some initially mountainous spp. have succeeded in populating plains with desert climate, and the majority of lowland and ubiquitous spp. have considerably enlarged their ranges.

2003

(18176)   MISOF, B. & G. FLECK, 2003. Comparative analysis of mt LSU rRNA secondary structures of odonates: structural variability and phylogenetic signal. *Insect mol. Biol.* 12(6): 535-547. — (Firt Author: Dept Ent., Res. Inst. & Mus. Zool. 'A. Koenig', Adenauerallee 160, D-53113 Bonn).

Secondary structures of the most conserved part of the mt 16S rRNA gene, domains IV and V, have been recently analysed in a comparative study. However, full secondary structures of the mt LSU rRNA molecule are published for only a few insect species. The present study presents full secondary structures of domains I, II, IV and V of Odon. (including also Epiophlebia) and of an Ephemera sp. (Ephemeroptera). The reconstructions are based on a comparative approach and minimal consensus structures derived from sequence alignments. The inferred structures exhibit remarkable similarities to the published Drosophila melanogaster model, which increases confidence in these structures. Structural variance within Odon. is homoplastic, and neighbour-joining trees based on tree edit distances do not correspond to any of the phylogenetically expected patterns. However, despite homoplastic quantitative structural variation, many similarities between Odon. and Ephemera sp. suggest promising character sets for higher order insect systematics that merit further investigations.

(18177)   *NIEUWSBRIEF VLINDER- EN LIBEL-LENWERKGROEP STAD EN OMMELAND*, Groningen, ISSN none, Vol. 11, No. 4 (Oct. 2003). (Dutch). — (Editors: Lichtboei 259, NL-9732 KD Groningen).

[Odonatological articles]: *Sangers, H.*: Protection of Lepidoptera and Odonata in the Zuidelijk Westerkwartier (p. 3); — *De Vries, N.*: A garden to enjoy (p. 4; with a list of 15 odon. spp. encountered in a garden at Sellingen); — *Gerard, J.*: Dragonfly Work+Group in Drenthe to start (p. 6); — *Oosting, M.*: A butterfly and dragonfly field trip to Middelstumerbos (pp. 7-8).

(18178)   PRYSWITT, K.-P., 2003. Die Zwerglibelle (Nehalennia speciosa) im NSG Helstorfer Moor (Region Hannover). *Mitt. ArbGem. zool. Heimatsf. Nds.* 9: 25. — (Lessingstr. 2, D-31535 Neustadt a. Rbge).

A N. speciosa population is reported from Helstor-

fer Moor (15-VI-2003, incl. exuviae). So far only 2 localities of this sp. are known in Lower Saxony (Germany).

(18179)   THALER, K., 2003. Partielle Inventar der Fauna von Nordtirol: niedere Pterygota (Insecta: Palaeoptera, Paurometabola, Paraneoptera [p.p.]). *Biol. Beitr.* 35(2): 785-800. (With Engl. s.). − (Inst. Zool. & Limnol., Univ. Innsbruck, Technikerstr. 25, A-6020 Innsbruck).

Includes a brief review (with bibliography) of the state of knowledge on the Odon. in N Tyrol, Austria.

2004

(18180)   AHMED, S., M. KASHIF & S. NISAR, 2004. Efficay of monomehypo 5G and chlorpyrifos 40EC against insect pests and their effect on natural enemies in rice eco-system. *Pak. Entomol.* 26(1): 87-94. − (First Author: Dept Agric. Ent., Univ. Agric., Faisalabad, Pakistan).

It was experimentally shown that the application of these insecticides triggered a ca 50% reduction of the larval and adult odon. population.

(18181)   BORISOV, S.N., 2004. Night hatching of dragonflies in southern part of West Siberia. *Euroasian ent. J.* 3(3): 216. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-620091 Novosibirsk).

Night hatching in Lestes macrostigma, Aeshna affinis, A. mixta, Sympetrum flaveolum and S. vulgatum is recorded. The date, air temperature, hatching hours and the hour of departure on maiden flight are stated for each sp.

(18182)   CANO VILLEGAS, F.J., 2004. Odonata in the Natural Monument of Los Sotos de la Albolafia (Cordoba, Andalusia). *Boln SAE* 11: 7-13. (Span., with Engl. s.). − (Montemayor 4, 1°-2, ES-14003 Córdoba).

A commented list of 7 spp.; − Spain. The breeding of Onychogomphus costae is for the first time documented for Andalusia.

(18183)   MBABAZI, D., F.L. ORACH-MEZA, B. MAKANGA, R.E. HECKY, J.S. BALIRWA, R. OGUTU-OEWAYO, P. VERBURG, G. NAMULEMO, E. MUHUMUZA & J. LUYIGA, 2004. Trophic structure and energy flow in fish communi-

ties of two lakes of the Lake Victoria basin. *Uganda J. agric. Sci.* 9: 348-359. − (First Author: Fisheries Resources Res. Inst., P.O. Box 343, Jinja, Uganda).

Odon. are reported in the diets (stomach contents) of Astatoreochromis alluaudii, Harpagochromis squamipinus (both Cichlidae), Clarias gariepinus (Claridae) and Protopterus aethiopicus (Protopteridae).

(18184)   STARZYK, J.R., 2004. Contribution of entomologists of Lviv to the development of nature conservation in eastern Galicia. *Nauk. Visn.* 14(8): 38-46. (With Ukr. s.). − (Author's address not stated).

Has a paragraph describing and appreciating the odonatol. work of J. Dziedzielewicz (1844-1918). Notable is his monograph, *Odonata Haliciae reliquarumque provinciarum Poloniae*, Mus. Dzieduszyckianum, vi+176 pp., pl. 1 excl. (1902)

(18185)   URBAN, M.C., 2004. Disturbance heterogeneity determines freshwater metacommunity structure. *Ecology* 85(11): 2971-2978. − (Natn. Cent. Ecol. Analysis & Synthesis, 735 State St., Suite 300, Santa Barbara, CA 93101, USA).

The relative importance of regional (dispersal) and local (abiotic and biotic environmental variation) processes in explaining the structure of a freshwater pond metacommunity are assessed. The study was conducted within a 200 ha section of the Yale-Myers Research Station, Union, CT (USA). The 2 odon. spp. (Lestes, Sympetrum) that were found in the study, only occurred in ponds containing high (> 45%) macrophyte cover.

2005

(18186)   BORISOV, S.N., 2005. Aperiodic changes in number of Lestes macrostigma (Eversmann, 1836) (Odonata, Lestidae) in forest-steppe of West Siberia. *Euroasian ent. J.* 4(1): 30-32. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

An increase in L. macrostigma abundance in the lower reaches of the Karasuk river (forest-steppe of Novosibirsk Oblast, Russia) was noticed during 2000-2001, whereas a single record (1973) had been hitherto known. The possible reasons of the fluctuation in abundance are discussed, and an extreme variation in wing venation is brought on record.

(18187)   BORISOV, S.N., 2005. Summer migration of species of Sympecma Burmeister, 1839 (Odonata, Lestidae) in northern Tien-Shan. *Euroasian ent. J.* 4(3): 256. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

The details are provided on the migration of S. gobica, S. fusca and S. paedisca from the lowlands to the foothills of northern Tien-Shan in June 2005.

(18188)   CANO, E. & A. JIMENEZ, 2005. Evolución de las poblaciones de insectos en una tabla e arroz de las marismas del bajo Guadalquivir. *Limnetica* 24(1/2): 61-66. (With Engl. s.). − (Depto Fisiol. & Zool., Fac. Biol., Univ. Sevilla, Avda Reina Mercedes 6, ES-41012 Sevilla).

In the marshes of the lower Guadalquivir river (Spain) rice is grown using a flow-through system, which keeps the water oxygenated and its temperature at ca 20-25°C. Here, the quantitative occurrence (July-Sept.) of Calopterygidae and Libellulidae in the rice fields is shown family-wise.

(18189)   MELLADO DIAZ, A., 2005. *The ecology of stream macroinvertebrate assemblages from the Segura river basin (SE Spain). Environmental factors, spatio-temporal variability, indicator taxa, diversity trends and applications for bioassessment.* PhD thesis, Depto Ecol. & Hidrobiol., Fac. Biol., Univ. Marcia. 196 pp. (General introduction and Acknowledgements in Span., the rest of the work in Engl.).

The dissertation has 4 chapters, titled: "Macroinvertebrate assessment in streams from the Segura river basin: seasonal trends, processing method and taxonomic resolution effects on multivariate patterns and community metrics" (pp. 23-61), "Macroinvertebrate communities from the Segura river basin: stream types, indicator taxa and environmental factors explaining spatial patterns" (pp. 63-98), "Biological and ecological traits of stream macroinvertebrates from a semi-arid catchment: patterns along complex environmental gradients" (pp. 101-158), and "Taxa richness, diversity and functional diversity in macroinvertebrate assemblages from the Segura river basin: natural variations and anthropogenic influences" (pp. 159-189). − 16 odon. genera are considered, a list of spp. is not provided.

(18190)   MELLO, M.J., 2005. Inventory of Macrolepidoptera and other insects in the Boston Harbor Islands National Park area. *NEast. Nat.* 12 (Special Issue 3): 99-144. − (Lloyd Cent. Envir. Stud., 430 Potomska Rd, Dartmouth, MA 02748, USA).

14 islands were surveyed. 15 identified odon. spp. are recorded from the islands of Worlds End and Lovells (Massachusetts, USA).

(18191)   PAOLETTI, M.G. & D.L. DUFOUR, 2005. Edible invertebrates among Amazonian Indians: a critical review of disappearing knowledge. *In*: M.G. Paoletti, [Ed.], *Ecological implications of mini-livestock: potential of insects, rodents, frogs and snails,* pp. 293-342, Science Publishers, Enfield/NH. − (First Author: Dept Biol., Padova Univ., Via U. Bassi 58/b, Padova, Italy).

Aeshna brevifrons, A. marchali, A. peralta, Coryphaeshna adnexa, Zonophora sp. and Dasythemis sp. that are eaten (mostly as larvae) by the Amerindian tribes of Quichuas, Otavalos (both Equador) and Ye'Kuana (Venezuela) are listed. They are consumed mostly raw. The Ye'Kuana collecting technique, using a large basket, is documented photographically.

2006

(18192)   ÁLVAREZ, D. & A.G. NICIEZA, 2006. Factors determining tadpole vulnerability to predators: can prior experience compensate for a suboptimal shape? *Evol. Ecol.* 20: 523-534. − (Dept Functional Biol., Univ. Oviedo, ES-33071 Oviedo).

In Rana temporaria, the tadpole tail size and shape are important determinants of survival from Aeshna cyanea larvae predation. Also tadpoles that had previously been in the presence of a predator preying upon a conspecific show enhanced survivorship during strong predation events. In contrast, in Bufo bufo, the tadpole tail shape is not integrated in the antipredator strategy, and the prior experience with aeshnid larvae does not enhance B. bufo abilities to escape attacks by dragonflies.

(18193)   BORISOV, S.N., 2006. Adaptations of dragonflies (Odonata) under desert conditions. *Ent. Rev.* 86(5): 534-543. Originally published in Russian in *Zool. Zh.* (2006) 85(7): 820-829. − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

Different types of odon. adaptations to climatic conditions of the desert zone are described. The

main larvae habitats there are lotic or semi-lotic artificial reservoirs. The life cycles are synchronous with seasonal climatic changes, reproduction being restricted to periods of the optimal hygrothermal conditions. Some spp. reveal vertical seasonal migrations. The labile daily activity rhythms allow the dragonflies to avoid the effects of unfavourable conditions. Adults of many spp. emerge at night.

(18194)   BORISOV, S.N., 2006. The altitudinal distribution of dragonflies (Odonata) in the Middle Asia. *Entomologicheskie issledovaniya v severnoy Azii* (proc. 7th Meet. Entomologists Siber. & Far East), pp. 208-210, Inst. Anim. Syst. & Ecol., RAS, Novosibirsk. (Russ., with Engl. title). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
75 spp. are known from the region, 11 of these are rare, therefore only 64 spp. are considered in this paper. 3 main species-groups are distinguished in the fauna, viz.: 13 spp. are restricted to the mountains, 15 spp. are restricted to the lowlands, and 36 spp. are ubiquitous, occurring at all elevations. The latter group is subdivided into 5 subgroups, viz.: 7 spp. have boreo-mountainous distribution, 8 spp. represent southern faunal elements, 10 spp. are rheophile or oxyphile, 8 spp. are characterised by seasonal vertical migrations, and 3 spp. are obligatory migrants. For each sp. information is provided on the elevations at which it occurs.

(18195)   MARTIN CASACUBERTA, R., 2006. Odonata of Catalonia: catalogue and geographic analysis. Erratum. *Boln Asoc. esp. Ent.* 30(1/2): 223-225. − (C. Marti Juliá 19-23, 1° 1a, ES-08911 Barcelona).
Tab. 1 ("List of species recorded from Catalonia, with author and date of first record"), given incompletely in the original paper (*OA* 17948), is reproduced.

