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RICHNESS AND STRUCTURE OF AN ODONATA LARVAL ASSEMBLAGE FROM RÍO PINOLAPA, TEPALCATEPEC, MICHOACÁN, MEXICO IN RELATION TO THEIR HABITAT CHARACTERISTICS

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The odon. larval assemblage from Río Pinolapa (RP) in the municipality of Tepalcatepec, Michoacán, is described. Sampling was conducted twice in each season (8 trips in total), and additionally some physicochemical variables of the river channel were recorded. Strata (shores, riffles and eddies) and seasonal variation of assemblages are described and compared using classical diversity measures such as Shannon's diversity index, Simpson's diversity index as a dominance measure, Margalef's richness index and Pielou's evenness index. For comparing strata and seasonal diversity the Renyi's diversity profiles were used. A Cluster Analysis was performed on a Bray--Curtis similarity matrix to explore the faunal relationships among year seasons and strata. CCA was also performed to investigate the relationships between the physicochemical and species abundance matrixes. As results, 28 spp. (12 Zygoptera and 16 Anisoptera) were recorded as larvae. Most abundant species were *Erpetogomphus elaps*, *Brechmorhoga praecox* and *Phyllogomphoides luisi*. The highest number of spp. was registered in winter and the lowest in summer. Among strata the highest abundance was recorded in riffles, although the shoreline had the largest number of spp. The most similar assemblages were those of autumn and winter. Shore habitats were more heterogeneous than eddies and riffles and this could explain the larger number of species. The Clench's model explains better the data. Additionally, we used the slope of cumulative number of spp. curve for assessing completeness of the RP list. CCA was significant, with pH, autumn, shoreline and riffles the most important variables. This means that species variation is related to physicochemical, temporal and strata conditions in RP.

INTRODUCTION

The estimation of biodiversity has become one of the major goals for ecologists up to now (MAGURRAN, 2004). Conservation of biodiversity requires the knowledge of its patterns and magnitude (BASELGA & NOVOA, 2008), where the process of making an inventory of unknown assemblages, as well as describing new species, represents the first step in understanding that biodiversity, and also the foundation for any later research related to biodiversity. Unfortunately, this kind of work has received relatively little attention by many journals, propitiating a great abandonment by researchers (WHEELER, 2004; WHEELER et al., 2004; DE CARVALHO et al., 2005).

Different methods for biodiversity assessment have been developed as an indicator of ecosystem conditions, conservation goals, management and environmental monitoring (SPELLERBERG, 1991). Usually, the number of species is the more used measure of diversity (MAYR, 1992; MORENO, 2000). However, diversity depends not only on the number of species but also on the relative abundance of them. Generally, species are distributed according to hierarchical abundance classes, from some very abundant to some very rare. As some species become more abundant and others become rarer, the lower the biodiversity of the community will be. Then, the conservation of biodiversity is mainly a problem concerning to the ecological behavior of the rare species.

In this manner, measuring the relative abundance of species will allow us to identify those species that, due to their rareness in the community, are more sensitive to environmental changes (MORENO, 2001) and, consequently, more exposed to extirpation.

On the other hand, Odonata have become among the most used aquatic insect groups in ecological quality assessment today, because they are relatively large, abundant, widely distributed, easy to collect, the larvae are rather sedentary and easy to rear in laboratory, and there is limited genetic variation (HELLAWELL, 1986). Also, they are relatively easy to identify in comparison with other groups (STORK, 1994), and are generally well represented in aquatic samples (HAMMOND, 1994). Moreover, they respond quickly to environmental stress (NOSS, 1990). Fortunately, the identification of immature stages has been developed in the last two decades in Mexico. However, an important gap still remains on the knowledge of the structure and function of Mexican Odonata assemblages, with relatively few studies dealing with this subject (NOVELO-GUTIÉRREZ & GONZÁLEZ-SORIANO, 1991; GÓMEZ-ANAYA et al., 2000; NOVELO-GUTIÉRREZ et al., 2002; ALONSO-EGUÍALIS, 2004). The exploration of patterns in time and space of Odonata larval assemblages can supply basic data for future research.

The goal of this work is to describe the structure and seasonal variation of the Odonata larval assemblage from the Río Pinolapa and relate it to environmental factors.

STUDY AREA

The Río Pinolapa (RP) is located at (19°00.524N; 103°01.456W), municipality of Tepalcatepec, in Michoacán State, Mexico (Fig. 1). The sampling site is at 616 m asl. Average gradient was 0.02 (1°08'44.75", n = 7), minimum = 0.006 (0°20'37.57"), maximum = 0.042 (2°24'18.03"). Average depth = 0.11 m (IC = 0.05 - 0.19 m, n = 8); average width = 2.18 m (IC = 0.65 - 3.71 m, n = 8); current velocity = 37.58 m/s (IC= 28.57 - 46.58 m/s, n = 8); discharge = 9.16 m^3/s (IC = 3.32 - 21.65 m^3/s). Averages of physicochemical variables were: temperature = 28.03°C (IC = 27.02- 29.04°C, n = 30), pH = 8.47 (IC = 8.33-8.61, n = 30), conductivity = 666.83 µS/cm (IC = 640.70 - 692.96 µS/cm, n = 30) and oxygen = 7.78 ppm (IC = 7.05 - 8.51 ppm, n = 30).

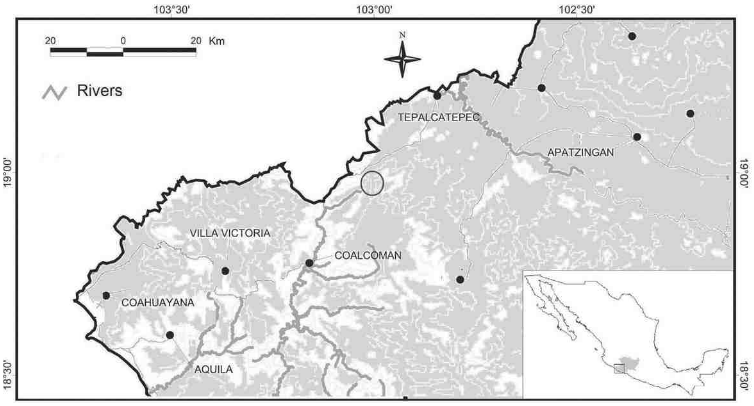

Fig. 1. Sampling site (empty circle) in municipality of Tepalcatepec, Michoacán, México.

MATERIAL AND METHODS

COLLECTING. – Larvae were collected twice in each season (8 trips in total) at shores, and in riffles (at mid-channel) and eddies. Usually, sampling was done at the end of the first third and at the beginning of the last third of each season. We used an aquatic D-frame net, and samples were preserved in 96% alcohol with one replacement before 24 h. A stereomicroscope was used to separate and quantify all larvae to the species level. In addition to the larval sampling, physicochemical variables such as pH, dissolved oxygen, temperature and conductivity were recorded for each sample. Depth, width, and current velocity were measured and discharge was then calculated. The gradient (slope) was measured at seven points of the 500 m long sampling transect according to RESH et al. (1996).

DIVERSITY MEASURES AND DATA ANALYSIS. – Richness and composition, as well as classical diversity measures such as the Shannon's diversity index (*H'*), the Simpson's index (*D*), the Margalef's richness index (*R*), and the Pielou's evenness index (*J*) were used in order to describe the Odonata assemblages by season, strata and as a whole (MORENO, 2001). Also, the Renyi's diversity profiles (TÓTHMÉRÉSZ, 1995, 1998; JAKAB, 2002) were used for comparing diversity, as proposed by SOUTHWOOD & HENDERSON (2000). In this method when the value of the scale used as a parameter is low, the method is extremely sensitive to the presence of rare species. As the value of the scale increases, diversity is less sensitive to rare species. At a high value, the method is sensitive only to common species. The result of this scale-dependent characterization of diversity can be used in a graphical form to visualize the diversity relations of assemblages. This curve is usually called 'the diversity profile of the assemblage'. It is important to stress that curves of two diversity profiles may intersect. For two communities, the intersection of the diversity profiles means that one of the communities is more diverse for rare species, while the other one is more diverse for common species. The Species Diversity & Richness package v. 3.0 was employed to generate the Renyi's values, exporting them to an Excel spreadsheet to show them graphically.

THEORETICAL RICHNESS. – An estimate of the theoretical richness using non parametric estimators Chao2, Bootstrap, and upper limit of Mao Tau was carried out, using Estimates 8.0 (COLWELL, 2006). Additionally, parametric methods as richness estimators by extrapolation were also used, which apply the observed curve of species accumulation for modeling the addition of new species in relation to the sampling effort (PALMER, 1990; SOBERÓN & LLORENTE, 1993). The Clench's (CLENCH, 1979) and Linear dependence models were applied, as exemplified by JIMÉNEZ-VALVERDE & HORTAL (2000). Likewise, the slope on the cumulative species curve was used to assess the completeness of assemblages (HORTAL & LOBO, 2005). The slopes were obtained by means of the first derivative of the Clench's and Linear dependence functions (NOVELO-GUTIÉRREZ & GÓMEZ-ANAYA, 2009).

CLUSTER ANALYSIS. – Beta diversity was assessed by methods of classification. A Cluster Analysis (CA) on a Bray-Curtis (BC) similarity matrix [(1-W) where W = BC dissimilarity)] and the Unweighted Pair Group Method with Arithmetic mean (UPGMA) were used to explore the faunal relationships among seasons and strata. This analysis was performed using PC-ORD ver 4.5 (McCUNE & GRACE, 2002).

CANONICAL CORRESPONDENCE ANALYSIS. – The Canonical Correspondence Analysis (CCA), a direct ordination method, was used to relate species abundance with environmental variables (TER BRAAK & SMILAUER, 1998). The number of environmental variables was then reduced using the automatic forward selection option in the CANOCO 4.5 program. The statistical significance of the relationship between the species and the set of environmental variables was tested by a Monte Carlo permutation test, using an F-ratio of the sum of all eigenvalues as the statistical test (TER BRAAK and PRENTICE, 1988).

RESULTS

SEASONAL PHYSICOCHEMICAL VARIATION

Temperature, pH and conductivity had higher averages in summer, while oxygen was highest in spring. In fact, oxygen decreases gradually from spring to winter (Tab. I). All pH values were slightly alkaline. Oxygen levels were very low in winter when both abundance and species richness were highest.

LARVAL RICHNESS AND COMPOSITION

A total of 3,278 Odonata larvae belonging to 28 species (12 Zygoptera and 16 Anisoptera), 16 genera and six families were collected (Tab. II). *Erpetogomphus elaps* (50.21%) was the dominant species; other numerically important species were *Brechmorhoga praecox* (14.16%) and *Phyllogomphoides luisi* (6.72%) (Fig. 2). A further 61.54% of all species occurred in low abundance (<1%) and were considered rare.

Table I
Averages and 95% confidence intervals for the physichemical variables of Río Pinolapa

	Temperature	-95%	95%	pH	-95%	95%	Conductivity	-95%	95%	Oxygen	-95%	95%
Spring	31.90	31.29	32.51	8.68	8.56	8.81	706.33	647.6	765.1	10.5	9.55	11.45
Summer	34.95	34.34	35.56	8.95	8.83	9.08	752.00	693.3	810.7	7.28	6.33	8.23
Autumn	26.18	25.75	26.61	8.11	8.02	8.19	567.83	526.3	609.4	8.68	8.01	9.36
Winter	20.93	20.32	21.54	8.50	8.37	8.63	740.17	681.4	798.9	3.74	2.78	4.69

SEASONAL NUMERICAL DOMINANCE

During spring *Erpetogomphus elaps* (38.73%), *Argia oenea* (17.40%), and *Progomphus marcelae* (14.95%) dominated numerically. Only seven species were detected in summer (four of which were gomphids), with very low total and relative abundances. No coenagrionid was recorded in this season. *E. elaps* (44.15%) and *B. praecox* (28.39%) dominated in autumn. Finally, during winter *E. elaps* (60.10%) dominated the assemblage. *Argia tezpi* (8.74%) and *Phyllogomphoides. luisi* (6.52%) were present as codominant species together with *E. elaps*. It is interesting to note that while *E. elaps* clearly dominated throughout the year in the larval stage, the imagoes were not very commonly encountered.