(18196)   URBAN, M.C., D.K. SKELLY, D. BURCHSTED, W. PRICE & S. LOWRY, 2006 Stream communities across a rural-urban landscape gradient. *Diversity Distrib.* 12: 337-350. − (First Author: Natn. Cent. Ecol. Analysis & Synthesis, 735 State St., Suite 300, Santa Barbara, CA 93101, USA).
9 odon. taxa (mostly genera: Calopterygidae, Coenagrionidae, Gomphidae, Cordulegastridae) are listed from 18 headwater streams in New Haven co., Connecticut, USA.

2007

(18197)   ADOMSSENT, M., 2007. Erstnachweis der Schabrackenlibelle Anax ephippiger (Burmeister, 1839) für Niedersachsen (Odonata). *Ent. Nachr. Ber.* 51(2): 137-139. − (Inst. Umweltkommunikation, Univ. Lüneburg, D-21332 Lüneburg).
1♂, on the Ilmenau, ca 4 km S of Bad Bevensen, 26-V-2007. This is the first record for Lower Saxony, Germany.

(18198)   BOŽIČ, L., A. MEDVED, E. VUKELIČ & Ž. ŠALAMUN, 2007. *Načrt upravljanja za naravni rezervat Iški morost*. − [*Management plan for the "Iški Morost" nature reserve*]. DOPPS, Ljubljana. 40 pp. (Slovene). − (c/o Bird Life Slovenia DOPPS, P.O. Box 2722, SI-1001 Ljubljana).
The Reserve (surface 63.5 ha) is situated within the SE region of Ljubljana Moor (LM). Close to 30 odon. spp. are said to occur there, but a list is not given. Instead, a checklist of the 48 spp. hitherto recorded from LM is provided along with annotations on their status of legal protection. It is emphasized, the LM populations of Coenagrion ornatum, C. pulchellum, Somatochlora flavomaculata and Libellula fulva are the largest of these spp. in Slovenia. − For the LM odon. fauna, see *OA* 12165.

(18199)   McPEEK, M.A. & J.M. BROWN, 2007. Clade age and not diversification rate explains species richness among animal taxa. *Am. Nat.* 169(4): E97-E106. − (First Author: Dept Biol. Sci., Dartmouth Coll., Hanover, NH 03755, USA).
Animal taxa show remarkable variability in species richness across phylogenetic groups. Most explanations for this disparity postulate that taxa with more spp. have phenotypes or ecologies that cause higher diversification rates (i.e., higher speciation rates or lower extinction rates). Here it is shown that clade longevity, and not diversification rate has primarily shaped patterns of species richness across major animal clades: more diverse taxa are older and thus have had more time to accumulate species. Diversification rates calculated from 163 species-level molecular phylogenies were highly consistent within and among Arthropoda (incl. Odon.), Chordata and Mollusca and did not correlate with species richness. Clades with higher estimated diversification rates were younger, but species numbers increased with increasing clade age. A fossil-based data set also revealed a strong, positive relationship between

total extant species richness and crown group age across the orders of insects and vertebrates. These findings do not negate the importance of ecology or phenotype in influencing diversification rates, but they do show that clade longevity is the dominant signal in major animal biodiversity patterns. Thus, some key innovations may have acted through fostering clade longevity and not by heightening diversification rate.

(18200)　MERTENS, J., L. BELADJAL, F. JANSENS & P. MATTHYS, 2007. Pitfall trapping in flooding habitats: a new technique reveals Archisotoma pulchella (Collembola: Isotomidae) as new to the Belgian fauna. *Belg. J. Zool.* 137(2): 177-181. − (First Author: Terrest. Ecol., Univ. Gent, Ledeganckstraat 35, B-9000 Gent).

Flooding habitats are unique ecosystems with complex land-water interactions. Here a pitfall trap, developed for use in temporarily submerged areas is described. Based on a literature search of pitfall trapping in different habitats, an overview is provided of animal taxa (incl. Odon.) collected there.

(18201)　MIKOLAJEWSKI, D.J., G. JOOP & B. WOHLFAHRT, 2007. Coping with predators and food limitation: testing life history theory for sex-specific larval development. *Oikos* 116: 642-649. − (First Author: Dept Anim. & Plant Sci., Univ. Sheffield, Western Bank, Sheffield, S10 2TN, UK).

For animals with complex life cycles, recent models of sexual size-dimorphism at maturity assume 3 key variables to optimise larval life history: activity in the larval stage, development time, and size at maturation. However, model predictions remain largely untested. In the territorial Libellula depressa exhibiting a flexible development time it was here tested for ♂-biased sexual size-dimorphism and sex differences in larval activity, development time, and growth rate. Based on models it was predicted that ♂♂ achieve their larger size compared to ♀♀ by a longer development rather than being more active. Results revealed that ♂♂ took longer to develop and achieved a larger size than ♀♀, but were not more active. Compared to ♂♂, ♀♀ exhibited a higher growth rate which was not achieved by an activity-mediated increased food intake. It is concluded that sexual size dimorphism in spp. with a flexible development time is mediated by differences in developmental length but not activity. Furthermore, sexes differ in their plastic responses to food availability and predator presence, making it necessary to consider sex-specific differences in testing further life history responses.

(18202)　PRYSWITT, K.-P. & J. RIEDEL, 2007. Grüne Mosaikjungfer (Aeshna viridis) im Netz der Wespenspinne (Agriope bruennichi). *Naturk. Beitr. Soltau-Fallingbostel* 13/14: 52-54. − (First Author: Lessingstr. 2, D-31535 Neustadt a. Rbge).

In a heavily damaged A. brunnichi web, an A. viridis ♂ was found (28-VII-2006) near Grindau (Lünenburger Heide, Germany). Although one of the wings was slightly damaged, the dragonfly was able to tear himself out of the web on his own. From the same locality Aeshna affinis is also reported.

(18203)　URBAN, M.C., 2007. Predator size and phenology shape prey survival in temporary ponds. *Oecologia* 154: 571-580. − (Natn. Cent. Ecol. Analysis & Synthesis, 735 State St., Suite 300, Santa Barbara, CA 93101, USA).

The libellulid larvae (Leucorrhinia, Pachydiplax, Sympetrum) are among the gap-limited predators of spotted salamander larvae (Ambystoma maculatum), i.e. they cannot capture larger individuals as they cannot readily handle prey larger than their labium widths. The aeshnid larvae, on the other hand, are gap-unconstrained predators, whose stiff prementum enables them to grasp prey larger than themselves and can prey upon the salamander larvae throughout the prey's entire size ontogeny. Here it was examined how predator-size dynamics in 40 temporary ponds in southern New England (USA) affects the survival of A. maculatum larvae.

(18204)　VADADI-FÜLÖP, C., G. MÉSZÁROS, G. JABLONSZKY & L. HUFNAGEL, 2007. Ecology of the Ráckeve-Soroksár Danube: a review. *Appl. Ecol. envir. Res.* 5(1): 133-163. − (First Author: Dept Syst. Zool. & Ecol., Eötvös Loránd Univ., Rázmány P. sétány 1/c, HU-1117 Budapest).

A descriptive review of the literature (96 titles, incl. web references) on the second largest side arm in the Hungarian section of the Danube, with a checklist of the recorded animal spp., incl. 10 odon. spp. For the primary publications on the regional Odon., see P. Benedek (1966, *Entomologica hung.* 2: 501-518 and H. Steinmann (1962, *ibidem* 1: 141-198).

2008

(18205)   ALMEIDA, D., A. ALMODÓVAR, G.G.
NICOLA & B. ELVIRA, 2008. Feeding tactics
and body condition of two introduced populations
of pumpkinseed Lepomis gibbosus: taking advan-
tage of human disturbances? *Ecology of Fresh-
water Fish* 2008: 9 pp.; − DOI 10.1111/j.1600-
0633.2008.00317.x − (First Author: Dept Zool. &
Physic Antropol., Fac. Biol., Complutense Univ.
ES-28040 Madrid).

The Relative Importance (RI) indices of Zygoptera
and Anisoptera larvae in the L. gibbosus diet in
Cabañeros National Park (Spain) are 039 and 0.43,
respectively. That of undetermined odon. amounts
to 0.54.

(18206)   BELOVA, Yu.N., M.N. DOLGANOVA,
N.S. KOLESOVA, A.A. SHABUNOV & I.V. FILO-
NENKO, 2008. *Diversity of insects of the Vologda
region*. Dept Zool. & Ecol., Vologda St. Pedag.
Univ., Vologda. 368 pp., 16 col. pls excl. ISBN 978-
-5-87822-369-0. (Russ., with Engl. s., Conclusion &
Contents tab.).

The monograph is devoted to the analysis of the
diversity of Odon. and some groups in 6 other or-
ders, and to the history of their study within the
territory of the Vologda region, Russia. The records
are provided for 33 odon. spp. (pp. 16-25, pls 1-2).
Ophiogomphus cecilia and Cordulegaster boltonii
are red listed for the region.

(18207)   BORISOV, S.N., 2008 Dragon-flies (Odona-
ta) in ornithological traps from western Tien-Shan.
Eurasian ent. J. 7(1): 10. (Russ., with Engl. s.). −
(Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze
11, RUS-630091 Novosibirsk).

Sympecma fusca, S. gobica, S. paedisca, Aeshna
mixta, Anax parthenope, Sympetrum arenicolor
and S. fonscolombii are reported (Talasskiy Ala-
-Too, alt. 1200 m).

(18208)   BOTS, J., L. DE BRUYN, R. VAN DAMME
& H. VAN GOSSUM, 2008. Effects of phenotypic
variation onto body temperature and flight activity
in a polymorphic insect. *Physiol. Ent.* 33: 138-144.
− (Evol. Ecol. Gr., Dept Biol., Univ. Antwerp,
Groenenborgerlaan 171, B-2020 Antwerpen).

According to biophysical principles, colour and size
are important phenotypic factors that may influ-
ence body temperature and activity in ectothermic
insects. In taxa showing ♀-limited polymorphism,
♂♂ and ♀ morphs differ in body colour, size and
activity pattern. However, no previous study has
evaluated whether such phenotypic and behavioural
variation relates to differences between ♂♂ and ♀
morphs in thermal properties. In the present study,
the relationships between body colour, size, activity
and body temperature are examined under labo-
ratory and field conditions, for the polymorphic
zygopteran, Enallagma cyathigerum. Contrary to
expectation, ♂♂ and ♀ morphs of this sp. do not
differ in thermal properties (i.e. heating character-
istics or field body temperatures). When question-
ing phenotype and activity, temperature does not
appear to be relevant for understanding the main-
tenance of ♀-limited polymorphism.

(18209)   COOPER, I.A., 2008. *Ecological causes of
female-limited dimorphism in Hawaiian damselflies*.
PhD thesis, Dept Biol., Indiana Univ. viii+98+3
pp. − (UMI Microform 3331355, available from:
ProQuest LLLC, 789 East Eisenhower Parkway,
P.O. Box 1346, Ann Arbor, MI 48106-1346, USA;
− Author's address: 1001 E 3rd St., Jordan Hall,
Bloomington, IN 47405, USA).

Evolution theory posits that sexual selection, more
so than natural selection, drives sex differences, such
as bright ♂♂ and inter-sexual mimicry. However,
♀-limited dimorphism has not been fully explained
by sexual selection even though this phenomenon
includes what appears to be intersexual mimicry of
bright ♂♂. This dissertation presents evidence that
natural selection over an ecological gradient may
explain sexual dimorphism and ♀-limited dimor-
phism in a zygopteran sp., as well as macroevolu-
tionary patterns of sexual dimorphism throughout
a zygopteran genus. New cases of ♀-limited colour
dimorphism in the endemic Hawaiian Megalagrion
spp. are here documented. M. calliphya and M.
hawaiiense contain a typical, green ♀ morph (gy-
nomorph) as well a red ♀ morph (andromorph) that
is similar in colour to the ♂. In M. calliphya, habitat
differences are described between the sexes and pat-
terns of colour variation in ♂♂ and ♀♀ over an
elevational gradient on Hawaii Island that varies in
temperature and solar radiation. Using transplant
experiments, it is determined that body temperature
does not differ between the ♀ morphs according
to hue, although it is affected by body brightness.
Therefore, environmental temperature is not a se-
lective agent on the ♀-limited dimorphism. How-

ever, solar radiation may select for red individuals, including andromorphs, under exposed conditions. A comparison of antioxidant ability between the ♀ morphs as well between ♂♂ over an elevational gradient indicated that red pigmentation is an effective antioxidant that may enable red individuals to exist where free radicals are produced from high radiation levels. Finally, the ecological explanation is given for the ♀-limited dimorphism to patterns of sex differences throughout the Megalagrion genus as well a case of ♀-limited dimorphism in the distantly related Nehalennia irene.

(18210)   HILFERT-RÜPPELL, D. & G. RÜPPELL, 2008. Alternative Taktiken im Fortpflanzungsverhalten von Calopteryx splendens in einem geographischen Vergleich (Odonata: Calopterygidae). *Entomologie heute* 20: 93-103. (With Engl. s.). – (An der Wasserfurche 32, D-38162 Cremlingen-Destedt).
At high density of individuals, C. splendens ♂♂ exhibited different alternative tactics of reproduction, between which they were able to change. Precedent copulation influenced the choice of the tactics and the outcome of fights. The causes are discussed. In a northern population, the frequency, intensity and success of the alternative tactics were higher than in a southern population. On the other hand, C. haemorrhoidalis that is restricted to the W Mediterranean region, never showed alternative tactics during the investigation period: neither at the roosting site nor in enclosure experiments. The geographical variations in behaviour within a sp. and in comparison to a southern sp. are discussed in a climatic context.

(18211)   MARTYNOV, A.V. & V.V. MARTYNOV, 2008. Biology of Lestes macrostima (Odonata: Lestidae) in southeastern Ukraine. *Kharkov. ent. Soc. Gazette* 15(1/2): 185-192. (Russ., with Engl. s.). – (Dept Zool., Fac. Biol., Donetsk Natn. Univ., ShChorsa 46, UKR-83050 Donetsk).
L. macrostigma is adapted to the development in ephemeral water basins of variable salinity. Its life cycle follows the seasonal changes in the immediate environment. Here, it was studied in SE Ukraine in relation to changes in the environment salinity. The oviposition and life history under natural and laboratory conditions are described.

(18212)   McPEEK, M.A., L. SHEN, J.Z. TORREY & H. FARID, 2008. The tempo and mode of three-dimensional morphological evolution in male reproductive structures. *Am. Nat.* 171(5): E158-E178. – (First Author: Dept Biol. Sci., Dartmouth Coll., Hanover, NH 03755, USA).
Various evolutionary forces may shape the evolution of traits that influence the mating decisions of ♂♂ and ♀♀. Phenotypic traits that ♂♂ and ♀♀ use to judge the species identify of potential mates should evolve in a punctuated fashion, changing significantly at the time of speciation but hanging little between speciation events. In contrast, traits experiencing sexual selection or sexually antagonistic interactions are generally expected to change continuously over time because of the directional selection pressures imposed on one sex by the actions of the other. To test these hypotheses, spherical harmonic representations of the shapes of ♂ mating structures in reconstructions of the evolutionary tempo of these structures across the history of the Enallagma clade were used. The analyses show that the evolution of these structures is completely consistent with a punctuated model of evolutionary change and a constant evolutionary rate throughout the clade's history. In addition, no inter-population variation in shape was detected across the range of one species. These results indicate that ♂ mating structures in this genus are used primarily for identifying the species of potential mates and experience little or no selection from intraspecific sexual selection or sexual antagonism. The implications of these results for speciation are discussed.

(18213)   MIKOLAJEWSKI, D.J., R. STOKS, J. ROLFF & G. JOOP, 2008. Predators and cannibals modulate sex-specific plasticity in life-history and immune traits. *Funct. Ecol.* 22: 114-120. – (First Author: Dept Anim. & Plant Sci., Univ. Sheffield, Western Bank, Sheffield, S10 2TN, UK).
In organisms with complex life cycles, optimality models predict age and size at transition to translate larval condition into adult fitness. Recent studies, however, revealed that only a proportion of fitness is explained by age and size at transition. Moreover, sexes differ in the linkage of larval condition and adult fitness. In this study, the hypothesis is tested that immune traits may be partly decoupled from age and size at habitat transition and therefore contribute to the sex-specific linkage of larval condition and adult fitness. Coenagrion puella larvae were reared under the threat of predators and can-

nibals. Sex-specific patterns were then examined in 2 life-history and immune traits. Results revealed immune traits to be partly decoupled from life-history traits. Moreover, the sexes differed in the plasticity of life-history as well as immune traits. The results give strong evidence that sex-specific translation of larval condition into adult fitness may be linked to immune traits as well as age and size at transition.

(18214)　ROCHÉ, B., J.-L. DOMMANGET, D. GRAND & M. PAPAZIAN, 2008. *Atlas des odonates de Corse*. Soc. Fr. Odonatol., Bois-d'Arcy & SEMA, Bastia. 128 pp. ISBN none. Softcover (20.5 × 28.5 cm). − (c/o D. Grand, Impasse de la Voûte, F-69270 Saint-Romain au Mont d'Or).
A beautifully produced atlas of the odon. fauna of the island of Corsica (France), covering 49 spp./ sspp. For each sp. are stated the general and local distribution and its status in France and on the island. A brief morphological description, an outline on bionomics (incl. habitats of larvae and adult phenology), a map of known localities and a portrait of the sp. are also provided. An exhaustive regional bibliography (since 1850) is appended.

(18215)　VADADI-FÜLÖP, C., L. HUFNAGEL, C. SIPKAY & C. VERASZTO, 2008. Evaluation of climate change scenarios based on aquatic food web modelling. *Appl. Ecol. envir. Res.* 6(1): 1-28. − (First Author: Dept Syst. Zool. & Ecol., Eötvös Loránd Univ., Pázmány P. sétány 1/c, HU-1117 Budapest).
Ischnura pumilio is among the taxa considered.

2009

(18216)　ÁLVAREZ, D. & A.G. NICIEZA, 2009. Differential success of prey escaping predators: tadpole vulnerability or predator selection? *Copeia* 2009(3): 453-457. − (Dept Functional Biol., Univ. Oviedo, ES-33071 Oviedo).
The vulnerability of Rana temporaria and Bufo bufo tadpoles to predation of Aeshna larvae when the 2 spp. co-occur was examined. The Bufo tadpoles were more vulnerable than those of Rana, although the dragonfly larvae did not show initial preference for either prey sp. Differences in susceptibility to predation seem to be associated with Bufo low performance in evasive responses.

(18217)　BENAZZOUZ, B., M. MOUNA, M.

AMEZIAN, K. BENSUSAN, C. PEREZ & J. CORTES, 2009. Assessment and conservation of the dragonflies and damselflies (Insecta: Odonata) at the marshes of Smir. *Bull. Inst. scient.*, Rabat 31(2): 79-84. (With Fr. s.). − (Second Author: Dépt Zool. & Ecol. Anim., Inst. Scient., Univ. Mohammed V, B.P. 703, Agdal, Rabat, Morocco).
A commented list of 15 spp.; NW Morocco.

(18218)　BORISOV, S.W., 2009. Dragonflies (Odonata) of a thermal spring in "Altyn Emel" Nature Park (South East Kazakhstan). *Euroasian ent. J.* 8(3): 362. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
Ischnura elegans, I. pumilio, Orthetrum anceps and O. brunneum are reported from the spring (temp. 32ºC), situated at 43.921ºN, 78.793ºE.

(18219)　CAESAR, R.M. & J.W. WENZEL, 2009. A phylogenetic test of classical species groups in Argia (Odonata: Coenagrionidae). *Entomologica am.* 115(2): 97-108. − (Dept Ent., Ohio St. Univ., Columbus, OH, USA).
The first cladistic analysis of Argia spp., focusing on those occurring in North America north of Mexico, is presented. The analysis is based on mitochondrial 16S rDNA and morphological character of both sexes of adults and immatures. Classical work on Argia taxonomy and phylogeny is re-examined. The results agree considerably with previous hypotheses. Argia is recovered as monophyletic. The clade composed of A. funcki plus A. hagens is basal among the spp. studied here. A. fumipennis, including the 3 sspp., appears to be a paraphyletic assemblage, and thus may warrant being considered separate spp. as originally described. The feasibility of producing a thorough phylogenetic analysis of the entire genus using multiple sources of data is discussed.

(18220)　CIEMIŃSKI, J. & B. ZDANOWSKI, 2009. Changes in the zoobenthos structure in a system of heated lakes in central Poland. *Arch. pol. Fish.* 17: 221-238. (With Pol. s.). − (Dept Hydrobiol., Inland Fish. Inst., Oczapowskiego 10, PO-10-718 Olsztyn).
3 identified Zygoptera spp. are recorded from the Konin lakes system that comprises the cooling system of a power plant.

(18221)　DALZOCHIO, M.S., 2009. Description of

the last instar larva of Nephepeltia berlai (Odonata, Libellulidae). *EntomoBrasilis* 2(3): 70-72. (Port., with Engl. s.). − (Rua Terezina 2305, Bairro Tropical, BR-85807-140 Cascavel, PR).

The larva is described and illustrated based on material from Cascavel, Paraná, Brazil. The generic concept is redefined.

(18222) DALZOCHIO, M.S., 2009. Description of the ultimate stadium of larva of Micrathyria pseudeximia Wetfall (Odonata, Libellulidae). *Entomo-Brasilis* 2(2): 54, 57. (Port., with Engl. s.). − (Rua Terezina 2305, Bairro Tropical, BR-85807-140 Cascavel, PR).

The larva is described and illustrated based on material from Cascavel, Paraná, Brazil.

(18223) DALZOCHIO, M.S. & M.E. RODRIGUES, 2009. Description of the last instar larva of Oxyagrion sulmatogrossense Costa, Souza & Santos (Odonata, Coenagrionidae). *EntomoBrasilis* 2(3): 73-75. (Port., with Engl. s.). − (First Author: Rua Terezina 2305, Bairro Tropical, BR-85807-140 Cascavel, PR).

The larva is described and illustrated based on material from Cascavel, Paraná, Brazil.

(18224) DAVID, A., S. FERENTI, O. HODISAN, B.-V. HORIA & O. GALE, 2009. The food analysis of a Triturus cristatus population near Ignesti locality, Arad county, Romania. *Herpetologica romanica* 3: 47-52. − (First Author: Dept Biol., Fac. Sci., Univ. Oradea, Universitatii 1, RO-410087 Oradea).

Using the stomach flushing method, the trophic spectrum of a created newt population (55 ♂, 55 ♀) was examined (March, Apr.). Odon. larvae were found in ♀♀ only, where they represented 0.17% of the prey taxa consumed.

(18225) DIJKSTRA, K.-D.B., S. TCHIBOZO & S.S. OGBOGU, 2009. The status and distribution of dragonflies and damselflies (Odonata) in western Africa. *In*: K.G. Smith et al., [Eds], *The status and distribution of freshwater biodiversity in western Africa*, pp. 41-55, IUCN, Gland-Cambridge, ISBN 978-2-8317-1163-8. − (First Author: Naturalis, P.O. Box 9517, NL-2300 RA Leiden).

An overview of the regional Odon. in relation to the freshwater ecoregions is presented, and conservation status, patterns of species richness, and the major threats to dragonflies are outlined. Conservation recommendations, i.e. conservation measures and the required research, are suggested.

(18226) DOMINIAK, P. & W. MICHALCZUK, 2009. Two species of biting midges (Diptera: Ceratopogonidae) new to the Polish fauna. *Dipteron* 25: 8-13. (Pol., with Engl. s.). − (First Author: Dept Invert. Zool., Univ. Gdanks, Piłsudskiego 46, PO-81-378 Gdynia).

Forcipomyia paludis (from Coenagrion ornatum) and Monohelea estonica are recorded and a review of odon. hosts of the former is provided.

(18227) EID, E., A. KATBEH-BADER, M. AL OTOOM & Y. OTHMAN, 2009. Contribution to the entomofauna of Dibeen Forest Reserve in Jordan. *Cesa News* [Cent. Ent. Stud. Ankara] 49: 19-41. − (Second Author: Dept Plant Prot., Fac. Agric., Univ. Jordan, Amman-11942, Jordan).

The Reserve is situated ca 50 km N of Amman. Orthetrum chrysostigma and Trithemis arteriosa were recorded during the March-May 2006 survey.

(18228) FARKAS, A., T. HAJAB & G. DEVAI, 2009. Assessment of riverine dragonfly populations (Odonata: Gomphidae) on the basis of exuviae on the reach of the river Tisza at Vásárosnamény. *Acta boil. debrecina Oecol. Hung.* 20: 65-78. (Hung., with Engl. s.). − (First Author: Dept Hydrobiol., Fac. Sci. & Technol., Univ. Debrecen, Egyetem ter 1, H-4032 Debrecen).

Gomphus flavipes, G. vulgatissimus and Ophiogomphus cecilia are forming stable populations in the Tisza (Hungary). Unlike in most riverine spp., there was no higher rate of ♀♀ during emergence, and protandry was not observed.

(18229) FERENTI, S. & S.-D. COVACIU-MARCOV, 2009. The food composition of some Bombina populations from Livada forest (Satu Mare county, Romania). *Biharean Biologist* 3(2): 143-150. − (Dept Biol., Fac. Sci., Univ. Oradea, Universitatii 1, RO-410087 Oradea).