SEASONAL ASSEMBLAGES

Table III and Figure 3 show the seasonal ecological parameters. The smallest number of species was recorded in summer, spring and autumn were intermediate, and the highest number of species was found in winter. The abundance pattern seems to follow the richness one, being higher in winter and lower in summer. Shannon's diversity index (*H'*) seems to vary little throughout the four seasons, although it was a little higher in spring. Dominance (*D*) was higher in winter, mainly due to the great abundance of *E. elaps.* Renyi´s diversity profiles are shown in Figure 4. The summer pattern was a straight line. It showed the minimum number of species for $\alpha = 0$ (the basic structure of assemblages), but for values up to 2 (Simpson index) the pattern showed that summer diversity was the highest.

SIMILARITY

The Odonata larval assemblages from autumn and winter were the most similar, mainly due to their high and similar abundance (Fig. 5), nevertheless, they were quite different in richness sharing a high number of species (13). Some species like *Argia oculata*, *Erpetogomphus cophias* and *Paltothemis lineatipes* were exclusively

Table II
Richness and composition of seasonal Odonata larval assemblages from Río Pinolapa

Taxa	Key	Spring	%	Summer	%	Autumn	%	Winter	%	Total	%
Number of individuals			410	12.45	20	0.61	1452	44.32	1396	42.61	3278
Number of species			15	55.56	7	25.93	16	59.26	22	81.48	100
ZYGOPTERA											
Calopterygidae											
Hetaerina americana	*Heam*	-	-	4	20.0	22	1.52	7	0.50	33	1.01
Platystictidae											
Palaemnema domina	*Pado*	23	5.64	-	-	16	1.10	54	3.87	93	2.84
Coenagrionidae											
Argia funcki	*Arfu*	7	1.72	-	-	-	-	-	-	7	0.21
A. oculata	*Aroc*	-	-	-	-	3	0.21	-	-	3	0.09
A. oenea	*Aroe*	71	17.40	-	-	14	0.96	53	3.80	138	4.21
A. pallens	*Arpa*	1	0.25	-	-	-	-	8	0.57	9	0.27
A. pulla	*Arpu*	-	-	-	-	-	-	6	0.43	6	0.18
A. tezpi	*Arte*	1	0.25	-	-	20	1.38	122	8.74	143	4.37
Enallagma novaehispaniae	*Enno*	5	1.23	-	-	-	-	2	0.14	7	0.21
E. semicirculare	*Ense*	-	-	-	-	-	-	3	0.21	3	0.09
Telebasis salva	*Tesa*	2	0.49	-	-	-	-	-	-	2	0.06
Protoneuridae											
Protoneura cara	*Prca*	-	-	-	-	-	-	1	0.07	1	0.03
ANISOPTERA											
Gomphidae											
Erpetogomphus bothrops	*Erbo*	-	-	-	-	-	-	1	0.07	1	0.03
E. cophias	*Erco*	-	-	-	-	1	0.07	-	-	1	0.03
E. elaps	*Erel*	158	38.73	7	35.0	641	44.15	839	60.10	1645	50.21
Progomphus clendoni	*Prcl*	13	3.19	2	10.0	9	0.62	8	0.57	32	0.98
P. lambertoi	*Prla*	1	0.25	-	-	91	6.27	1	0.07	93	2.84
P. marcelae	*Prma*	61	14.95	-	-	8	0.55	65	4.66	134	4.09
Phyllogomphoides luisi	*Phlu*	21	5.15	2	10.0	106	7.30	91	6.52	220	6.72
P. pacificus	*Phpa*	-	-	2	10.0	9	0.62	8	0.57	19	0.58
Libellulidae											
Dythemis nigrescens	*Dyni*	-	-	-	-	-	-	7	0.50	7	0.21
Brechmorhoga praecox	*Brpr*	5	1.23	2	10.0	412	28.37	45	3.22	464	14.16
Erythrodiplax sp.	*Ersp*	-	0.00	-	-	-	-	7	0.50	7	0.21
Macrothemis inacuta	*Main*	7	1.72	-	-	-	-	-	-	7	0.21
M. pseudimitans	*Maps*	28	6.86	1	5.0	83	5.72	60	4.30	172	5.25
Paltothemis lineatipes	*Pali*	-	-	-	-	3	0.21	-	-	3	0.09
Perithemis domitia	*Pedm*	-	-	-	-	-	-	2	0.14	2	0.06
Pseudoleon superbus	*Pssu*	6	1.47	-	-	14	0.96	6	0.43	26	0.79

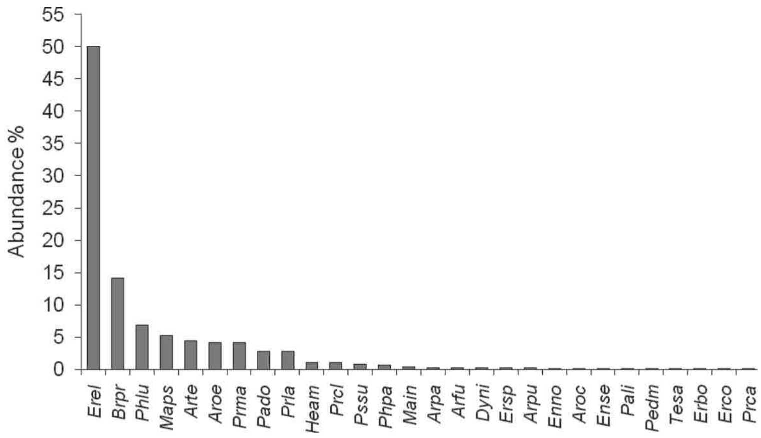

Fig. 2. Relative abundance of Odonata species from Río Pinolapa. Key to species in Table II.

recorded in autumn, while others as *Argia pulla*, *Enallagma semicirculare*, *Protoneura cara*, *Dythemis nigrescens* and *Erythrodiplax* sp., were only found in winter. Summer contains an assemblage of very few species.

DIVERSITY AND ABUNDANCE BY STRATA

Table IV shows the ecological parameters of the Odonata larval assemblages by strata of RP. Number of species in the shores was almost twice as much of that of the riffles (middle-channel), and more than twice as much of that of eddies. However, the abundance was higher in the middle-channel of the water body. The diversity H' was higher in the shores while the dominance did in eddies.

The major amount of larvae in all strata was *Erpetogomphus elaps*, however, in the riffles we found a higher proportion of *Brechmorhoga praecox* (24.42%).

When diversity is compared and ordered using the Renyi's profiles (Fig. 6), it

Table III
Seasonality of the ecological parameters of Odonata larval assemblages at Río Pinolapa

	Spring	Summer	Autumn	Winter	Total
Number of species	15	7	16	22	28
Number of specimens	401	20	1452	1396	3269
Simpson (*D*)	0.22	0.21	0.29	0.38	0.29
Shannon-Weaver (*H*')	1.89	1.76	1.63	1.61	1.85
Margalef richness (*R*)	2.34	2.00	2.06	2.90	3.09
Pielou evenness (*J*)	0.70	0.90	0.59	0.52	0.57

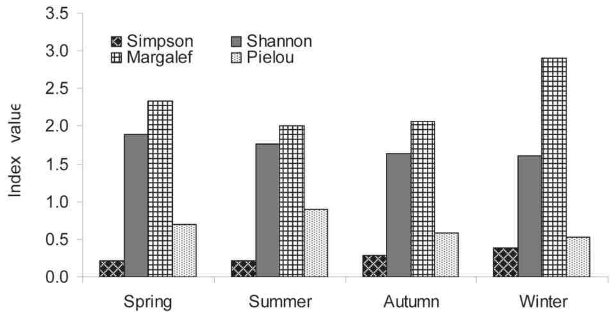

Fig. 3. Ecological parameters per season of the Odonata larval assemblage at Río Pinolapa. Collections were made between March 2005 and January 2006.

follows the gradient shores>riffles>eddies. This fact confirms that shores contain the highest diversity of Odonata larvae in RP.

THEORETICAL RICHNESS ESTIMATION

NON-PARAMETRIC MODELS. — The cumulative species curves generated by non parametric estimators Chao2, and Bootstrap are shown in Figure 7. The estimated number of species was 41.4, and 32.4 species, respectively, which gave a sampling efficiency of 67.6%, and 86.3, respectively. These richness estimators indicate a lack of register from 4 to 13 species. The estimated number of species using the Mao Tau upper limit of class interval was 34.7, which means that still should be added to the list 6-7 species, being the efficiency of the total sampling effort of 80%. The number of species with a single individual (singletons) was 3, with two individuals (doubletons) was 2, the number of unique species was 11, and for duplicated ones was 3.

PARAMETRIC MODELS. — Figure 8 shows cumulative species curves generated by the Clench's and Linear dependence functions. The first function predicted 30.67 species and explained 98% of data variation, while the second one predicted 25.74 species and explained 95% of data variation. The Clench's model indicates that there are 3 species to be registered yet, and the linear dependence in-

Table IV
Ecological parameters of the Odonata larval assemblages by stratum at Río Pinolapa

Index/stratum	Shores	Riffles	Eddies
Number of species	25	14	10
Number of specimens*	1062	1713	323
Simpson (*D*)	0.27	0.32	0.47
Shannon-Weaver (*H'*)	1.93	1.54	1.18
Margalef's richness (*R*)	3.44	1.61	1.56
Pielou's (*J*) eveness	0.60	0.60	0.51

* Some samples were omitted because of insufficient field data.

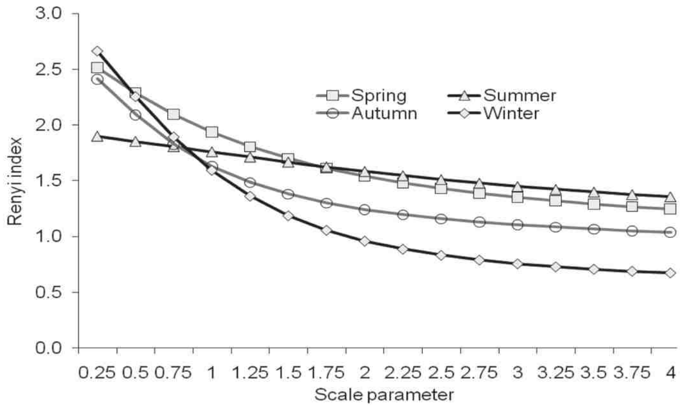

Fig. 4. Renyi's diversity profiles for the four seasonal Odonata larval assemblages from Río Pinolapa.

dicates the list has been completed. Based on the explained variance (R^2, determination coefficient), the Clench's estimation explained better the data variation; its prediction is considered further. Finally, slopes for both curves were 0.10 for Clench's function and 0.04 for Linear dependence.

THE SPECIES-ENVIRONMENT RELATIONSHIPS

The results of the CCA were globally significant (trace = 0.937, F = 1.59, p <0.05, Tab. V). The first three axes offered a good solution to the ordination of the physicochemical variables and abundance of species, since from the total variability in the data (inertia = 3.701), it was possible to explain 87.9% by means of these group of axes. The significance test of the first canonical axis showed it was significant (eigenvalue = 0.292, F = 2.822, p <0.05).