Using the stomach flushing method, the diet of 247 Bombina individuals (B. bombina/B. variegata) from 6 hybrid populations was examined (Apr., May). Depending on the type of habitat, odon. larvae represented 0.16-1.04% of the food. Adult odon. were identified in stomach contents of a single population (0.38%).

(18230)   FERENTI, S., N. DIMANCEA, A. DAVID,
A. TÂNTAR & D. DÂRÂBAN, 2009. Data on
the feeding of a Rana ridibunda population from
Sarighiol de Deal, Tulcea county, Romania. *Bihar-
ean Biologist* 3(1): 45-50. (First Author: Dept Biol.,
Fac. Sci., Univ. Oradea, Universitatii 1, RO-410087
Oradea).
The trophic spectrum of 86 individuals was exam-
ined (July) by using the stomach flushing method.
The percentage of consumed taxa depended on sex
and age of the frogs. The odon. larvae were repre-
sented in diet by 6.25, 3.47 and 3.57% in ♂, ♀ and
juvenile animals, respectively. The remains of adult
odon. were not found.

(18231)   FLECK, G., N. HAMADA & A.L. CAR-
VALHO, 2009. A remarkable new genus and species
of dragonfly (Odonata: Anisoptera: Libellulidae)
from Brazil and notes on its bionomics and phy-
logenetic affinities. *Annls Soc. ent. Fr.* (N.S.) 45(3):
275-284. (With Fr. s.). − (First Author: Entomolo-
gie, Mus. Natn. Hist. Nat., 45 Rue Buffon, F-75005
Paris).
Orionothemis felixorioni gen. n., sp. n. is described
and illustrated from adults emerged from the reared
larvae and an immature ♂ taken in association
with its possible exuviae. Holotype ♂: Bahia, Luis
Eduardo Magalhâes municipality, Rio das Pêmeas,
1-X-2007; deposited in Insto Nac. Pesquisas da
Amazônia, Manaus. The taxon exhibits remark-
able features, such as enormous dorsal and lateral
spines perpendicular to the body axis, totally fused
last abdominal segments in the larva, strongly differ-
entiated and sexually dimorphic posterior legs, and
the incompletely chitinized 8ᵗʰ abdominal tergite
of the adult. Orionothemis is closely related to the
neotropical Elasmothemis and the oriental Ony-
chothemis. Larvae were collected in the abundant
immersed vegetation of a clear and cool stream on
the Brazilian central plateau ("planalto"), in an area
that is endangered by deforestation and irrigation.

(18232)   IVINSKIS, P. & J. RIMŠAITÉ, 2009. Odo-
nata of Purvinas wetland in eastern Lithuania. *Acta
biol. Univ. daugavp*. 9(1): 39-42. − (Inst. Ecol., Vil-
nius Univ., Akademijos 2, LT-08412 Vilnius).
A commented list of 39 spp., recorded during 2005-
2007. Coenagrion armatum, Nehalennia speciosa,
Sympecma paedisca, Somatochlora flavomaculata,
Leucorrhinia albifrons and L. pectoralis are of par-
ticular interest.

(18233)   IWASAKI, H., D. SUDA & M. WATAN-
ABE, 2009. Foraging activity of Sympetrum infus-
catum (Selys) adults living in Satoyama forest gaps
(Odonata: Libellulidae). *Jap. J. appl. Ent. Zool.*
53: 165-171. (Jap., with Engl. s.). − (First Author:
Grad. Sch. Life & Envir. Sci., Univ. Tsukuba, Ten-
nodai, Tsukuba, Ibaraki, 305-8572, JA).
The adults live in the forest gaps throughout their
life except when visiting paddy fields for oviposition.
They prey on small flying insects, using sit-and-wait
tactics. They perch on the tips of branches or grass
all day and take off when a small flying insect comes
into sight. In the present study, the foraging behav-
iour in the forest gaps was observed. The perching
height was high in the morning and evening and low
around noon. The diurnal change in the perching
height corresponded to the abundance of flying
small insects. The mean daily frequency of forag-
ing flights was 251 for ♀♀ and 182 for ♂♂, and the
mean actual number of insects captured was 109
and 89, respectively. A total of 2.935.300 small fly-
ing insects were preyed on by S. infuscatum adults
one day in the Satomaya forest gaps.

(18234)   KOVÁCS, T., A. AMBRUS, P. OLAJOS &
G. SZILÁGYI, 2009. Records of Ephemeroptera
and Odonata from the Biebrza National Park, Po-
land. *Folia hist. nat. Mus. matraensis* 33: 87-96. −
(First Author: Matra Mus., Kossuth Lajos u. 40,
HU-3200 Gyöngyös).
The reords are presented for 42 odon. spp.

(18235)   KRISKA, G., B. BERNATH, R. FARKAS
& G. HORVATH, 2009. Degrees of polarization of
reflected light eliciting polarotaxis in dragonflies
(Odonata), mayflies (Ephemeroptera) and tabanid
flies (Tabanidae). *J. Insect Physiol.* 55: 1167-1173.
− (Last Author: Envir. Optics Lab., Dept Biol.
Physics, Phys. Inst., Eötvös Univ., Pázmány sétáni
1, HU-1117 Budapest).
With few exceptions, insects whose larvae devel-
op in freshwater possess positive polarotaxis, i.e.,
are attracted to sources of horizontally polarized
light, because they detect water by means of the
horizontal polarization of light reflected from the
water surface. They can be deceived by artificial
surfaces (e.g. oil lakes, asphalt roads, black plastic
sheets, dark-coloured cars, black gravestones, dark
glass surfaces, solar panels) reflecting highly an
horizontally polarized light. Apart from the surface
characteristics, the extent of such a 'polarized light

pollution' depends on the illumination conditions, direction of view, and the threshold $p-$ of polarization sensitivity of a give sp. $p-$ means the minimum degree of linear polarization p of reflected light that can elicit positive polarotaxis from a give sp. Earlier there were no quantitative data on $p-$ in aquatic insects. The aim of this work is to provide such data. Using imaging polarimetry in the red, green and blue parts of the spectrum, in multiple-choice field experiments the threshold $p-$ of ventral polarization sensitivity was measured in Ephemeroptera, Odon. and tabanid flies, the positive polarotaxis of which has been shown earlier. In the blue (450 nm) spectral range, for example. The following thresholds were obtained: Odon.: Enallagma cyathigerum ($0\% < p- \le 17\%$), Ischnura elegans ($17\% \le p- \le 24\%$). Ephem.: Baetis rhodani ($32\% \le p- \le 55\%$), Ephemera danica, Epeorus silvicola, Rhithrogena semicolorata ($55\% \le p- \le 92\%$). Tabanidae: Tabanus bovinus, Tabanus tergestinus ($32\% \le p- \le 55\%$), Tabanus maculicornis ($55\% \le p- \le 92\%$).

(18236) LEMELIN, H., 2009. Goodwill hunting: dragon hunters, dragonflies and leisure. *Current Issues in Tourism* 12(5/6): 553-571. − (Sch. Outdoor Recreation, Parks & Tourism, Lakehead Univ., 955 Oliver Rd, Thunder Bay, ON, P7B 5E1, CA).

In Asia, insects have a long history of being part of recreation and tourism activities, with some spp. of e.g. dragonflies being raised as pets. While the role of insects in recreation and tourism (i.e. dragonfly gatherings, educational outings) is somewhat more modest in N America, Europe, and Australia, some of these activities are increasing in popularity. The availability of field guides, associations, and websites is helping to facilitate the growth of these leisure activities. Participant observations and interviews were used to provide an empirical understanding of how one particular insect order (Odonata) attracts participants to recreation and tourism activities, fosters interests, and creates controversies (e.g. collecting). A theoretical framework provided by naturework, an interpretivistic approach developed by G.A. Fine (2003, *Morel tales: the culture of mushrooming*. Univ. Illinois Press) is used to understand the philosophies involved in dragonflying. The conclusion highlights how new forms of recreation and tourism activities can promote greater awareness of insects. − (See also *OA* 17471).

(18237) MØLLER, A.P. & T.A. MOUSSEAU, 2009. Reduced abundance of insects and spiders linked to radiation at Chernobyl 20 years after the accident. *Biol. Lett.* 2009: 4 pp.; DOI: 10.1o98/rsbl.2008.0778, on line 18 March 2009. − (First Author: Lab. Ecol., Syst. & Evol., Univ. Paris-Sud, Bâtiment 362, F-91405 Orsay).

Effects of low-level radiation on abundance of animals are poorly known. Here, standardized point counts and line transects of bumble-bees, butterflies, grasshoppers, dragonflies and spider webs were conducted at forest sites around Chernobyl (the Ukraine) differing in background radiation by over 4 orders of magnitude. The odon. abundance was 105 during point counts, with abundance decreasing significantly with radiation. The same pattern appeared in the other groups as well. It is concluded that the ecological effects of radiation from Chernobyl on animals are greater than previously assumed.

(18238) NICOARĂ, M., M. ERHAN, G. PLĂVAN, I. COJOCARU, A. DAVIDEANU & A. NICOARĂ, 2009. The ecological complex role of the macroinvertebrate fauna from the river Ciric (Iași, Romania). *Anal. stiint. Univ. Al. I. Cuza* (Biol. anim.) 55: 125-132. (With Roman. s.). − (Fac. Biol., Al. I.Cuza Univ., Bd Carol I 20/A, RO-700505 Iași).

8 odon. spp. are listed from the river Ciric basin (Iași, Romania). − See also *OA* 15332.

(18239) PEIXOTO, P.E.C. & P. DE MARCO, Jr, 2009. No size or density effect on alternative mate-locating tactics in the tropical damselfly Hetaerina rosea males (Odonata: Calopterygidae). *Revta Biol. trop.* 57(1/2): 361-370. (With Span. s.). − (Second Author: Lab. Ecol., Depto Biol. Geral, Univ. Fed. Goiás, BR-74001-970 Goiânia, GO).

H. rosea ♂♂ may defend mating sites along river margins (resident ♂♂) or, alternatively, wander among different areas presumably searching for mates (non-territorial ♂♂). Although the occurrence of territorial and non-territorial ♂♂ of this sp. is very common in Brazil, studies examining which factors may be responsible for the adoption of alternative mate-locating tactics are inexistent. Here, the relationship between the adoption of these alternative mate-locating tactics were investigated at 3 sites. Samples were monthly undertaken in sites 1 and 2: Sept. 2001 – Aug. 2002, and in site 3: May 1999 – Jan. 2001. Using the scan method with fixed

areas and mark-resighting techniques, no relationship between the proportion of non-territorial ♂ ♂ and ♂ abundance per month was found on sites 2 (n = 6) and 3 (n = 7), indicating that the adoption of alternative mate-locating tactics is not affected by competition for territories. In the same way, non-territorial and resident ♂ ♂ showed similar body and thoracic weight measures (n = 30 and n = 27 for sites 2 and 3, respectively). Maybe the non-territorial tactic is adopted by individuals searching for better territories or ♂ ♂ that were evicted from their defended sites. The absence of relationship between weight and ♂ territorial status is in accordance with other Hetaerina spp. However, other traits not investigated here such as parasitic load, fat content and age may influence the adoption of different mate-acquisition tactics in H. rosea ♂ ♂.

(18240)   PIVKO KNEŽEVIČ, A., 2009. *The evaluation of the effect of Sewage Treatment Plant Celje on the river Savinja regarding longitudinal changes of macroinvertebrate community*. Graduation Thesis, Dept Biol., Biotech. Fac., Univ. Ljubljana. xii+82 pp. + App. A-C. (Slovene, with Engl. s.). – Vodnikova 3, SI-3320 Velenje).

The effect of the Central Sewage Plant Celje (CSPC) on macroinvertebrate community in the Savinja river (Slovenia) is assessed. Samples were taken at a locality upstream from the CSPC effluence and at 2 sites at the distances of, respectively ca 1 km (Tremerje) and 3 km (Laško) downstream from the Plant. Calopteryx splendens, Platycnemis pennipes, Gomphus vulgatissimus and Onychogomphus forcipatus were recorded at the 2 downstream stations only, and odon. contributed < 1% of the taxa represented in samples.

(18241)   RISERVATO, E., J.-P. BOUDOT, S. FERREIRA, M. JOVIĆ, V.J. KALKMAN, W. SCHNEIDER, B. SAMRAOUI & A. CUTTELOD, 2009. *The status and distribution of dragonflies of the Mediterranean basin*. IUCN, Gland-Malaga. vii + 33 pp. IUCN 978-2-8317-1161-4. – (Available from: IUCN Cent. Mediterr. Cooperation, C/ Marie Curie 22, ES-29590 Campanillas, Malaga). Engl. edn of the work listed in *OA* 17784.

(18242)   RÜPPELL, G. & D. HILFERT-RÜPPELL, 2009. Flugmanöver von Calopteryx splendens (Calopterygidae, Odonata) an der Oker nördlich von Braunschweig, analysiert mit einer neuen Zeit-lupentechnik. *Braunschweig. naturk. Schr.* 8(2): 421-438. (with Engl. s.). – (An der Wasserfurche 32, D-38162 Cremlingen-Destedt).