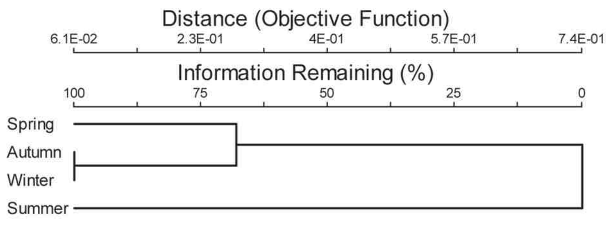

Fig. 5. Dendrogram showing the faunal relationships among the year seasons assemblages of odonate larvae. Based on a Bray-Curtis similarity matrix and the unweighted pair-group arithmetic averaging (UPGMA).

Table V
Results of the canonical correspondence analysis (CCA) of log-transformed Odonata larvae abundance as a function of their environmental variables

Axes	1	2	3	4	Total inertia
Eigenvalues	0.29	0.25	0.18	0.09	3.705
Species-environment correlations	0.82	0.85	0.76	0.66	
Cumulative percentage variance					
of species data	7.9	14.7	19.5	22	
of species-environment relation	31.2	58	76.9	86.8	
Sum of all eigenvalues					3.705
Sum of all canonical eigenvalues					0.937

The first axis was the most important, explaining 31.2% of variance, and it was also the most strongly correlated with pH, riffles and autumn. The second axis explained 26.8% of variance, and it correlated strongly with conductivity. The third and fourth axes explained only 16.7% and 12.1% of variance, respectively, and were not considered further.

When the distribution of the species in the eight collections and three strata is analyzed together with the CCA of the Figure 9, it is posible to make the following precisions: *Paltothemis lineatipes, Erpetogomphus cophias, Progomphus*

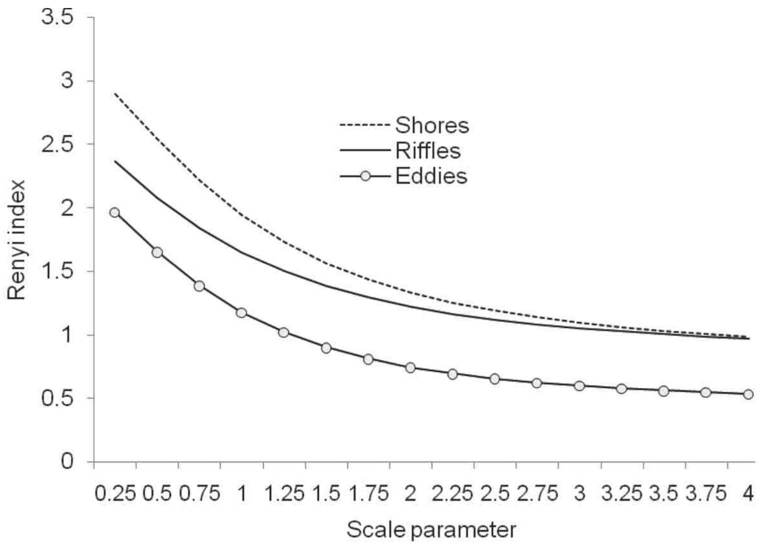

Fig. 6. Renyi's diversity profiles for three strata assemblages of Odonata larvae from Río Pinolapa. Profiles differ mainly at their basic level of structure, the number of species. Profiles never cross in α range from 1 to 4. Values of Renyi when $\alpha = 4$ were: shores profile = 0.982, riffles profile = 0.969 and eddies profile = 0.535.

lambertoi, and *Hetaerina americana* do associate well with the autumn. Particularly, *P. lambertoi* was registered almost in 100% (91 out of 92 specimens) from the shores at the beginning of the autumn. *Argia oenea* and *Palaemnema domina* were almost invariably registered from the riffles and at late winter. Only seven larvae of *Macrothemis inequiunguis* were registered from late spring on shores.

DISCUSSION

GENERAL ASPECTS

A total of 28 Odonata species (12 Zygoptera and 16 Anisoptera) were found and 3,276 larvae were identified in this work. The size of the Odonata larval assemblage from RP is similar to other Mexican water bodies reported (ALONSO-EGUÍALIS, 2004; GÓMEZ-ANAYA et al., 2000; NOVELO-GUTIÉRREZ & GONZÁLEZ-SORIANO, 1991; NOVELO-GUTIÉRREZ et al., 2002; BOND et al., 2006). Usually, the most speciose families are Libellulidae and Coenagrionidae. In this case Coenagrionidae, Gomphidae and Libellulidae were best represented. The single genus *Argia* contributed 50% of Coenagrionidae; in Gomphidae three genera contributed more or less equally, and in Libellulidae seven genera contributed to the diversity.

DIVERSITY AND ABUNDANCE

The highest and lowest species richness was found in winter and summer, respectively. The greatest abundance of individuals was recorded in autumn and

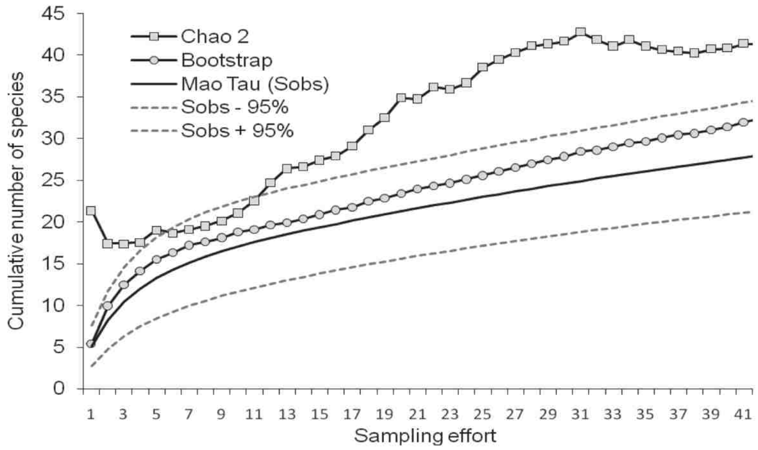

Fig. 7. Cumulative species curves generated by non-parametric estimators Mao Tau (S_{obs}), Chao2, and Bootstrap for the Odonata larval assemblage from Río Pinolapa.

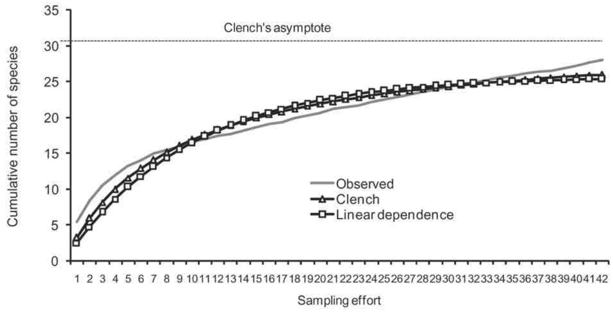

Fig. 8. Cumulative species curves generated by the Clench's function (a = 3.68, b = 0.12, asymptote = 30.67, R = 0.98), and linear dependence function (a = 2.63, b = 0.102, asymptote = 25.74, R = 0.95), for the Odonata larval assemblage from Río Pinolapa. The slope was estimated by the first derivative of Clench's function $[a/(1+b*n)^2]$ and the first derivative of Linear dependence function [a*exp(-b*n)].

winter. This could be due to the emergence pattern of the seasonal species. Most of them emerge during the dry season (at the end of the winter and through the spring). Thus, when the rains come in the summer, very few species are present as larvae. Summer is the season with a great reproductive activity, so that when autumn comes, there are large populations of larvae of the majority of odonate species. Later, as time goes on, abundance decreases through mortality until the lower abundances in spring and then, with emergence of the adults, even lower in summer. Among strata, the highest species richness was found at shoreline and the lowest in eddies; while the highest abundance occurred in riffles and the lowest in eddies. Eddies were the most simplified stratum, usually with a muddy bottom and some decaying leaves, and lacking any kind of aquatic plant; this could result in the lowest richness and abundance. Richness distribution pattern was different to that of abundance in RP. Thus, 55.39% of all abundance was recorded in riffles, 34.20% in shorelines and 10.40% in eddies. The most abundant species in all three strata was *Erpetogomphus elaps*, with 53.79%, 32.44%, and 13.77%, respectively. This species is, apparently, the best adapted to different conditions in time and space in RP, despite having a restricted period as adults (late summer to early autumn).

RENYI'S DIVERSITY PROFILES

Diversity ordering can be performed by using a diversity index family (TÓTHMÉRÉSZ, 1995), as proposed by SOUTHWOOD & HENDERSON (2000). The Renyi's diversity profiles method has been poorly used in comparing and ordering diversity of aquatic macroinvertebrate assemblages (SIPKAY et al. 2007) and even less used with Odonata assemblages (JAKAB et al., 2002). In this method a scale parameter (alpha) is related to the abundance-dominance structure of the community. At different values of the scale the function is sensitive to rare, common, and intermediate-abundance species. When comparing two Renyi diversity profiles, if they do not cross each other, it means that the upper profile represents a more diverse assemblage under any common measure of diversity; but if these profiles do cross each other once, it means that one assemblage is more diverse when rare species are weighted more heavily (low alpha), and the other assemblage is more diverse when common species are weighted more heavily (high alpha). When the diversity profiles cross each other, the communities cannot be ordered according to their diversity, because one of them is more diverse for rare species, the other for common ones. Renyi's diversity is sensitive to rare species for small values of the scale, whereas it is sensitive to abundant species for larger values of the scale. Seasonal diversity profiles crossed once, mainly for $\alpha<1$ values (Fig. 4). It means that these assemblages are mainly different in rare species. Strata profiles do not cross; however, shore and riffles profiles were similar in abundant and frequent species ($\alpha>2$), and, definitively, eddies profile was the least diverse.

Species distribution must meet the ecological requirements of all stages in the life cycle (CORBET, 1999). Although the imagoes have more mobility than immature, adequate substrates must be present for the larval emergence (rocks, vegetation, twigs, etc.). In consequence, the disturbance of the original conditions (e.g. riparian vegetation) will affect richness (SMITH et al., 2007). In RP the major diversity in shores can be explained because of major microhabitat heterogeneity. In shores we observed different size of rocks, sand, algae, plants, roots, mud, leaf packs, detritus, and different combinations of these substrates. Number of substrates in riffles and eddies or combinations of them were limited. In shores we found 10 Zygoptera species (1 calopterygid, 1 platystictid, 1 protoneurid, 7 coenagrionids), and 15 Anisoptera (7 gomphids and 8 libellulids). All Zygoptera species are endophitic in oviposition and they can find the needed substrates in shores. Gomphids and libellulids females lack ovipositor and they release their eggs on the water surface near the shores.

Most of the riffle samples of RP come from shallow and smooth flowing water places. In riffles we found 14 species (5 Zygoptera and 9 Anisoptera). *Brechmorhoga praecox* was the most abundant species in this stratum, as have been reported to different species of this genus (CORBET, 1999), and particularly for this species (BOND et al., 2006). Most of *B. praecox* larvae were caught, mainly, at the end of autumn. They exhibit different disruptive color patterns, being cryptic at sand and fine gravel bottom. Must of Coenagrionidae species were recorded from shores, except *Argia oenea* and *A. tezpi* which were more abundant in riffles.

CUMULATIVE CURVES OF SPECIES

The non-parametric estimation achieved by Bootstrap agrees well with the parametric estimation made by Clench function, which predicted 31 species (3 species more to be added). For parametric estimations, we chose initially the model that better fitted data using the coefficient of determination (R^2). This model was the Clench's function. Then, we used the slope of the curve evaluated at the maximum sampling effort by the first derived of both functions, as an approach of completeness of the list, according to JIMÉNEZ-VALVERDE & HORTAL (2003), and HORTAL & LOBO (2005). Although the slope was smaller with the Linear dependence (0.04), we believe this function underestimates the number of species (since it predicted fewer species than the recorded ones). We think few species could exist yet to be added to the list for the studied section of the river. The slope of the first derived of Clench (0.10) is relatively small, supporting the idea that the list is practically complete.

CCA

Several authors have explored the relationship between some environmental factors and odonate faunas using multivariate techniques (SAMWAYS, 2003; SCHINDLER et al., 2003; HOFFMANN & MASON, 2005; OPPEL, 2005; CARCHINI, 2007; FLENNER & SAHLÉN, 2008; SATO & RIDDIFORD, 2008; HAMASAKI et al., 2009). In this work the CCA showed significant correlation between both environmental and species matrices. Additionally, the CCA biplot allowed visualization of some particular facts and the establishment of some hypotheses on species-species and environment-species relationships. For example, *Palaemnema domina* and *Argia oenea* are well associated with riffles stratum, indicating similar ecological requirements. *P. domina* is usually

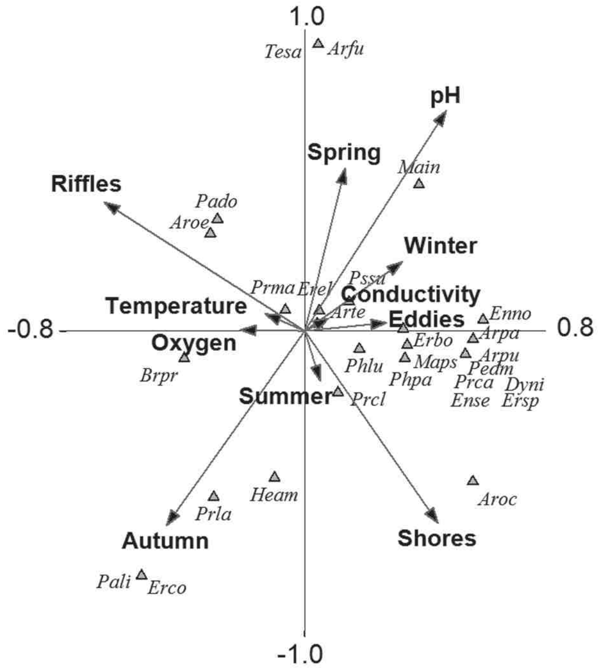

Fig. 9. Biplot of CCA ordination showing environmental variables (arrows) most strongly correlated with axes CC1 and CC2 and species in triangles. Seasons and strata were included in CCA as dummy variables. In terms of predicting larval assemblage composition, important environmental variables have longer arrows than less important ones.

found under mid-sized rocks (8-10 cm diam.) in riffles, as is *A. oenea*, although this last species is found also commonly among rough gravel. *Erpetogomphus elaps* is close to the origin on Figure 9, meaning it is the most ubiquitous species in RP. Apparently, the larvae are well adapted to both erosional and depositional environments. Moreover, it was found in every collection and through all seasons.

FINAL CONSIDERATIONS

Contrary to species lists from lentic water bodies (lakes, lagoons, ponds) which can be considered complete lists because one can sample the whole water body, the 28 recorded species in the RP survey represent just a part of a bigger assemblage. This bigger assemblage extends up and down stream changing in richness, composition, and abundance with changes in river conditions. From this point of view, the assemblage here described represents a relatively local measure of this group of insects, and also a measure of the conservation status of the river. It is possible that for many species with low abundance and distribution in space (strata) and time (seasons), the best conditions for their reproduction could be up or down stream. In this bigger assemblage the floristic, climatic, altitudinal and microhabitat changes should be considered, because the more the changes in the river conditions, the larger the species list should be.

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AT THE CENTENARY OF DR B.F. BELYSHEV'S BIRTH: THE IMPACT OF HIS WORK ON SIBERIAN ODONATOLOGY

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A brief appreciation of B.F. Belyshev's (1910-1993) work is presented and its impact on the current development of odonatology in Siberia is outlined. The bibliography (1993-2010, partim) of the members of his "school" is appended.

INTRODUCTION

The history of Russian odonatology is associated with two great names: the Russian classic, Professor N.N. Bartenev (1882-1946) and Dr B.F. Belyshev (1910-1993), who marked, respectively, the first and the second half of the 20th century. Celebrating the 100th anniversary of Dr Belyshev's birth, we consider as a special privilege to have the opportunity to devote a few lines to our esteemed colleague and mentor. For his biography and bibliography, see *Odonatologica* 4(1975): 207-218, 20(1991): 1-8, *Notulae odonatologicae* 4(1993): 35-36 and *Euroasian entomological Journal* 9(2010): 223-230.

BELYSHEV's WORK AND ITS IMPACT ON THE DEVELOPMENT OF ODONATOLOGY IN SIBERIA

Boris Feodorovich Belyshev was born in Tomsk (Siberia) on 13 December 1910. Already as a child he had a remarkable interest in natural sciences, and he was only 16 when his first technical ornithological note appeared in the local periodical, *Uragus*, followed during the subsequent years by a long line of articles and bird notes. Appreciating his scientific life, one should bear in mind the special features of his personal "life history", which were often much less favourable than those of most of his colleagues-odonatologists, during some periods even the keeping in touch with foreign workers was a hard proposition, and much of the foreign literature was hardly available. Nevertheless, Belyshev's dedication to science was unfailing. In 1951 he published his first odonatological paper, and from that time on he devoted himself entirely to the science of odonatology.

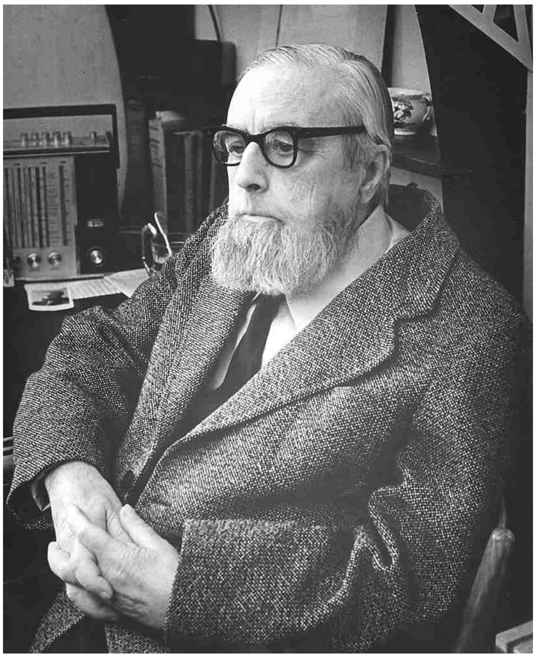
Prior to Belyshev, the information on Siberian dragonflies was very fragmentary. He was the first to study systematically the fauna, distribution and ecology of this vast territory. His early endeavours resulted in his M.Sc. thesis ("*Odonate fauna of the Upper Ob region*", 1958) and in the voluminous D.Sc. dissertation ("*Odonate fauna of Siberia*", 1964), defended at the University of Irkutsk. The 1960s and 1970s were his creative peak. During this period he published more than 120 works, including the 3-volume monograph, "*Dragonflies of Siberia*" (1973-1974), which is to remain the key work for long time to come.

Dr Belyshev was one of the very first odonatologists who as early as 1965 rendered support to the idea of founding an international odonatological society and an international odonatological periodical. It was about this time he commenced the work with graduate students, of whom e.g. A.Yu. Haritonov defended his thesis in 1975 (fauna and ecology of the Urals) and V.V. Zaika in 1982 (fauna of the southern part of the West-Siberian plain). In consequence, a group of young odonatologists gathered around Dr Belyshev, at what is now the Institute of Animal Systematics and Ecology of the Russian Academy of Scienes in Novosibirsk, where the First National Symposium of Odonatology was convened in 1986. This resulted in publication of a collection of papers, published under the title "*Fauna and ecology of dragonflies*" (1989). This book, along with the dragonfly identification guide based on wing venation (1977) and two volumes on odonate biogeography of the world (1981, 1983), represents a kind of cummulative summary of the achievements of the Belyshev period in Russia. Almost all what was published in Russia during the subsequent years, preceding his death in 1993, was done in close collaboration with him and/or under direct influence of his work.

Appreciating the odonatological oeuvre of Dr Belyshev, one should emphasize the versatility of his contributions. His studies on the composition of odonate faunas of Siberia and the Russian Far East became a "discovery" for the world scientific community. His followers are continuing along these initiatives and by now, the fauna of about a half of this vast territory (130 species) is known reasonably well.

Unfortunately, this could not be said about our knowledge on the odonate fauna of some of the other Asian regions of Russia, which is but inadequately explored. For example, data are almost lacking on the northern area of the West-Siberian plain and on the Yenisei-Lena interfluve. The mountains of the South, northern Siberia, the Okhotsk Sea coast and the northern part of Russian Far East were also insufficiently studied, mostly so due to the unfavourable field conditions with which the expeditions are inevitably faced. So far the information is available only on ca 50-70% of the regional odonate faunas and the subject remains among the targets for the near future.

Dr Belyshev devoted much time to odonate biogeography of Russia and of the world, its history and evolution, and he was the first to set up an original scheme of land zones based on odonate distribution. It goes without saying, in his time he was able to use only the classical approach to these problems. The application of molecular approach in palaeobiogeography and species evolution will inevitably shed new light on some of his conclusions.



Dr Boris Feodorovich Belyshev (1910-1993), portrait dated December 1992.

The third major achievement of Belyshev's work were his, in Russia innovative studies on odonate ecology. He worked out a basin typification as a biotope base of odonate spatial distribution, revealed regional features of their phenology, estimated threshold values of some climatic factors, has shown diurnal activities of the adults, experimented on elective feeding of dragonfly larvae, provided numerous data on odonate autecology, and paid much attention to dragonfly migrations. In Russia, he was also the first worker studying population density and other population biology features of individual species. The work in most of these fields is currently carried on and is being developed further by his students and by members of his "school". The current trends are clearly represented by the paper published by his students and followers in the recentmost issue (2010, Vol. 9, No. 2) of the *Euroasian entomological Journal*, devoted to the anniversary of his birth.

No doubt, Dr Belyshev's scientific oeuvre represents the base for all subsequent odonatological research in Siberia and generally in Russia. The Russian odonatological centre in Novosibirsk is another lasting monument of his odonatological genius, a firm guarantee for the future development of our science.

The bibliography of his "school" (1993-2010) is appended below.

BIBLIOGRAPHY OF THE MEMBERS OF THE "B.F. BELYSHEV SCHOOL" (1993-2010, partim)

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EUGREGARINE PARASITISM OF *ERYTHEMIS SIMPLICICOLLIS* (SAY) AT A CONSTRUCTED WETLAND: A FITNESS COST TO FEMALES? (ANISOPTERA: LIBELLULIDAE)

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Eugregarine parasites infect a wide variety of invertebrates. Some authors suggest that eugregarines are rather harmless, but recent studies suggest otherwise. Among odonate-eugregarine investigations, Zygoptera have been more frequently studied than Anisoptera. Adult dragonfly populations were surveyed for eugregarines at a constructed, flow-through wetland system and the fitness cost of infection was assessed in a common and widespread dragonfly host sp., *E. simplicicollis*. Populations were sampled weekly throughout the flight season. Host fitness parameters measured included wing load, egg size, clutch size, and total egg count. Of the 22 host spp. surveyed, 8 hosted eugregarines and 2 of these odon. spp. were previously undocumented as hosts. While eugregarine parasitism has been shown to exhibit seasonality, parasite prevalence and intensity in *E. simplicicollis* in this study showed no seasonal trend. The fitness parameters measured were not correlated with the presence or intensity of eugregarines. These findings suggest that either eugregarines do not affect wing loading and egg production in *E. simplicicollis*, or that virulence depends on parasite intensity and/or the specific eugregarine spp. infecting the hosts.