By means of a new digital slow motion technique, C. splendens flight manoeuvres were filmed and analysed at the Oker river N of Braunschweig (Germany). The new method allowed to detect new details even in basic flight behaviour. Furthermore, rare manoeuvres were analysed, viz.: compensation movements after crashing by gusts, changing the direction of flight, escaping manoeuvres from Anax imperator, aggressive flights between ♀ ♀, and a crash with ♂ and ♀. In all these flight manoeuvres C. splendens showed that the special mode of wing beating by moving both wing pairs in parallel is useful not only for signalling but for a very good manoeuvrability as well.

(18243)   SCHULTZ, T.D. & O.M. FINCKE, 2009. Structural colours create a flashing cue for sexual recognition and male quality in a neotropical giant damselfly. *Funct. Ecol.* 23: 724-732. – (First Author: Dept Biol., Denison Univ., Granville, OH 43023, USA).

Structural coloration is common among animals that produce sexual displays involving motion or ultraviolet reflection. Different sources of colour may provide multi-component signals that indicate the location, sex and fitness of a potential mate or rival. Here was investigated the proximate basis and ultimate function of the wing coloration of the territorial Megaloprepus caerulatus, which produces a dynamic, high contrast display during flight. The wings of both sexes have blue and white bands, but the location of the white patches are sex specific. Wax filaments produce diffuse, white areas through broadband scattering of wavelengths between 300 and 700 nm. Blue bands reflect wavelengths between 300 and 500 nm (λmax = 398 nm) and shift in hue with viewing angle, the result of thin layer interference produced by layers of cuticle and pigment within the wing membrane. Both wing bands strongly reflect UV wavelengths. Both the iridescent UV-blue and white wing patches provide high contrast against the vegetation in forest light gaps where mating occurs. Moreover, the iridescent signal oscillates during flight. Angle-dependent UV-blue iridescence is periodically extinguished during each wing beat cycle, in contrast to the white areas, which remain bright. ♂ ♂ distinguish potential mates from rivals by the presence of a ♀'s white

wing tip. Blackening the white wing bands of ♂♂ and adding white wing tips to resemble a ♀ elicits a sexual rather than aggressive response from ♂♂. Conversely, blackening the white wing tips of ♀♀ reduces sexual responses. The proportional area of the white wing bands of ♂♂ is indicative of wing symmetry, correlated with body size, and in turn, territory residency suggesting that it may serve as a signal of ♂ condition during intra- and inter-sexual interactions. It is proposed that the flashing iridescent UV-blue wing bands provide a beacon to potential mates across forest light gaps, whereas the white patches serve in male recognition and may indicate ♂ quality or territorial status. The study identifies a unique combination of interference and broadband reflectors that provide a dynamic multicomponent signal.

(18244)   SIMAIKA, J.P., 2009. Diversity of Nature's Valley damsels and dragons: Groot river. *Nature's News*, NVT 25: 4-6. − (Dept Conserv. Ecol. & Ent., Fac. AgriSci., Univ. Stellenbosch, Private Bag XI, Matieland-7602, SA).
On the dragonfly world of Nature's Valley (Cape, Sth Africa), in a local newsletter, with taxonomic nomenclature.

(18245)   SZÁLLASSY, N., Z.D. SZABO & B.H. NAGY, 2009. Survival of dragonfly Libellula fulva males according to their mating status: a four year study. *Entomologica romanica* 14: 13-17. (With Roman. s.). − (First Author: Dept. Math. & Sci. Teaching, Babes Bolyai Univ., Sindicatelor 7, RO-400029 Cluj-Napoca).
Using the mark-recapture method at a locality in E Hungary, the recapture and the survival rate of the mated ♂♂ were higher than those of the solitary individuals.

(18246)   TAYLOR, J., 2009. Dragonflies and other insects in Mexico. *Newsl. west. austral. Insect Study Soc.* 2009 (Dec.): 3-4. − (Author's address not stated).
The summary of a talk, given at the Oct. 2009 meeting of the Society, with a photograph of Mecistogaster modesta.

(18247)   WARE, J.I. & J. LOUTON, 2009. In the muck: collecting, rearing and imagining dragonfly and damselfly larvae for Encyclopedia of Life Odonata pages. *Bug Dispatch* [Natn. Mus. Nat.

Hist., Smithsonian Instn, Washington] 1(2): 3-4. − (Second author: Dept Ent., Natn. Mus. Nat. Hist., Smithsonian Instn, Washington, D.C. 20560, USA).
On the preparation of specimens for digital photography, with the goal to produce a large number of useful images in a reasonable amount of time.

(18248)   WEDMANN, S., M. POSCHMANN & T. HÖRNSCHEMEYER, 2009. Fossil insects from the Late Oligocene Enspel Lagerstätte and their palaeobiographic and palaeoclimatic significance. *Palaebio. Palaeoenvir.* 2009: 10 pp.; − DOI: 10.1007/sl2549-009-0013-3. − (First Author: Forschungsstn Grube Messel, Senckenberg, Markstrasse 35, D-64409 Messel).
An outline of the fauna is presented. The assemblage is analysed in terms of its climatic demands and some of its palaeobiogeographic features are pointed out. The odon. fauna is represented by a single adult zygopteran and by several larval and adult Anisoptera, mostly referable to the Aeshnidae and including Oligoaeschna jungi. − For the complete list of fauna, see *OA* 18169.

2010

(18249)   AROVIITA, J., H. MYKRÄ & H. HÄMÄLÄINEN, 2010. River bioassessment and the preservation of threatened species: towards acceptable biological quality criteria. *Ecol. Indicators* 10: 789-795. − (First Author: Dept Biol. & Envir. Stud., P.O. Box 35, FIN-40014 University of Jyväskylä).
A central objective of environmental management is to maintain biodiversity, including populations of threatened species. Freshwater ecosystems are increasingly assessed by their biotic properties, but whether the resulting classifications of biotic condition are sufficient to protect spp. with conservation status has received very little consideration. Here, data were used from 225 reference and impacted river sites from Finland to examine whether the occurrence and abundance of threatened macroinvertebrate spp. (TS), including Ophiogomphus cecilia, are associated with a commonly used estimate of biological condition (Observed-to-Expected number of predicted taxa of macroinvertebrates or O/E-ratio of taxonomic completeness, based on a predictive model). It is suggested that a minimal acceptable condition below which restoration is

needed, equivalent to, e.g. 'good' ecological status described by the European Union Water Framework Directive, should also ensure the occurrence of TS populations. Therefore conventional procedures for condition assessment, including Ophiogomphus cecilia, and 2 classifications were examined by using the 10th or 25th percentiles of a reference O/E. However, particularly if the 10th percentile threshold was used, there were only few occurrences and low abundance of TS in the suggested 'good' condition. The results imply that conventional criteria for satisfactory condition may not be sufficient for preservation of threatened river macroinvertebrates. However, this approach could bring an objective, meaningful, and societally acceptable means for setting site quality criteria in freshwater assessment.

(18250)   BAZOVA, N.V. & A.V. BAZOV, 2010. Ecology of odonate larvae (Odonata) in the Selenga river. *Euroasian ent. J.* 9(2): 285-289. (Russ., with Engl. s.). − (First Author: Inst. Gen. & Exp. Biol., Russ. Acad. Sci., Sachjianova 4, RUS-670042 Ulan--Ude).
Long-term data on the occurrence, abundance and biomass of Ophiogomphus sp. larvae in the channel part of the Selenga (the main tributary of Lake Baikal), from its mouth to the Mongolian border, are analysed, based on 2316 quantitative samples, taken from 25 vertical sections from beneath the ice (Dec. & March, 1987-2005). The parameters were noted to a depth of 1-2 m, with a low stream velocity (0.0-0.4 m/s). During the under-the-ice period, larvae move to the deeper parts of the channel because of the significant fall of water level and the increasing of the ice thickness near the bank (up to 2 m). This is considered as a normal behaviour in this sp.

(18251)   BEDJANIČ, M., 2010. *Naravovarstveno pomembne stoječe vode v nižinskem svetu severovzhodne Slovenije in smernice za njihovo upravljanje, s poudarkom na ohranjanju favne kačjih pastirjev (Insecta: Odonata).* − [*Stagnant water bodies of nature protection importance in the lowland of northeastern Slovenia and directives for their management, with emphasis on conservation of dragonfly fauna (Insecta: Odonata)*]. Seminarska naloga Limnologija stoječih voda / Post-Graduate Diss., Bioteh. Fac., Univ. Ljubljana, 96 pp. (Slovene). − (Kolodvorska 21/B, SI-2310 Slovenska Bistrica).
Includes chapters on "Biology and ecology of drag-
onflies", "Threats to dragonfly fauna" and "Dragonflies and nature conservation".

(18252)   BELEVICH, O.E. & Yu.A. YURCHENKO, 2010. Twilight activity of dragonflies of the genus Aeshna Fabricius, 1775 (Odonata, Aeshnidae) in the southern part of West Siberia. *Euroasian ent. J.* 9(2): 275-279. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
Twilight flying of Aeshna spp. in the forest zone of southern W Siberia is due, above all, to trophic activity. It was recorded throughout the summer season, a peak occurring in the secondhalf of July. Average duration of the crepuscular flight was ca 1 h. The extreme values of temperatures at which it was observed were 9.5 and 25.5ºC. Swarming dragonflies concentrated mainly near the forest or alone standing trees.

(18253)   BORISOV, S.N., 2010. Autumnal migrations of dragonflies in the Chokpak Pass of West Tien--Shan, observed and actual flight measurements. *Euroasian ent. J.* 9(1): 7-12. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
Obligate migrations of Anax ephippiger, Anax parthenope and Sympetrum fonscolombii were studied using ornithological traps established in Chokpak Pass (42.530ºN, 70.605ºE) in western Tien-Shan. The correlation between flight and cold air fronts is described, and the inequality of dragonfly migration intensity in different years was defined by ornithological trap data. These finding can explain the actual change in number of migrating dragonflies in different years. and the characteristics of dragonflies falling into traps, due to winds from different directions. Noticeable above-ground flights were registered only with S-W headwinds. However, numbers observed or trapped may provide only an approximate measure of odon. autumnal movements since a large proportion of these occurs at higher altitudes.

(18254)   BORISOV, S.N., 2010. Geographic variations in the life cycle of Sympecma paedisca (Brauer, 1877) (Odonata, Lestidae) in the plains of central Asia. *Euroasian ent. J.* 9(2): 249-254. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
Latitudinal changes in life cycle of S. paedisca

from forest-steppe zone of South Siberia (53°N) to deserts of Tadjikistan depression (37°N) are shown. Areally, the species is univoltine with long-term adult period, including aestivation and hibernation. To the South, the reproductive period of the sp. is moderately extended and moved to springtime. Latitudinally there is a more significant change in the ratio of aestivation and hibernation period duration. In the northern part, the areal time from exclusion to imago wintering covers less than 3 months and the imago winters for 7 months, while in the southern part these periods last 6 and 4 months respectively. During the pre-reproductive period dragonflies make bidirectional migrations. Aestivation appeared far from where the imago emerged, but the wintering imago returns to these habitats. In the plains (forest-steppe) of Siberia, dragonfly migrations are shorter than in central Asia. Dragonflies from the former, after emergence, move to the mountains for the whole summer period, and return to the plains in late autumn. This strategy avoids the high summer temperatures experienced in the central Asian plains. However, some dragonflies remain in the plains throughout the summer in habitats from where they emerged.

(18255)   DE PAIVA SILVA, D., O. DE MARCO & D. CHAVES RESENDE, 2010. Adult odonate abundance and community assemblage measures as indicators of stream ecological integrity: a case study. *Ecol. Indicators* 10: 744-452. − (Second Author: Lab. Ecol. Teór. & Sintese, Depto Ecol., Univ. Fed. Góias, C.P. 131, BR-74001-970 Góias).
The study was conducted on the Turvo Sujo river, upstream and downstream the city of Viçosa (Minas Gerais, Brazil). It is emphasized that the effects of water parameters are much less important than a landscape dominated by pastures and practically without forest, and it is suggested to use species-abundance models to determine the degree of impacts on a given community.