INTRODUCTION

Dragonflies host a variety of ecto- and endoparasites, most of which influence their hosts' fitness (BONN et al., 1996; REINHARDT, 1996; ROLFF et al., 2000; CÓRDOBA-AGUILAR, 2002; CÓRDOBA-AGUILAR et al., 2003; MARDEN & COBB, 2004; CANALES-LAZCANO et al., 2005). Eugregarine-odonate investigations have focused primarily on damselfly hosts (ÅBRO, 1971,

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1976; SIVA-JOTHY & PLAISTOW, 1999; SIVA-JOTHY, 2000; CORDOBA--AGUILAR, 2002; HECKER et al., 2002; CORDOBA-AGUILAR et al., 2003; CLOPTON, 2004; TSUBAKI & HOOPER, 2004; CANALES-LAZCANO et al., 2005) with relatively few studies on dragonfly hosts (MARDEN & COBB, 2004; SCHILDER & MARDEN, 2006; CLOPTON et al., 2007; LOCKLIN & VODOPICH, 2009; 2010).

Nine genera of eugregarines (Apicomplexa: Eugregarinorida: Actinocephalidae) have been identified as odonate parasites: *Actinocephalus*, *Calyxocephalus, Domadracunculus, Geneiorhynchus, Hoplorhynchus*, *Mukundaella, Nubenocephalus, Prismatospora*, and *Steganorhynchus* (RICHARDSON & JANOVY, 1990; CLOPTON et al., 1993; CLOPTON, 1995; PERCIVAL et al., 1995; SARKAR, 1997; CLOPTON, 2004; HAYS et al., 2007). All are monoxenous eugregarines that infect their hosts when odonates ingest oocyst-contaminated water and/or insect prey phoretically carrying oocysts on/in their bodies (ÅBRO, 1976). Excysted sporozoites attach to the odonate's intestinal epithelium as trophozoites, absorb nutrients, mature, and detach as gamonts. Two gamonts fuse to form a gametocyst that passes out of the host with feces. Within the gametocyst, hundreds of gametes form and fuse to produce the infective oocysts. To complete the life cycle, oocysts are then released into the environment as the gametocyst ruptures (BUSH et al., 2001; ROBERTS & JANOVY, 2005).

Eugregarine parasites have been historically viewed as relatively harmless (BUSH et al., 2001), but some studies have shown that the cost of eugregarine infections involves effects on fecundity and mortality of invertebrates (see SMITH & CLOPTON, 2003). Among odonate studies, eugregarines have been shown to reduce longevity (HECKER et al., 2002; CÓRDOBA-AGUILAR et al., 2003; CANALES-LAZCANO et al., 2005; TSUBAKI & HOOPER, 2004), reduce fecundity (CÓRDOBA-AGUILAR et al., 2003; CANALES-LAZCANO et al., 2005), influence mating success (CÓRDOBA-AGUILAR et al., 2003), impair flight-muscle performance (SCHILDER & MARDEN, 2006), hinder the ability to maintain territories (MARDEN & COBB, 2004; CÓRDOBA-AGUILAR, 2002), reduce fat content (SIVA-JOTHY & PLAISTOW, 1999), and impair fat oxidation in flight muscles (MARDEN & COBB, 2004).

The present study was designed to (1) survey dragonfly populations for eugregarine parasitism, (2) determine the prevalence and intensity patterns throughout a flight season at a constructed wetland system, and (3) investigate impacts of eugregarine parasitism on fitness parameters including wing load, egg size, total egg count, and clutch size in a common and widespread host, *Erythemis simplicicollis* (Libellulidae).

METHODS

This study was conducted at the Lake Waco Wetland (LWW), TX, USA (31º60'88N, 97º30'69W). The wetland was constructed in 2001 as habitat mitigation for a 2-m pool rise of nearby Waco Lake. The 80-ha wetland receives pumped water from the North Bosque River and routes the flow through five sequential wetland cells before returning it 5-10 days later to the river that feeds Waco Lake (SCOTT et al., 2005).

Adult dragonfly populations were sampled weekly from May-October 2009 (= flight season). All collected individuals were netted within 15 m of the shorelines, taken to the laboratory, killed with ethyl acetate, identified (ABBOTT, 2005), and stored in 70% ethanol. Prior to preservation, specimens of *E. simplicicollis* were dorsally scanned at 600 dpi (MITCHELL & LASWELL, 2000) and weighed to the nearest 0.1 mg. Weight loss due to dessication in the laboratory was corrected following LOCKLIN & VODOPICH (2010). To survey for parasites and determine their prevalence (percentage of individuals infected) and intensity (number of parasites per infected individual), preserved abdomens were placed ventral-side up on a Styrofoam tray and dissected. The abdomens were split longitudinally and pinned to expose the crops and intestines. Parasites (trophozoites and gamonts) that were visible through the intestinal epithelium were counted.

We calculated monthly eugregarine prevalences and intensities in *E. simplicicollis* throughout the flight season and investigated potential impacts on parameters relating to species fitness, i.e. differences in wing load, egg size, total egg count, and clutch size. We define clutch size as the number of eggs laid (WATANABE & MATSU'URA, 2006) during induced oviposition (see methods below). Total egg count is the sum of eggs released during induced oviposition and the eggs retained in the abdomen. Egg viability was not tested. In adult dragonflies, eugregarines are not visually detectable in recently emerged tenerals (LOCKLIN & VODOPICH, 2010). Only mature host individuals are candidates for answering questions about parasite prevalence and intensity. Because wing loads (mg body wt x wing surface area^{-1}) were not affected by eugregarines (see below), we used wing loads as a surrogate for maturity of *E. simplicicollis*. Minimum wing load values for parasitized *E. simplicicollis* (♂ = 18.0 mg cm^{-2}; ♀ = 21.8 mg cm^{-2}) were used to signify mature adults (LOCKLIN & VODOPICH, 2010).

To calculate wing loads, total wing surface area of each *E. simplicicollis* was estimated by measuring the right hindwing length (mm) from the second axillary sclerite to the wing tip using Adobe Photoshop and regressing total wing surface area, *y*, using the following equations:

♂ $y = 0.470x - 5.94$ (r^2=0.92, 18 d.f., p <0.001)

♀ $y = 0.450x - 4.66$ (r^2=0.83, 23 d.f., p <0.001),

where *x* is hindwing length (mm).

To collect eggs, females were captured and induced to oviposit in the field (SUSA & WATANABE, 2007). The tip of each female's abdomen was repeatedly dipped vertically into a 7-ml vial of wetland water once per second until she stopped releasing eggs. If no eggs were released initially, then dipping continued for three minutes to ensure that she had no eggs to release or that she was unwilling. The females were preserved. The widths and lengths of ten randomly selected eggs from 24 females were measured (mm) using an ocular micrometer mounted in a compound microscope. Egg circumference, *C*, was calculated using a formula for ellipse perimeter:

$$C = \pi[1.5(a + b) - ((a \times b)^{1/2})]$$

where a = 0.5 x length and b = 0.5 x width (SCHENK & SÖNDGERATH, 2005). The eggs from the other females were preserved in 50% ethanol and later counted at 60X. Eggs retained in abdomens were also counted after dissection. The females caught for analysis of clutch size and total egg count were captured mid-morning presumably before daily ovipositing began.

RESULTS

Specimens of twenty-two anisopteran species (n = 1,378) were collected at the wetland, eight of which were parasitized by eugregarines (Tab I). Four of the unparasitized species collected (Tab II), *Anax junius* (Aeshnidae), *Epitheca princeps* (Corduliidae), *Tramea lacerata* (Libellulidae), and *T. onusta* (Libellulidae) have been previously reported to host eugregarines (CLOPTON et al., 2007; LOCKLIN & VODOPICH, 2010). Eugregarines were tentatively identified as members of the genera *Actinocephalus* and *Geneiorhynchus* (Eugregarinorida: Actinocephalidae).

Monthly eugregarine prevalences in mature *E. simplicicollis* showed no seasonal trend through the flight season (Freedman's test, $V_N = 0.07$, p = NS) (Fig. 1).

Table I
Dragonfly species (all members of Libellulidae) infected with eugregarine parasites at the Lake Waco Wetland; – IQR = interquartile range – [* indicates newly reported host]

Species	N	Prevalence (%)	Median intensity	IQR	Maximum intensity
Brachymesia gravida	1				
Males	1	100	11	-	11
Females	0	-	-	-	-
Celithemis eponina	67				
Males	34	9	2	1-9	9
Females	33	3	3	-	3
Erythemis simplicicollis	881				
Males	350	27	2	1-5	60
Females	531	32	2	1-4	55
*Libellula incesta**	3				
Males	1	0	-	-	-
Females	2	50	1	-	1
Libellula luctuosa	11				
Males	7	14	1	-	1
Females	4	0	-	-	-
*Pantala flavescens**	52				
Males	20	0	-	-	-
Females	32	3	1	-	1
Pachydiplax longipennis	134				
Males	108	12	2	1-2	4
Females	26	12	1	1-2	2
Perithemis tenera	64				
Males	41	10	2	1-6	7
Females	23	22	3	1-4	4

Eugregarine intensities were not normally distributed among hosts (Shapiro-Wilk test, $p < 0.001$), therefore nonparametric analyses were used to assess intensity data. Monthly median intensities ranged from 1.0 – 3.5 eugregarines in *E. simplicicollis* (Fig. 1) and the maximum intensity of 60 eugregarines occurred in a male *E. simplicicollis*.

Wing loads among mature *E. simplicicollis* individuals were not related to the presence/absence or intensity of eugregarines. Median wing loads (mg cm^{-2} with IQR) of infected versus uninfected individuals, respectively, were 25.6 (24.6 – 27.3) and 25.3 (23.8 – 27.0) in males and 30.9 (28.6 – 33.6) and 29.9 (27.1 – 32.4) in females. No difference was detected between median wing loads of infected versus uninfected in either males (Wilcoxon Rank Sum Test, $Z = -1.36$, $p = 0.173$) or females ($Z = -2.36$, $p = 0.18$). Likewise, wing load did not correlate with eugregarine intensity in either males (N = 189, Spearman's correlation, $r_s = 0.37$, $p = 0.79$) or females (N = 288, $r_s = 0.01$, $p = 0.99$) (Fig. 2).

Egg size, total egg count, and clutch size of *E. simplicicollis* were not correlated with the presence/absence or intensity of eugregarines. Of the females captured for egg analyses, 88% were gravid and 57% of these gravid females released one or more eggs into the glass vials. Egg sizes (circumference) for female *E. simplicicollis* ranged from 1.2 – 1.4 mm, but the presence of eugregarines had no effect on mean egg size. Mean egg sizes from infected versus uninfected females did not differ ($t = 1.41$, $p = 0.17$, N = 24), and egg size did not correlate with the intensity of infection (N = 24, $r_s = -0.19$, $p = 0.37$) (Fig. 3). Total egg counts ranged from 0 – 1,611 eggs $female^{-1}$. Mean numbers of total eggs from infected versus

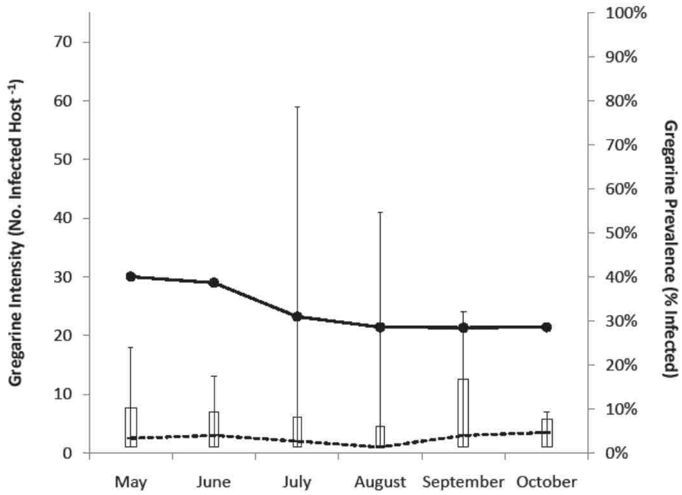

Fig. 1. Median gregarine intensity (dashed line) and gregarine prevalence (solid line) in *E. simplicicollis* throughout the odonate flight season at the Lake Waco Wetland, Texas, USA, 2009. Intensity data include interquartile range (boxes) and range (extended bars).

uninfected females were not significantly different (t = -1.63, p = 0.11), and eugregarine intensity did not correlate with the total number of eggs (N = 84, r_s = 0.143, p = 0.193) (Fig. 3). Clutch size data (Fig. 3) included only females having eggs available to release. Mean clutch size was 199 eggs female^{-1} (range = 0 – 967). The presence/absence of eugregarines had no significant effect on whether or not a female released eggs (χ^2_1 = 0.168, p = 0.682). No difference was found between the mean clutch sizes of infected versus uninfected females (t = -0.741, p = 0.461). Clutch sizes did not correlate with eugregarine intensity (N = 74, r_s = 0.09, p = 0.44) (Fig. 3).