(18256)   DE SOUZA, L.O.I., J.M. COSTA & T.C. SANTOS, 2010. Revalidation of Acanthagrion cuyabae (Odonata, Coenagrionidae) and descriptions of the female, with a key to the Brazilian species of the viridescens group. *Iheringia* (Zool.) 100(1): 79-83. (With Port. s.). − (Second Author: Depto Ent., Mus. Nac., UFRJ, Quinta da Boa Vista, São Cristóvão, BR-20940-040 Rio de Janeiro, RJ).
Recently, A. cuyabae Calv. was synonymized with

A. lancea Sel. Based on fresh material, the sp. is redescribed and its original status as a separate sp. is confirmed.

(18257)   DRONSIKOVA, M.V., 2010. Behaviour of Libellula quadrimaculata (Linnaeus, 1758) larva (Odonata, Libellulidae) and its modification during ontogenesis. *Euroasian ent. J.* 9(2): 255-262. (Russ., with Engl. s.). − (Kuzbass St. Pedag. Acad., Pros. Pionerskiy 13, RUS-654027 Novokuznetsk).
Based on laboratory experiments, the complexity and individuality of larvae behaviour during ontogenesis are revealed. Many behavioural features become apparent from the 6th instar onward. Larval aggression against conspecifics chiefly depends on their experience in earlier contacts. L. quadrimaculata larvae tend to aggregate, the numbers in clusters are changing with the increasing larval size and age.

(18258)   FULAN, J.A. & S.C. ALMEIDA, 2010. Effect of the spatial heterogeneity on the predation of Scinax fuscovarius and Physalaemus cuvieri tadpoles by Odonata larvae. *Acta Scient. Maringa* (Biol. Sci.) 32(2): 121-124. (With Port. s.). − (First Author: Inst. Educ., Agric. & Ambiente, Univ. Fed. Amazonas, Rua 29 de Agosto 786, BR-69800-000 Humanitá, Amazonas).
The objectives of this work were to analyse the effect of Micrathyria larvae predation on the 2 frog spp. with distinct habitats (benthic and mid-water) and to verify whether the presence and architecture of macrophytes can mediate this interaction. All animals were captured in a temporary pond and 16 tanks were used for 3 different treatments: with Pistia, Salvinia and without any macrophytes. 10 tadpoles of each sp. and 2 odon. larvae were placed in each tank. The survival of S. fuscovarius tadpoles was longer than that of P. cuviery tadpoles, except in the treatment with Salvinia in which P. cuvieri survived longer, There were no differences in S. fuscovarius survival among the 3 treatments, while P. cuvieri showed the shortest survival in the treatment without plant cover. However, all the differences were statistically non-significant. Therefore it is concluded that the tadpole survival of the 2 spp. was not affected by the presence and architecture of macrophytes or by their behaviour.

(18259)   GONZÁLEZ-SORIANO, E., 2010. A synopsis of the genus Amphipteryx Selys, 1853 (Odona-

ta: Amphipterygidae). *Zootaxa* 2531: 15-28. (With Span. s.). − (Depto Zool., Inst. Biol., UNAM, Apdo Postal 70-153, MX-04510 Mexico, D.F.).

This Mexoamerican gen. includes a single hitherto known sp. (A. agrioides Sel.) and 3 new spp. are described here, viz. A. chiapensis sp. n. (holotype ♂: Mexico, Chiapas state, cloud forest stream 3.5 mi E Rayón, alt. 1680 m, 10-VII-1965), A. meridionalis sp. n. (holotype ♂: Honduras, Comayagua dept, cloud forest stream ca 10 mi SW Siguatepeque, alt. 1620 m, 25-V-1972), and A. nataliae sp. n. (holotype ♂: Guatemala, Baja Verapaz dept, Sabo coffe plantation, ca 6 km E Purulhá, alt. 880 m, 6/7-X-1979, 28-IV/2-V-1980). Diagnostic illustrations and ♂/♀ keys are included.

(18260)   GROENENDIJK, D., 2010. Mysterious and beautiful, the Northern Emerald. *Vlinders* 2010(3): 18-21. (Dutch, with Engl. s.). − (De Vlinderstichting, P.O. Box 506, NL-6700 AM Wageningen).

In the Netherlands, Somatochlora arctica is known from 7 localities, it is among the most characteristic raised bog spp. and it is listed as threatened. Here, its Species Protection Plan that came into action in 2005 is outlined, the results are described and a distribution map is provided.

(18261)   HARITONOV, A.Yu., 2010. A dedication to Dr Boris Feodorovich Belyshev on his 100th birthday: retrospective and perspectives of odonatology in Siberia. *Euroasian ent. J.* 9(2): 223-230. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

A brief biography, appreciation of work and an exhaustive odonatol. bibliography of B.F. Belyshev (1910-1993) are presented along with an analysis of the work of the odonatol. school he founded.

(18262)   HARITONOV, A.Yu. & E.E. EREMINA, 2010. The dragonflies (Odonata) of South Ural: the value of regional faunistic research. *Euroasian ent. J.* 9(2): 263-273. (Russ., with Engl. s.). − (Second Author: Chelyabinsk St. Pedag. Univ., P.O. Box 2775, RUS-454014 Chelyabinsk).

The results of long-term faunistic research are summarized. Data on the abundance, occurrence, flight period and biotopical distribution of 69 spp. are provided. It is concluded that the structure of this regional odon. fauna has been markedly changed over time, particularly during recent years.

(18263)   HOPPENBROUWERS, P., 2010. Libellen kijken in de Millingerwaard. − [Dragonfly watching in Millingerwaard]. *Vlinders* 2010(3): 6-8. (Dutch). − (Author's address not stated).

Millingerwaard is the foreland (surface ca 700 ha) of the Waal river, nr Millingen-aan-de-Rijn (the Netherlands). An annotated checklist of the 43 hitherto recorded spp. is included.

(18264)   HUGHES, M., 2010. *Effects of zebra mussel colonization on dragonfly larvae burying behaviour*. BArts Diss., Dept Biol., Wesleyan Univ., Middletown/CT. 55 pp. − (Author's address not stated).

Invasive spp. have caused massive ecological and economic damage throughout the world. In N America, zebra mussels (Dreissena polymorpha) native to E Europe invaded aquatic ecosystems in the 1980s, altering ecological communities and harming human infrastructure. Zebra mussels have been found attached to dragonfly larvae, decreasing the likelihood of successful emergence as adults. This study assesses the negative impacts zebra mussel colonization has on dragonfly larvae by testing the effects of colonization on dragonfly burying behaviour. Macromia illinoiensis larvae and zebra mussels were collected and tested at Douglas Lake, Michigan in July and August 2009. Weather and water temperature affected uncolonized burial time, but not uncolonized burial depth. Uncolonized burial time, head width, and body area were predictors of which individual dragonflies got colonized. Once individuals were colonized, their burial depth was impaired, which could lead to early mortality. Because dragonflies link aquatic and terrestrial ecosystems, increased early mortality of dragonflies could cause cascading effects across ecosystems.

(18265)   *IDF-REPORT*. Newsletter of the International Dragonfly Fund (ISSN 1435-3393), Vols 21 (2009), 22 (2009), 23 (2010), 24 (2010), 25 (2010), 26 (2010). − (c/o M. Schorr, Schulstr. 7/B, D-54314 Zerf).

[Vol. 21]: *Jović, M.*: Report on Macedonia 2008 project: Odonata (pp. 1-23); − [Vol. 22]: *Malikova, E.I.*: Dragonflies (Odonata, Insecta) of the Far East of Russia (pp. 1-22); − [Vol. 23]: *Villanueva, R.J.T.*: Dragonflies of Pollilo island, Philippines (pp. 1-24); − [Vol. 24]: *Reels, G.*: Report on field surveys of dragonflies in Hainan, China, and preparation of a field guide to the Odonata of the island (pp. 1-60); − [Vol. 25]: *Dyatlova, E.S.*: Dragonflies of Moldo-

va: state of knowledge and personal observations (pp. 1-43); − [Vol. 26]: *Zhang, H.*: The superfamily Calopterygoidea in South China: taxonomy and distribution. Progress report for 2009 surveys (pp. 1-36).

(18266)   INOUE, K. & K. TANI, 2010. *All about red dragonflies*. Tombow Shuppan, Osaka. 184 pp. ISBN 978-4-88716-174-0. Softcover (18.0 × 25.5 cm). Price: Y 3780.—net. (Jap., with Engl. book and chapter titles; taxonomic nomenclature in titles of species treatments, but not in fig. captions and keys). − (Publishers: 2-3-11, Morinomiya-chuo, Chuo-ku, Osaka, 540-0003, JA)

Under the "red dragonflies" are considered in Japan all Sympetrum spp. (whether actually red or not), and the red spp. of the genera Agrionoptera, Boninthemis, Brachythemis, Crocothemis, Deielia, Diplacodes, Lyriothemis, Macrodiplax, Nannophya, Orthetrum, Pantala, Tholymis, Tramea and Trithemis; i.e. 39 spp., incl. the 25 Japanese Sympetrum taxa. The richly illustrated and beautifully produced book presents brief morphological descriptions of all spp., phenology graphs and descriptions of the habitats, includes a chapter on migration and brief chapters on various aspects of particular interest. Very useful are the col. phot. of the eggs of all Sympetrum spp., and, above all, the excellent pictorial keys to the Sympetrum adults and larvae, though to the reader not familiar with the language the use of these will be somewhat complicated and time-consuming, since only vernacular nomenclature is used there.

(18267)   KETENCHIEV, Kh.A. & L.K. ABREK-OVA, 2010. Biogeographical characteristics of the Aeshnide species of the Mineral'nye Vody region, Caucasus. *Yug Rossii Ekologiya Razvitie* 2010(1): 109-113. (Russ., with Engl. s.). − (Authors' address not stated).

The spp. occurring in the Mineral'nye Vody region (Russia) are listed and their distribution is briefly outlined.

(18268)   KOMOSIŃSKI, K., 2010. Leucorrhinia pectoralis (Charpentier, 1840). Species code: 1042. *In*: C. Holdiński, [Ed.], *Habitats and species of Natura 2000. Report on the surveys conducted in the Olsztyn and partially in the Białystok Regional Directorates of the State Forests in 2006-2008*, pp. 213-216, Mantis, Olsztyn. (Pol.) − (Author's address not

stated).

The ecology, status (14 sites) and the required conservation measures for the species in the region are outlined; − Poland.

(18269)   KOSTERIN, O.E. & S.N. BORISOV, 2010. Dragonflies (Odonata) of the Dzungarskiy Alatau mountains, South-East Kazakhstan. *Euroasian ent. J.* 9(2): 299-302. (Russ., with Engl. s.). − (First Author: Inst. Cytol. & Genet., Russ. Acad. Sci., Lavrentyev Ave. 10, RUS-630090 Novosibirsk).

An annotated list of 24 spp., collected during 1993-1994 and 2006-2007, is presented. Water bodies fit for odon. breeding are sparse and located mostly in foothills. Sympecma spp., Aeshna mixta and Sympetrum spp. migrate to the mountains in the pre-reproductive period.

(18270)   *LIBELLULA*. Zeitschrift der Gesellschaft deutschsprachiger Odonatologen, GdO (ISSN 0723-6514), Vol 29, Nos 1/2 (15 Aug. 2010). (Mostly Germ., with Engl. s's). − (c/o T. Fliedner, Louis-Seegelken-Str. 106, D-28717 Bremen).

Deubelius, K. & R. Jödicke: Leucorrhinia caudalis in Nordwestdeutschland (Odonata: Libellulidae) (pp. 1-12); − *Eigenheer, K.*: Massenschlupf von Gomphus vulgatissimus an einen neu gestalteten Flachufer der Aare (Odonata: Gomphidae) (pp. 13-20); − *Reithäusler, M. & A. Martens*: Der Anteil gebänderter Larven von Anax imperator in einem Gartenteich im November (Odonata: Aeshnidae) (pp. 21-28); − *Waldhauser, M. & M. Mikát*: New records of Coenagrion ornatum in the Czech Republic (Odonata: Coenagrionidae) (pp. 29-46); − *Schneider, T. & O. Müller*: Neue Funde von Boyeria Irene, Cordulegaster bidentata sicilica und C. trinacriae in Kalabrien (Odonata: Aeshnidae, Cordulegastridae) (pp. 47-54); − *Sciberras, A., J. Sciberras & S. Kunz*: Orthetrum nitidinerve new to the Maltese Islands (Odonata: Libellulidae) (pp. 55-60); − *De Knijf, G. & H. Demolder*: Odonata records from Alentejo and Algarve, southern Portugal (pp. 61-90); − *Malkmus, R. & F. Weihrauch*: Verbreitung und Phänologie von Sympetrum nigrifemur auf den Makaronesischen Inseln (Odonata: Libellulidae) (pp. 91-106); − *Dijkstra, K.-D.B. & J.-P. Boudot*: First update of the Atlas of the Odonata of the Mediterranean and North Africa: Orthetrum machadoi new to the Palaearctic and Agriocnemis sania new to the Egyptian Nile Valley (pp. 107-125); − *Schmidt, E.G.*: Adolf Portmann (1897-1982), ein

Basler Zoologe von Weltrang: "Mit Libellen fing es an" (Odonata) (pp. 127-141).