DISCUSSION

Of the eight parasitized dragonfly species collected at the wetland (Tab. I), two (*Libellula incesta* and *Pantala flavescens*, Libellulidae) are reported as hosts for the first time in this paper, and six were reported previously to host eugregarines (LOCKLIN & VODOPICH, 2009; 2010). Those odonate species surveyed in LOCKLIN & VODOPICH (2010) and those in this paper that lacked eugregarines should be considered as non-hosts only tentatively because the number of individuals examined was relatively small (Tab. II).

The lack of seasonal variation in parasite prevalence and intensity at LWW may be associated with water residence time. This wetland's continual flow and short residence time (5-10 days) is likely to dampen seasonal variation in oocyst density through time. LOCKLIN & VODOPICH (2010) found that eugregarine prevalence and intensity increased during the dragonfly flight season of each of

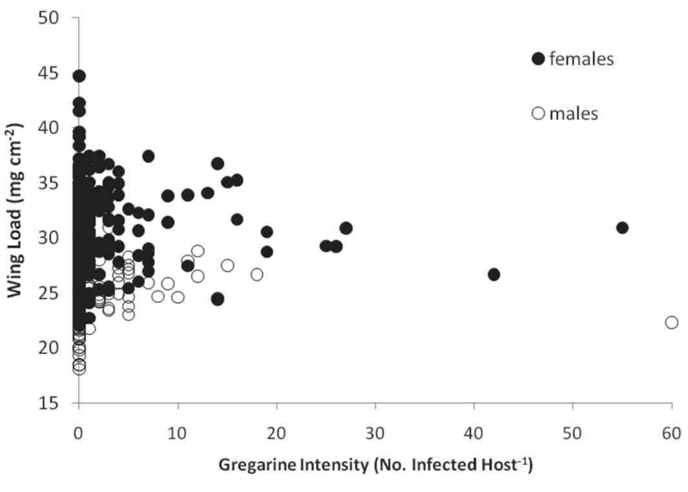

Fig. 2. Wing loads of males (open symbols) and females (closed symbols) *E. simplicicollis* versus gregarine intensity. No correlation was detected in males (N = 189, r_s = 0.37, p = 0.79) or females (N = 288, r_s = 0.01, p = 0.99).

two subsequent years in dragonfly populations at Battle Lake, a small nearby reservoir with a longer water residence time. In that study, we speculated that viable eugregarine oocyst concentrations and/or availability to hosts increased during the flight season and resulted in higher levels of infection towards the end of the season. In the current study, however, we detected no significant seasonality in eugregarine prevalence or intensity (Fig. 1). We propose that oocysts shed by infected hosts are constantly being washed through the wetland into the nearby North Bosque River because of the wetland's brief water residence time. Consequently, a reduced but stable concentration of eugregarine oocysts is likely and would result in the relatively unchanged levels of eugregarine infections found in this study.

Local physical, chemical, and biological processes may also influence the distribution and longevity of viable eugregarine oocysts and foster the steady prevalence and intensity found at LWW compared to Battle Lake. Because the morphometry and flow regimes differ between the two aquatic systems, abiotic conditions (e.g. water temperature, dissolved oxygen levels, etc.) in each are also likely to differ (KVARNÄS, 2001). The influence of these conditions on oocyst viability warrants further research. In an analogous system, much research has sought to detect and evaluate oocyst viability of the closely-related *Crypotosporidium parvum* (e.g., CALL et al., 2001; KATO et al., 2002; POKORNY et al., 2002). Unfortunately, the degree to which eugregarine oocysts are encountered by dragonflies in aquatic and/or terrestrial environments remains uncertain, and the factors influencing oocyst viability and longevity are still unknown.

Commonly, digestive-tract parasites reduce the host's ability to absorb nutrients and to accumulate and appropriately distribute fat (SIVA-JOTHY & PLAISTOW, 1999). During maturation from teneral to reproducing adult, odonates acquire color and mass critical for mate selection, and build fat reserves for sustained flight and egg production (CÓRDOBA-AGUILAR & CORDERO-RIVERA, 2005). Males distribute most of their fat in the thorax (ANHOLT et al., 1991) to support sustained flight and maintain territories (MARDEN & WAAGE, 1990; PLAISTOW & SIVA-JOTHY, 1996). The initial moments of flight depend on carbohydrate oxidation and then transition to lipid oxidation if flight is sustained (SCHILDER & MARDEN, 2006). SIVA-JOTHY & PLAISTOW (1999) found that eugregarines reduced fat content in pre-reproductive *Calopteryx splendens xanthostoma* males (Zygoptera: Calopterygidae). SCHILDER & MARDEN (2006) reported that eugregarines impaired fatty acid oxidation by flight muscles in infected *Libellula pulchella* males (Anisoptera: Libellulidae). Decreased fat content and/or impaired fat oxidation in infected odonates are likely to reduce male fitness because they hinder sustained flight.

Female odonates distribute more fat in the abdomen presumably for egg production (ANHOLT et al., 1991). If parasitized females have less fat content and/or an impaired fat metabolism, then we hypothesized that egg sizes, clutch sizes,

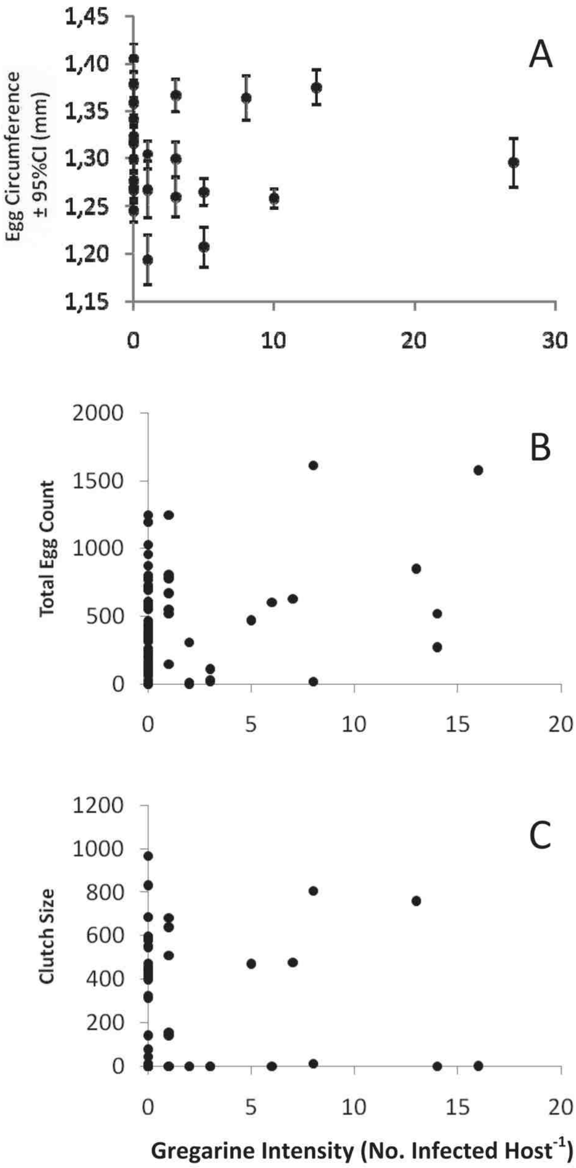

Fig. 3. Egg circumference (A), total egg count (B), and clutch size (C) of *E. simplicicollis* versus gregarine intensity. A: Each data point represents the mean circumference (mm) of ten eggs from a female; error bars represent 95% CI. No correlation was detected (N = 24, r_s = -0.19, p = 0.37). B: Total egg count includes all eggs released during induced oviposition plus retained eggs found during abdominal dissections. No correlation was detected (N = 84, r_s = 0.14, p = 0.19). C: Clutch size data include only females with eggs to oviposit. No correlation was detected (N = 74, r_s = 0.09, p = 0.44).

and/or the number of eggs produced would be less among infected females than uninfected females. CORDOBA-AGUILAR et al., (2003) found a negative correlation between eugregarine intensity and egg production in *Calopteryx haemorrhoidalis*. CANALES-LAZCANO et al. (2005) also found that eugregarine infection reduced egg numbers in female *Enallagma praevarum*. However, we detected no correlation between parasite intensity and the dragonfly egg parameters measured.

Parasites often have life history strategies that damage or impair the morphology and/or physiology of their host. But quantifying the fitness costs of such damage is difficult because the magnitude of host cost is determined by the damage a parasite causes (SIVA-JOTHY & PLAISTOW, 1999). The lack of detectable virulence described in this study may be due to 1) relatively low eugregarine intensities in the population, and/or 2) variation of virulence associated with individual gregarine species.

The level of virulence a host experiences may depend on parasite intensity. Eugregarine (order Eugregarinorida) and neogregarine (order Neogregarinorida) infections, for example, manifest dramatically different impacts on their hosts – eugregarines generally do little harm (RODRIGUEZ et al., 2007) whereas neogregarine infections often significantly impact their hosts negatively (ALTIZER & OBERHAUSER, 1999; LORD, 2006; BRADLEY & ALTIZER, 2005; LINDSEY et al., 2009). The difference in impact may stem from neogregarines proliferating vegetatively in the host while eugregarines do not. Specifically, neogregarines undergo multiple asexual divisions (merogony) after entering host's cells and the resulting merozoites spread and infect other tissues in that host. Eugregarine intensity, however, depends entirely on the number of oocysts ingested because they lack a vegetative reproductive stage. Consequently, eugregarine intensities tend to be lower than neogregarine intensities. RODRIGUEZ et al. (2007) suggested that unless parasite intensities exceed some threshold number, fitness impacts in the host may be negligible. ÅBRO (1974) reported that eugregarine intensities greater than 100 caused lesions in the alimentary canals of infected Zygoptera which may have permitted entry of pathogens into the haemocoel. Unfortunately for our efforts to detect fitness costs, intensities were low in *E. simplicicollis* females (median = 2, max = 55). Analyzing individuals with more intense infections may show that eugregarines can affect fitness of *E. simplicicollis* females with respect to egg production. However, CANALES-LAZCANO et al. (2005) and SIVA-JOTHY & PLAISTOW (1999) found that eugregarines were associated with reduced egg numbers and fat content, respectively, in damselflies with relatively low intensities. This suggests that significant fitness costs do not depend exclusively on eugregarine numbers, at least for some odonate host species. Moreover, if intensity relates directly to fitness costs of *E. simplicicollis*, then most individuals will not show signs of parasitism due to the nature of eugregarine reproduction (no merogony) and their aggregated distribution (i.e. a negative bi-

Table II
Dragonfly species collected at the Lake Waco Wetland that did not host eugregarine parasites – [* indicates a previously reported host species]

Family	Species	n
Aeshnidae	*Anax junius**	27
	Males	24
	Females	3
Corduliidae	*Epitheca princeps**	1
	Males	1
	Females	0
Gomphidae	*Arigomphus submedianus*	9
	Males	5
	Females	4
	Dromogomphus spoliatus	10
	Males	5
	Females	5
	Gomphus militaris	18
	Males	13
	Females	5
	Stylurus plagiatus	2
	Males	2
	Females	0
Libellulidae	*Dythemis nigrescens*	4
	Males	4
	Females	0
	Libellula comanche	1
	Males	1
	Females	0
	Libellula vibrans	1
	Males	1
	Females	0
	Orthemis ferruginea	2
	Males	1
	Females	1
	Pantala hymenaea	26
	Males	13
	Females	13
	Plathemis lydia	45
	Males	21
	Females	24
	*Tramea lacerata**	17
	Males	12
	Females	5
	*Tramea onusta**	2
	Males	2
	Females	0

nomial distribution) across dragonfly populations. Most infected odonates have low parasite intensities (LOCKLIN & VODOPICH, 2010). As a consequence, detecting effects of intense eugregarine infections in natural dragonfly populations may prove difficult because relatively few hosts have high intensities.

Parasite virulence may also depend on the parasite species infecting a host. For example, *Entamoeba histolytica* and *E. dispar* are protozoan parasites that infect humans. These closely-related congeners are difficult to differentiate morphologically (CLARK et al., 2006), but their virulence levels are significantly different. The former kills up to 100,000 people annually whereas the latter is a commensal (DIAMOND & CLARK, 1993; ROBERTS & JANOVY, 2005). Our understanding of species-level diversity among the eugregarine fauna infecting Odonata is progressing. Several species have been described from nine eugregarine genera identified in odonates, although none of the adult dragonfly species that we surveyed in the current study or in LOCKLIN & VODOPICH (2010) were hosts identified in those descriptions. However, if odonate-infecting eugregarines exhibit strong host species- and/or stage-specificity, then many new eugregarine species await description. Furthermore, if virulence varies among eugregarine species and their host species, then conclusions on the fitness costs (or lack thereof) in this host may be strengthened when more is known about the specific eugregarine fauna infecting *E. simplicicollis*.

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CONSERVATION ECOLOGY OF THE BRACKISH WATER DAMSELFLY, *MORTONAGRION HIROSEI* ASAHINA: DYNAMICS OF A NEWLY ESTABLISHED REED COMMUNITY (ZYGOPTERA: COENAGRIONIDAE)

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The endangered *M. hirosei* perches in the understory of dense reed communities in brackish water. To aid the conservation of a population, a new reed community (2110 m^2) was established in abandoned rice paddy fields adjacent to the original, threatened community (500 m^2) by transplanting reed rhizomes in January 2003; brackish water was supplied to the new community. It was assessed whether the new community developed into a suitable habitat for *M. hirosei* by comparing it to the original community in 2005. Shoot height, density, and aboveground biomass of the reeds and relative light intensity in the community were measured periodically during the growing season. Reed height and biomass were significantly lower in the new community than in the original one. This suggests that 3 yr after transplantation the new community was still underdeveloped. However, shoot density and relative light intensity in the understory were not significantly different between the two communities. Thus, the new reed community was offered in 2005 to *M. hirosei* adults as a suitable habitat.

INTRODUCTION

The endangered *Mortonagrion hirosei* Asahina inhabits reed [*Phragmites australis* (Cav.) Trin. ex Steudel] communities in brackish water (HIROSE, 1985). This species does not perform a maiden flight (WATANABE & MIMURA, 2003), and adults remain in the understory of the reed community throughout their lives, reproducing there (HIROSE & KOSUGE, 1973; SOMEYA, 1998; FUKUI & KATO, 1999; WATANABE & MIMURA, 2004). Therefore, the loss of brack-

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ish reed communities contributes to local extinctions of the species.

In 1998, a *M. hirosei* population was discovered in a small community (surface ca 500 m^2) on a narrow stream in the construction site of the Miyagawa Ryuuiki Sewage Plant in the city of Ise, Mie prefecture, Japan (WATANABE et al., 2002; WATANABE & MIMURA, 2003). A total of about 5,000 adults inhabited this community (WATANABE & MIMURA, 2003). Brackish water conditions in the community had been maintained by the supply of freshwater from upstream and seawater from downstream. When the sewage plant is functional, it will interfere with the supply of fresh water, resulting in the extinction of this damselfly population, due to increased salinity and/or increased sediment and litter deposition in the community. Therefore, the government of Mie prefecture decided not only to preserve the original habitat, but also to establish a new habitat to aid in the conservation of this population.

M. hirosei adults perch mainly on live and dead shoots of reeds, preferring the tips of broken stems or the dead blades of reeds 20 cm above the water surface. Further, they show little flight activity (WATANABE & MIMURA, 2004). The perch sites have a relative light intensity of about 10% and a max total shoot density (living and dead standing shoots) of 440 m^{-2} (WATANABE et al., 2002). Based on these facts, in January 2003, reed rhizomes were transplanted into abandoned rice paddy fields adjacent to the original community to create a new habitat for *M. hirosei*.

Mitigation plans have recently become more common for conserving species in developed areas. However, an analysis of 43 habitat conservation plans in the United States found that most included little information about habitat quantity and quality (HARDING et al. 2001). In this study, we investigated the growth and microenvironment of the newly established community to evaluate its development relative to the original community. This allowed us to evaluate the suitability of the new community as *M. hirosei* habitat.

STUDY SITES AND METHODS

Mortonagrion hirosei inhabits only a few isolated reed communities in Ise (WATANABE & MIMURA, 2004). The construction site of the Miyagawa Sewage Plant, located in an estuary of the Miyagawa River, was surrounded by rice paddy fields (34°31' N, 136°44' E). The original reed community was in a narrow stream at the site, where water depth was less than 5 cm and salinity averaged 10‰, with a maximum of 20‰ (WATANABE et al., 2002).

In January 2003, reed communities with shoot densities similar to the original community were identified. Soil blocks (20 cm deep, 1.6 m wide, and 0.6 m long) including reed rhizomes connected to dead shoots (cut 50 cm above the ground) were transported from these communities to an abandoned rice paddy fields (2110 m^2) adjacent to the original community (Fig. 1). The soil blocks were densely laid on the abandoned rice paddy fields. Artificial brackish water, a mixture of sea water and tap water, is supplied to the new reed community from three inflow sites on the west side (Fig. 1). The salinity of the artificial brackish water is regulated to an average of 10 ‰, not to exceed 20‰.

We established five quadrats (50 × 50 cm) both in the original community and in the new community

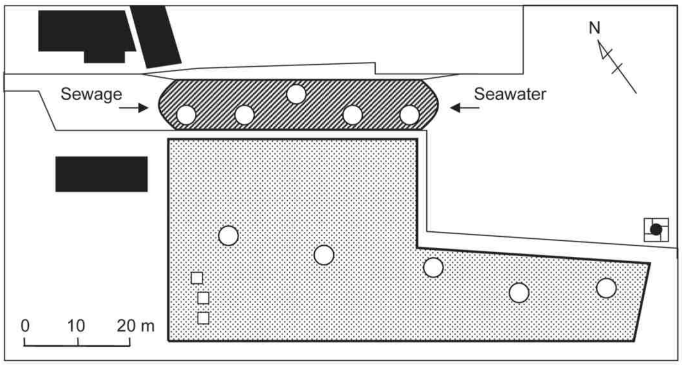

Fig. 1. The locations of the study sites. The original and established reed communities are shown by striped and doted areas, respectively. Sewage freshwater from west and seawater from east are supplied to the original community. Artificial brackish water, a mixture of seawater drawn from near the original community with tap water, is supplied to the new reed community from three inflow systems. Open circles show quadrats for investigation of reed growth process. Black areas show private houses.

(Fig. 1). In each quadrat, we marked all reed shoots and measured shoot density, height (H), and diameter at ground level (D). Aboveground biomass in each quadrat was estimated by the allometric relationship between D^2H and the dry weight of sampled shoots during the flight season of *M. hirosei* (late May to early August) in 2005. Light intensity was measured 20 cm above the water level in the community and simultaneously in a nearby open site with a digital luxmeter (IM-5, TOPCON) within 2 h of noon on cloudy days. Relative light intensity (RLI) was calculated as the ratio of light intensity in the community to light intensity in the open site. These measurements were taken at least once a month from April to October in 2003, 2004, and 2005.

RESULTS

COMMUNITY HEIGHT

In 2003, shoot growth began in early April in the original community. Reed height was 73 ± 3 (SE) cm in late April, and then increased gradually to 100 cm by mid-July (Fig. 2a). Reed height decreased in September because of shoot tip breakage. Most of the reed shoots were standing dead in October. In the new community, however, shoot growth was delayed and reed height was only 18 ± 1 cm in late April. In late May, when adult *M. hirosei* emerge, reed height was 40 cm, and then increased gradually to 60 cm by mid-September. Reed height in the new community was significantly lower than in the original community throughout the 2003 growing season ($p<0.001$, Mann-Whitney U test).

In 2005, the height of the original community in late April was 90 ± 2 cm, and then increased gradually to 160 cm by early July (Fig. 2b). The height of the new community was 88 ± 1 cm in late April, and increased to 140 cm in early July.

Reed height in the new community was significantly lower than in the original community from late May to early August 2005 ($p<0.001$, Mann-Whitney U test).

ABOVEGROUND BIOMASS

In 2005, the estimated aboveground biomass of the original community was 1067 ± 78 (SE) g m^{-2} in late May and 1285 ± 91 g m^{-2} in early August. Aboveground biomass of the new community was 744 ± 87 g m^{-2} in late May and 1321 ± 177 g m^{-2} in early August. Aboveground biomass differed significantly between the two communities in late May ($p<0.05$, Mann-Whitney U test) but not in early August ($p>0.05$, Mann-Whitney U test).

SHOOT DENSITY

In 2003, shoot density in the original community was 176 ± 40 (SE) m^{-2} in late April, and averaged 244 ± 15 m^{-2} during the *M. hirosei* flight season (Fig. 3a). Shoot density in the new community was 126 ± 26 m^{-2} in late April. The shoot density averaged 284 ± 13 m^{-2} during the flight season and increased until mid-September. Shoot density did not differ between the two communities during the growing season ($p>0.05$, Mann-Whitney U test), except in October ($p<0.05$, Mann-Whitney U test).

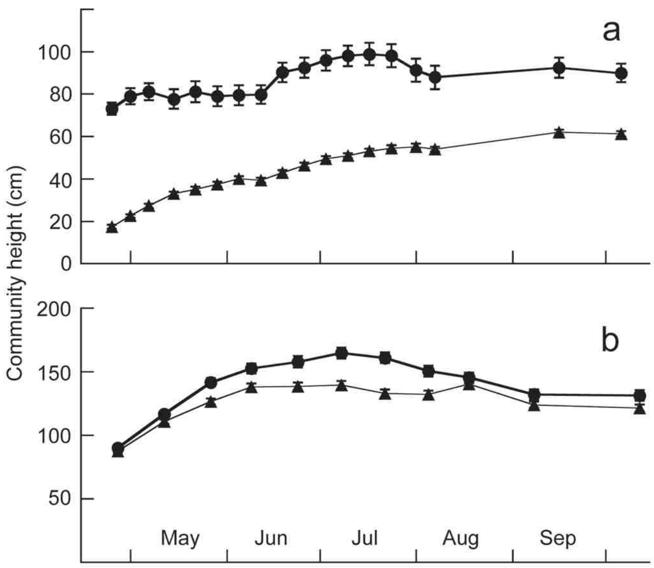

Fig. 2. Seasonal changes in community height in 2003 (a) and 2005 (b) (mean ± SE). Circles and triangles show the original and established reed community, respectively.