(18271)   *LIBELLULA* (SUPPL.) (ISSN 0723-6514), Vol. 10 (15 July 2010): Studien zur Libellenfauna Griechenlands, 4. 260 pp. − (c/o T. Fliedner, Louis- -Seegelken-Str. 106, D-28717 Bremen).
Lopau, W.: Verbreitungsatlas der Libellen in Grie- chenland (Odonata) (pp. 5-153); − Bisher unver- öffentlichte Libellenbeobachtungen aus Griechen- land, 4 (Odonata) (pp. 155-260). − [Both papers with Engl. s's. − Author's address: Am Bahndamm 121, D-26135 Oldenburg].

(18272)   MACHADO, A.B.M., 2010. Seven new spe- cies of Telebasis from Brazil (Odonata: Coenagrio- nidae). *Zootaxa* 2384: 53-64. − (Depto Zool., Inst. Cienc. Biol., UFMG, C.P. 486, BR-31270-901 Belo Horizonte, MG).
T. celiovallei sp. n. (Pará), T. divaricata sp. n. (Pará), T. lekoi sp. n. (Mato Grosso), T. myrianae sp. n. (Bahia), T. pallida sp. n. (Mato Grosso), T. pareci sp. n. (Mato Grosso) and T. pataxa sp. n. (Bahia) are described, diagnosed and illustrated.

(18273)   MALIKOVA, E.I., 2010. Zoogeographically interesting dragonfly (Odonata) records from the Upper Amur region. *Euroasian ent. J.* 9(2): 291- 294. (Russ., with Engl. s.). − (Blagoveshchensk St. Pedag. Univ., Lenina 104, RUS-675000 Blagovesh- chensk).
New records of 10 spp. are reported. Lestes tem- poralis, Paracercion calamorum, Anax parthenope julius and Sinictinogomphus clavatus are recorded for the first time from the region. The W Palaearc- tic Orthetrum cancellatum, reported from Upper Amur (Blagoveshchensk, Amurskaya Oblast, Rus- sia), probably migrated from Chinese Inner Mongo- lia, following a mass migration of the beet webworm (Loxostege sticticalis) in 2008.

(18274)   MARTYNOV, A.V. & V.V. MARTYNOV, 2010. Distribution of Cordulegaster bidentata (Se- lys, 1843) (Odonata, Cordulegastridae) in Ukraine. *Euroasian ent. J.* 9(2): 303-307. (Russ., with Engl. s.). − (Dept. Gen. & Appl. Ent., Schmalhausen Inst. Zool., Natn. Acad. Sci., Khmelnytskogo 15, UKR-01601 Kyiv).
The sp. is widespread in mountainous and sub- mountainous regions of the Carpathians (400-1700 m a.s.l.), most abundant populations occur at the

elevations of 400-1000 m. It is a thermoxerophilic sp., with a rather high ecological valence, inhabiting different types of habitats. Its basic requirements are a low water temperature and a moderate velocity; the latter providing for sand sedimentation on the bottom of a stream, required for larval develop- ment, which is the reason the sp. is avoiding rapidly flowing waters. In the Ukrainian Carpathians, the status of the sp. is considered satisfactory, the ma- jority of the known populations occur within nature conservation areas, therefore no additional protec- tion measures are deemed necessary. All known localities are listed.

(18275)   *ODONATRIX*. Bulletin of the Odonato- logical Section of the Polish Entomological So- ciety (ISSN 1733-8239), Vol. 6, No. 2 (31 July 2010). (Mostly Pol., with Engl. s's). − (c/o Dr P. Buczyński, Dept Zool., UMCS, Akademicka 19, PO-20-033 Lublin).
Da Costa, J.M.: New data on the Odonata in the Narew National Park (pp. 33-36); − *Cuber, P.*: Lestids (Odonata: Zygoptera: Lestidae) rarely ob- served in Silesian province (pp. 37-41); − *Buczyński, P., W. Cichocki & R. Rozwałka*: Rediscovery of So- matochlora alpestris (Selys, 1840) and a new locality of S. arctica (Zetterstedt, 1840) in the Orawa-Novy Targ basin (Odonata: Corduliidae) (pp. 42-46); − *Straka, M.*: Preliminary studies on the durability of damselfly (Odonata: Zygoptera) exuviae (pp. 46-49); − *Buczyński, P., P. Zurawlew & W. Michal- czuk*: New data on the occurrence of Crocothemis erythraea (Brullé, 1832) (Odonata: Libellulidae) in Poland (pp. 50-60); − *Buczyński, P.*: Polish and dedicated to Poland odonatological papers, 8: the year 2009 and supplement to the year 2008 (pp. 61- 64).

(18276)   PAARDENBIJTER verjaagt dazen uit paardenwei. − [Aeshna mixta drives away horse- flies (Tabanidae) from the pasture]. *Horses.nl*, 19 Aug. 2010. (Dutch).
A. mixta has appeared recently in large numbers in Hilversum, Elst, Veenendaal, Tilburg and elsewhere in the Netherlands. At a distance it looks like they are attacking the horses, but actually they are pick- ing up the flies sitting on them.

(18277)   POPOVA, O.N., 2010. The dragonfly larvae population (Odonata) in a temporal water pond. *Euroasian ent. J.* 9(2): 239-248. (Russ., with Engl.

s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

The structure and seasonal dynamics of odon. population of a temporary pond in Baraba forest-steppe (SW Siberia, Russia) are presented. Despite the extreme instability and poor conditions prevailing in the pond, the population is taxonomically rich (21 spp.), composed of a large number of individuals, resulting in high odon. biomass compared to that of the other aquatic insects. The odon. adaptations for survival in temporary ponds are discussed.

(18278) POPOVA, O.N. & A.Yu. HARITONOV, 2010. Population dynamics and migration in the dragonfly Libellula quadrimaculata L., 1758 (Odonata, Libellulidae). *Euroasian ent. J.* 9(2): 231-238. (Russ., with Engl. s.). (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).

Long-term data on population dynamics and spatial distribution are provided. The main research was conducted at the ISEA SO RAN Biological Station near Chany Lake (W Siberia, Russia). Counts, conducted during 1972-2009, demonstrated that L. quadrimaculata population size varied significantly during this period, the minimum density being 250 times lower than the maximum one (i.e. 0.04 v. 10 specimens per 1 m^2). The population density correlates with the water supply of the region, the dragonfly numbers reaching their highest values in 1 or 2 yr after a maximum water level. A mass migration in L. quadrimaculata which occurred in the SW part of the West-Siberian Plain, in the Ishym river Valley, is described in detail. The motive for the mass migrations is an excessive growth in population density. As a result, a mass exodus from native habitats takes place which not only optimizes their population size but also increases the input of chemical elements and organic matter into the soil ecosystem from eutrophic water bodies.

(18279) SCHOUTEN, M.A., A. BARENDREGT, P.A. VERWEIJ, V.J. KALKMAN, R.M.J.C. KLEUKERS, H.J.R. LENDERS & H.N. SIEBEL, 2010. Defining hotspots of characteristic species for multiple taxonomic groups in the Netherlands. *Biodiv. Conserv.* 19: 2517-2536. − (c/o V.J. Kalkman, Naturalis, P.O. Box 9517, NL-2300 RA Leiden).

The 'hotspots' are defined as regions containing characteristic spp. for several taxonomic groups.

Four biogeographical regions with characteristic odon. spp. are identified, viz. Southeast, Pleistocene sand, Fen area and Fen meadow area. For each of these the characteristic spp. are listed.

(18280) SIVTSEVA, L.V., 2010. New data on the dragonfly fauna (Odonata) of central Yakutia. *Euroasian ent. J.* 9(2): 295-298. (Russ., with Engl. s.). − (Inst. Biol. Problems of Cryolythozone, Russ. Acad. Sci., Lenina ave 41, RUS-677980 Yakutsk).

28 spp. are recorded. Coenagrion glaciale, Nihonogomphus ruptus, Somatochlora exuberata and S. graeseri are new to the region; − Russia.

(18281) ŠTEVOVE, B. & E. BULÁNKOVÁ, 2010. Macrozoobenthos of the middle part of the Vydrica stream: comparison after 50 and 25 years. *Folia faun. slovaca* 15(3): 19-24. (Slovak, with Engl. s.). − (Dept Ecol., Fac. Nat. Sci., Comenius Univ., Mlynská dolina B-2, SK-84215 Bratislava).

Cordulegaster heros is recorded from 2 localities on the stream; − Malé Karpaty Mts, Slovakia.

(18282) ŠVITRA, G., 2010. Data on eight protected species of dragonflies (Odonata) recorded in Lithuania in 2003-2009. *New rare Lithuania Insect Spec.* 21: 5-11. (With Lithuan. s.). − (Lithuan. Ent. Soc., Akademijos 2, LT-08412 Vilnius).

The records are presented of Sympecma paedisca, Aeshna viridis, Anax parthenope, Ophiogomphus cecilia, Cordulegaster boltonii, Leucorrhinia albifrons, L. caudalis and L. pectoralis.

(18283) TENNESSEN, K.J., 2010. The madicolous nymph of Heteropodagrion sanguinipes Selys (Odonata: Megapodagrionidae). *Zootaxa* 2531: 29-38. (with Span. s.). − (125 N Oxford St., Wautoma, WI 54982, USA).

The larva is described and illustrated on the supposed specimens of this sp. from W Ecuador. It is unique in the fam. by possessing a slightly curved row of very small transverse ridges on each side of the prementum.

(18284) TOGASHI, H., T. SUZUKI & J. URABE, 2010. Spatial variations in chironomid larvae and dragonfly predation on a Japanese high mountain moor. *Verh. int. Ver. Limnol.* 30(9): 1357-1362. − (Div. Ecol. & Evol. Biol., Sch. Life Sci., Tohoku Univ., Aoba, Aoba-ku, Sendai, 980-8578, JA).

A field experiment examining changes in the abun-

dance of chironomid larvae by manipulating dragonfly biomass was conducted at Shibakusa-Daira moors (alt. 1500-1700 m), Zao Mts. Aeshna juncea and A. nigroflava had a negative impact on the abundance of chironomid larvae, due largely to the impact on Alotanypus. However, in Tanytarsus, Procladius and Chironomus no significant difference was detected between the effect indices of pre- and post-manipulation.

(18285)   VALLADARES-DIEZ, L.F., F. GARCIA-CRIADO, R.A. MAZÉ-GONZÁLEZ, D. MIGUÉLEZ-CARBAJO & F.J. VEGA-MORENO, 2010. *Estudio de la comunidad de odonatos de los parques del Anillo Verde de Vitoria-Gasteiz*. Inst. Medio Ambiente, Recursos Naturales y Biodiv., Univ. León. 128 pp.
27 spp. are recorded, incl. Sympetrum meridionale that is new to the prov. of Álava, Spain.

(18286)   VALTONEN, P., 2010. Sudenkorennot − Dragonflies and damselflies (Odonata). *In*: P. Rassi et al., [Eds], *The 2010 Red List of Finnish species*, pp. 383-386, Finnish Environment Inst., Helsinki. ISBN 978-952-11-3805-8. (Bilingual: Finn./Engl.). − (Author: Kaukolankuja 2, FIN-33820 Kangasala).
Since the publication of S. Karjalainen's book (2002; see *OA* 14380) the interests in odon. faunistics in Finland has greatly increased, in consequence of which the 2000 odon. Red List could be revised now. Of the 55 spp. known to occur in Finland, the status of 52 spp. is assessed and Nehalennia speciosa is the only one remaining on the Red List as endangered (EN).

(18287)   VAN BEEST, G., 2010. Libellen in Zuid-Oost Friesland, 3. − [Dragonflies in southeastern Friesland, 3]. *Natuur Nabij* 38(3): 23-24. (Dutch). − (c/o Secretariaat IVN Eemland, Ereprijsstraat 88, NL-3765 AL Soest).
Notes on spp. encountered during the summer and autumn along the Scheene, SE Friesland, the Netherlands. Vernacular nomenclature only.

(18288)   VOGRIN, M. & L. GLOBEVNIK, 2010. *BioMura: von Totarmen biss Fluss. Ökologisch Lehrpfad*. Folded map with text. Institut za vode Republike Slovenije, Ljubljana. 10 pp. (Bilingual: Slovene/German). − (First Author: Zg. Hajdina 83/c, SI-2288 Hajdina).

Includes references to Odon.; the Mura river, Slovenia.

(18289)   WHITE, E.L., J.D. CORSER & M.D. SCHLESINGER, 2010. *The New York dragonfly and damselfly survey 2005-2009; distribution and status of the odonates of New York*. New York Natural Heritage Program, Albany, New York. ix + 424 pp. ISBN none. − (Publishers: 625 Broadway, 5th Floor, Albany, NY 12233-4757, USA).
Over 2170 survey sites were visited, 4383 surveys were conducted, and 5 spp. are added to the state list (194 spp.). A list is compiled for each county, and distribution maps and phenology charts are presented for all spp. Full species accounts are included for all 48 SGCN, including an outline of habitat characteristics, and distribution and inventory needs.

(18290)   WILDERMUTH, H., 2010. Die Wasserschlauch-Arten im oberen Glattal, Kanton Zürich, mit besonderer Berücksichtigung von Utricularia stygia Thor. *Bauhinia* 22: 61-82. (With Engl. s.). − (Haltbergstr. 43, CH-8630 Rüti).
Special attention is paid to co-occurrence of Utricularia stygia, U. intermedia, U. minor and the zygopteran Nehalennia speciosa; − Switzerland.

(18291)   WITTWER, T., G. SAHLEN & F. SUHLING, 2010. Does one community shape the other? Dragonflies and fish in Swedish lakes. *Insect Conserv. Diver.* 2010: 10 pp. − DOI: 10.1111/jl752-4598.2010.00083.x − (First Auhor: Dept Earth & Ecosyst. Sci., Lund Univ., Sölvegatan 12, S-223-62 Lund).
Freshwater communities are often structured by predation. In permanent lentic freshwater habitats odon. larvae are major predators which, in return, suffer predation by fish. Antipredator traits vary between the odon. spp., and the dragonfly communities are therefore shaped by the presence of fish. But fish communities vary, and as different fish spp. affect dragonflies in different ways, the species composition of the fish community may affect the composition of the dragonfly community. Odon. larvae were sampled in 24 lakes with a known fish stock in SW Sweden, and the impact of fish as well as vegetation structure on dragonfly communities was explored by means of multivariate analyses. It was found that the presence of 4 fish spp., affected the odon. community structure. The impact

strength depended mainly on the abundance of Perca fluviatilis, with which most odon. spp. were negatively correlated. Many spp. were also positively correlated with the occurrence of at least 1 fish sp., which may reflect similar habitat requirements or imply indirect positive effects of these fish sp. Of the 24 recorded odon. spp., 4 did not occur in lakes dominated by P fluviatilis, whereas only 1 sp. was lacking in lakes dominated by Rutilus rutilus. The odon. species diversity was higher in R. rutilus lakes than in P. fluviatilis lakes. The results suggest that the fish species composition is a major determinant of the dragonfly community, which in turn will influence the lower trophic levels.

(18292)   YAMADA, Y., H. SASAKI & Y. HARAU-CHI, 2010. Composition of road-killed insects on coastal roads around Lake Shikotsu in Hokkaido, Japan. *J. Rakuno Gakuen Univ.* 34(2): 177-184. (With Jap. s.). − (First Author: Lab. Ent., Graduate School, Rakuno Gakuen Univ., Ebetsu, Hokkaido, 069-8501, JA).
The insect victims of traffic were systematically collected on 2 roads along the lake, of which one runs at a 50-100 m distance from the shore, whereas the other follows the shore closely. Between mid June and mid Sept., 5004.3 victims were counted per km, of which 444.1 were odon., pertaining to 12 spp. Macromia amphigena masaca was the dominant sp. The environment is described and the results are statistically worked out. The number of odon. victims was significantly higher on the road close to the shore. The list of killed odon. spp. (Aeshnidae, Gomphidae, Cordulegastridae, Corduliidae, Libellulidae) is provided.

(18293)   YATES, A.G. & R.C. BAILEY, 2010. Covarying patterns of macroinvertebrate and fish assemblages along natural and human activity gradients: implications for bioassessment. *Hydrobiologia* 637: 87-100. − (First Author: Aquat. Ecosyst. Impacts Res. Div., Canada Cent. Inland Waters, Environment Canada, 867 Lakeshore Rd, P.O. Box 5050, Burlington, ON, L7R 4A6, CA).
Bioassessment is based upon the premise that biological assemblages have predictable relationships with the surrounding natural and human environments. As the nature of these relationships can vary from region to region, it is important that environment-biota relationships be established prior to the initiation of any bioassessment program. In this study, multivariate analysis was used to establish how fish and benthic macroinvertebrate (BMI) assemblages in SW Ontario streams (Canada) vary across natural and human activity gradients. The use of canonical correspondence analysis allowed to determine that changes in community composition of both fish and BMI are strongly correlated with variation in the extent of human activity. The Coenagrionidae, Calopterygidae and Aeshnidae are considered.

(18294)   YURCHENKO, Yu.A. & O.E. BELEVICH, 2010. Daily dynamics of distribution of Enallagma cyathigerum (Charpentier, 1840) (Odonata, Coenagrionidae) in different biotopes of the forest-steppe zone of the southern part of West Siberia. *Euroasian ent. J.* 9(2): 280-284. (Russ., with Engl. s.). − (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, RUS-630091 Novosibirsk).
The biotopical distribution of the sp. depends on its physiological development. Immediately after emergence, dragonflies migrate away from the water. After reaching maturity, they prefer open habitats, away from water, where they copulate during the first half of the day. As the mated pairs return to the water for oviposition, during the second half of the day, the number of individuals in all terrestrial habitats decreases sharply. Near-water habitats are transient. To move in strong winds (up to 7 m/s), E. cyathigerum uses the space between plants over the soil surface.

(18295)   ZESSIN, W., 2010. Die Kleine Königslibelle (Odonata: Aeshnidae: Anax parthenope) neu am Waldsee in Kraak, Landkreis Ludwigslust, Mecklenburg. *Virgo/ MittBl. ent. Ver. Mecklenburg* 13(2): 69-70. − Lange Str. 9, D-19230 Jasnitz).
A. parthenope is for the first time recorded from Kraaker Waldsee (Ludwigslust, Mecklenburg, Germany), 2010, without the exact date. The impact of the exceptionally cold and long 2009/2010 winter on the odon. fauna is outlined. The effect of the long-lasting ice-cover, causing oxygen deficiency in water, is emphasized.

(18296)   ZESSIN, W. & C. BRAUCKMANN, 2010. Aulertupus tembrocki n. gen. et sp. (Odonatoptera: Meganisoptera: Aulertupidae n. fam.) aus dem Ober-Karbon von Mazon Creek, Illinois (USA). *Virgo / MittBl. ent. Ver. Mecklenburg* 13(2): 36-43. (With Engl. s.). − (First Author: Lange Str. 9, D-19230

Jasnitz).
Along Oligotypus makowskii Carpenter & Richardson, 1971 and Paralogopsis longipes Handlirsch, 1911, Aulertupus tembrocki gen. n., sp. n. is the third giant dragonfly sp. (Meganisoptera) from the famous nodules of Westphalian C/D (Moscovian) age of the Mazon Creek collection sites in Illinois, USA, which is described and illustrated on adults. It is assigned here to Aulertupidae fam. n. The 3 recently described additional spp. from the same locality (see *OA* 17912) are based on larvae and cannot be grouped on fam. level.

(18297)   ZHAO, H.-X., Y.-J. YIN & Z. ZHONG, 2010. Micro and nano structures and morphologies on the wing veins of dragonflies. *Chin. Sci. Bull.* 55(10): 1993-1995. − (Last Author: Sch. Aerospace Eng. & Appl. Mechanics, Tongji Univ., Shanghai-200092, China).
On the surfaces of Crocothemis servilia and Pantala flavescens veins, not only ripple wave morphologies are distributed, but also spikes are grown. On spike surfaces, straight stripe wave morphologies appear along the generatrix. These micro and nano structures may contribute to the remarkable dragonfly flying abilities.

2011

(18298)   KALNINŠ, M., 2011. Spāru (Odonata) dienvidu sugu izplatiba Latvija un blakus teritorijās. *Latvijas Univ. 69 zināt. Konf.* (Biol./Zool.), 1 p. (Latvian). − (Fac. Biol., Univ. Latvia, Kronvalda bulv. 4, LV-1586 Riga).
A commented list of 19 spp.

(18299)   MARIN, A.A., M. DUMBRAVĂ-
-DODOACĂ, M. PETROVICI & G. HERLO, 2011. The human impact on benthic community structure and dynamics of different ecosystems from Lunca Muresului Nature Park (West of Romania). *Int. J. Bioflux Soc.* 4(1): 72-78. (With Rom. s.). − (Second Author: Dept Biol., West Univ. Temisoara, Pestalozzi St. 16/A, RO-300115 Temisoara).

During different seasons, samples were taken from the Mures river and Caramidariei Lake. Odon. are among the 9 groups considered. The names of spp. are not stated.

(18300)   RĂESCU, C.-S., M. DUMBRAVĂ-
-DODOACĂ & M. PETROVICI, 2011. Macrozoobenthic community structure and dynamics in Cerna river (western Romania). *Int. J. Bioflux Soc.* 4(1): 79-87. (With Rom. & Hung. s's). − (Dept Biol., West Univ. Temisoara, Pestalozzi St. 16/A, RO-300115 Temisoara).
The macroinvertebrate community in the river (incl. Odon.) is characterized by the decrease in density and abundance values, as water quality becomes downstream more and degraded. The deterioration is also emphasized by the biotic index EPT/Ch values. The detailed quantitative data are order-wise presented, but a list of spp. is not provided.

(18301)   THURESSON, M. & J. PANSAR, 2011. *Bottenfauna och vattenväxter i Mårdsjön.* − [*Benthic fauna and aquatic plants in Mårdsjön*]. Länsstyrelsen i Stockholms län, Stockholm, 10 pp. (Swed.). − (First Author: Miljoanalys.stockholm@lansstyrelsen.se).
The larvae of 11 odon. spp. are reported from Mårdsjön, in the Natura 2000 area, prov. Stockholm, Sweden.

(18302)   VAN HELSDINGEN, P.J., 2011. Spiders in a hostile world (Arachnoidea, Araneae). *Arch. Mitt.* 40: 55-64. − (Naturalis, P.O. Box 9517, N-2300 RA Leiden).
All Pseudostigmatidae in which the adult feeding habits are known prey exclusively on web-building spiders. Gifted with very good vision, they aim directly at the spider. Spp. showing this behaviour are Mecistogaster linearis, M. modesta, M. ornata, Megaloprepus coerulatus and Pseudostigma accedens. M. coerulatus was seen preying on small Argyrodes sp. (Theridiidae) at a Nephila web. M. modesta was seen at work near orb webs, as well as at the lampshade-shaped webs of pholcids.

NOTICE TO AUTHORS

The journal is covered by *Current Contents, Science Citation Index* etc., and by most of the major abstracting services.

In addition to the usual *Research Papers*, three types of papers are published: (1) *Review Articles* (original and critical accounts of theoretically important, rounded-off topics, pointing out lacunae in our knowledge on the subject and making suggestions for future research), (2) *Short Communications (*concise but complete accounts of small rounded-off topics, which will not be included in a later paper) and, (3) *Preliminary Research Notes* (brief reports of work that has progressed to the stage where research would be advanced if the results were made available to other workers in the same field).

Papers on the local faunistics of European and other well explored countries will be accepted only if containing theoretically important new information and/or critical views.

It is understood, the submitted papers have not been published elsewhere and authors of accepted articles agree not to publish them elsewhere at a later date.

All submitted manuscripts are examined by the Referee Board and/or by (an) external Referee(s).

Manuscripts should be written in one of the western congress languages (English, French, German, Italian) but preferably in English. The manuscript must be as concise as possible, and accompanied by an IBM-compatible diskette, preferably any version of Microsoft Word for Windows, or by a CD. The text and the illustrations should be submitted in duplicate. Linguistically inadequate manuscripts will be returned to the author.

Alternatively, the manuscripts can also be submitted as an attached file to the e-mail address: mb.kiauta@12move.nl.

The term "larva" should be used to provide uniformity between publications; "nymph" and "naiad" are unacceptable.

An English abstract, styled according to the recommendations of UNESCO, must precede the text and in case of contributions in languages other than English, should be supplemented by an English translation of the title.

References should read in the text as follows: AGUESSE (1968), (AGUESSE, 1968) or CONCI & NIELSEN (1956). At the end of the paper they should be listed alphabetically according to the first author, i.e.:

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.

Footnotes should be avoided whenever possible. They should be written on separate sheets.

Tables should be typewritten on separate sheets, corresponding to the printing area, preferably in a vertical direction. They should have headings which make their meaning comprehensible without reference to the text.

Illustrations should be separate from the text, with the author's name on the back in soft pencil. They should be mounted and labelled by the author, under careful consideration of the % reduction required. Drawings for reproduction should be on good paper in Indian ink, photographs should be furnished as glossy positive prints. The illustrations should be at least one and a half times as large as the ultimate size desired. Very large figures can easily be damaged in the mail. Captions should be selfexplanatory, without reference to the text.

Manuscripts not prepared according to these instructions may suffer delay and cause extra costs to the authors; in serious cases they will be returned.

The Editors reserve the right to adjust the style to certain standards of uniformity.

Reprints can be ordered from the Editors, at € 0.25 per page. Orders under 50 copies cannot be accepted. For orders over 300 copies a reduced rate will be applied. The Publisher is unable to provide free reprints.

As a rule, no page charges will be levied, but costs will be charged for substantial text changes/additions in the proofs, for exceptionally elaborate tables, for elaborate figure remounting and relabelling, and for colour illustrations.

It is understood that authors submitting manuscripts agree to the above financial and other stipulations.

CONTENTS