In 2005, shoot density in the original community was 228 ± 20 m^{-2}, with little change throughout the growing season (Fig. 3b). Shoot density in the new community was 250 ± 19 m^{-2} from late April to early August, and then decreased until the end of the growing season. Shoot density did not differ between the two communities (p<0.05, Mann-Whitney U test).

LIGHT CONDITIONS IN REED COMMUNITIES

The canopy of the reed communities created shade in the understory. In 2003, RLI 20 cm above the water level in the original community was about 40% in late April and decreased to 10% by late June. Mean RLI during the flight season was 20% (Fig. 4a). RLI in the new community was about 90% in late April and decreased until the end of growing season. RLI in the new community was significantly higher than in the original community from late April to late July (p<0.05, Mann-Whitney U test).

In 2005, RLI in the original community was about 20% in late April and about 6% after late May (Fig. 4b). RLI in the new community was about 20% in late April, decreased to 6% by late May, and increased gradually after early August. RLI in the new community was not significantly different than in the original community from late April to mid-August (p>0.05, Mann-Whitney U test).

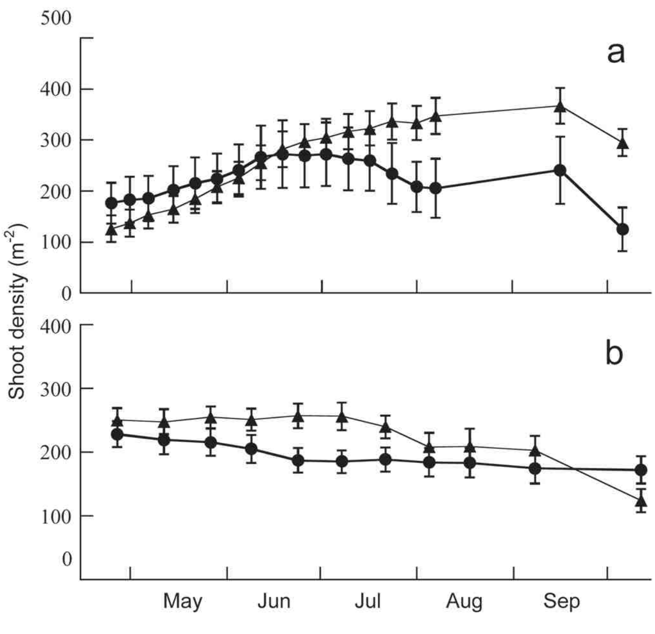

Fig. 3. Seasonal changes in shoot density of reed community in 2003 (a) and 2005 (b) (mean ± SE, n = 5). Circles and triangles show the original and established reed community, respectively.

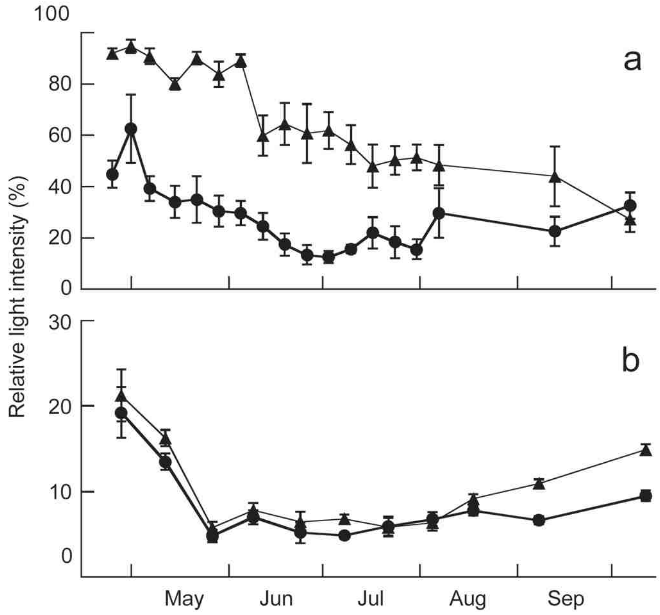

Fig. 4. Seasonal changes in relative light intensity 20 cm above the water level in 2003 (a) and 2005 (b) (mean ± SE, n = 5). Circles and triangles show the original and established reed community, respectively.

DISCUSSION

M. hirosei adults perch in the understory of dense reed communities where RLI is about 10% (WATANABE et al., 2002). In such dense communities, odonate species with low flight activity, such as *M. hirosei*, are able to move among perches (WATANABE & MIMURA, 2004), whereas species with higher flight activity, such as the predatory *Ischnura senegalensis* (Rambur), are not be able to move freely (NISYU, 1997). Therefore, suitable communities for adult *M. hirosei* should have high shoot density and a shaded understory. We found that newly created communities may not initially be suitable habitat for *M. hirosei*, but become more suitable as the communities develop.

In the first growing season after transplantation (2003), the new community had a higher number of shorter shoots than the original community. This growth pattern is thought to be a response to stress that occurs when reeds are damaged (CLEVERING, 1999; ARMSTRONG et al., 1996a, 1996b), suggesting that the transplantation process damaged the reed growth. This underdeveloped reed community resulted in higher light intensity in the understory during the flight season of *M. hirosei*. MATSU'URA & WATANABE (2004) found that *Anax parthenope julius* Brauer, *Orthetrum albistylum speciosum* (Uhler), and *Sympetrum* spp. oviposited in a newly created community. Many adult *I. senegalensis*, *I. asiatica* Brauer, and *Mortonagrion selenion* (Ris) were observed in the community during the first year of our study. Consequently, the new community seemed to be an unsuitable habitat for adult *M. hirosei* during the first year because it provided other odonate species with the open space they need for flight. For *M. hirosei*, it is necessary to maintain a higher shoot density without mowing dead standing shoots (MATSU'URA & WATANABE, 2004).

In the third year after transplantation (2005), the reeds in the new community were still shorter than those in the original community during the flight season of *M. hirosei*, although the new community was taller than it was in 2003. In the new community, low RLI in the understory (less than 10%) was maintained during the flight season of *M. hirosei*, as was a high shoot density. Consequently, the new community was a more suitable habitat for adult *M. hirosei* in 2005 than it was in 2003. The growth rate of spring shoots in the new community may be lower than that in the original community because the total aboveground biomass of the new community was lower than that of the original community in late May. Spring shoots grow using materials stored in the rhizome (GRANÉLI et al., 1992). If stored materials were used to recover from damage suffered during transplantation, they may have been less available for spring shoot growth in the new community. Newly formed rhizomes grow by the second year after transplantation and store materials for spring shoot growth after the third year (YUTANI & ASAEDA, 2002; ASAEDA et al., 2006). Thus, rhizomes formed after transplantation will act as storage organs after 2005, suggesting that the new community will develop further in the coming years. We expect that the new community will become an even more suitable habitat for *M. hirosei* after 2006.

YAMANE and colleagues (2004) transplanted reed rhizomes to conserve a *M. hirosei* population in a wetland along the Tone river in eastern Japan. There, the height of the new community was similar to that of the original one during the first year after transplantation, and adult *M. hirosei* were observed in the new community. However, 5 years later, no *M. hirosei* were observed in the community. Therefore, continuous monitoring of the reed community and the *M. hirosei* population are necessary in our new community. This study suggests that quantitative monitoring of the environmental conditions within a newly created habitat is necessary for the successful conservation of endangered species.

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CHLOROGOMPHINAE DRAGONFLIES OF GUIZHOU PROVINCE (CHINA), WITH FIRST DESCRIPTIONS OF *CHLOROGOMPHUS TUNTI* NEEDHAM AND *WATANABEOPETALIA USIGNATA* (CHAO) LARVAE (ANISOPTERA: CORDULEGASTRIDAE)

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Five species are recorded from the province, 4 of which are new for the region. *C. tunti* and *W. usignata* larvae are described based on the specimens reared in the laboratory. The adults are illustrated and some biological information is provided.

INTRODUCTION

The chlorogomphines species are rarely encountered and distributed mostly in mountainous areas of the Oriental Realm. The Chinese chlorogomphines have a high species diversity, over half of the known species were recorded from China (CHEN, 1950; CHAO, 1999; ISHIDA, 1996; KARUBE, 1995a, 1995b, 2001, 2002; WILSON & REELS, 2001; WILSON, 2002, 2005). However, the status of the (sub)family is somewhat confused (CARLE, 1995; KARUBE, 2002). CARLE (1995) elevated the Chlorogomphinae to the family rank, with two subfamilies, Chlorogomphinae and Chloropetalinae, which altogether include three tribes, containing eight genera. But KARUBE (2002) did not agree with Carle's opinion, he suggested Chlorogomphidae should be better treated as a subfamily of Cordulegastridae based on the features of male genitalia, the analysis of mitochondrial DNA, and especially on the morphological characters of larvae. Furthermore, KARUBE (2002) downgraded CARLE's (1995) subfamily Chloropetalinae to tribus Chloropetalini within the subfam-

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ily Chlorogomphinae, and established a new genus, *Watanabeopetalia*, which includes some species previously belonging to *Orogomphus, Chlorogomphus* and *Chloropetalia*. KARUBE (2002) and WILSON (2002) also regarded the new genera *Aurorachlorus* and *Sinorogomphus*, established by CARLE (1995), as subgenera of the genus *Chlorogomphus*. In this sense, we agree with Karube's classificatory arrangement.

The Guizhou province, located in southwestern China, is characterized by karst limestone arranged in steep hills and intermontane basins. Guizhou has a subtropical humid climate. The weather is frequently cloudy and rainy throughout the year. The temperature is moderate, not too cold in the winter, or hot in the summer. Annual rainfall averages to almost 1000-1300 mm and annual temperature averages to 15ºC approximately. Guizhou province, adjacent to Yunnan province, is usually regarded as one of the biodiversity "hotspots" in China.

Only a single Chlorogomphinae species, *Chlorogomphus papilio* Ris, was so far known to occur in this region (CAO, 2005; LI & JIN, 2006). Recently, we made several Odonata surveys in southwestern China. The results show a much higher Odonata species diversity in Guizhou than we expected. In addition to *C. papilio*, four more chlorogomphid species were collected: *C. tunti* Needham, 1930, *C. n. nasutus* Needham, 1930, *C. suzukii* (Oguma, 1926), and *Watanabeopetalia usignata* (Chao, 1999). What merits our special attention is that most Chinese chlorogomphine larvae are poorly known, so we focused on collecting their final instar larvae. These are difficult to be found, because, probably due to their long life cycle, their population density is quite low. In the field, at first sight, the Chlorogomphinae larvae are similar to those of Cordulegastrinae, but can be easily distinguished from the latter by the strongly divergent wing buds and by the frontal shelf on head.

In the present paper, we report on the adults of 5 species and describe the final instar larvae of *Chlorogomphus tunti* and *Watanabeopetalia usignata* for the first time. The association of larva and adult is confirmed by the specimens reared in the laboratory. Most of the larvae collected from Guizhou emerged successfully in two weeks' rearing in the laboratory.

All examined specimens are deposited in the Collection of Aquatic Insects and Soil Animals, Department of Entomology, South China Agricultural University, Guangzhou, China.

CHLOROGOMPHUS (*AURORACHLORUS*) *PAPILIO* RIS, 1927

Figure 54

Chlorogomphus papilio: RIS, 1927: 103-105, fig. 1; - NEEDHAM, 1930: 95-96, pl. 10, figs 4, 4a, 4b; – CHEN, 1950: 138, 144, 146-147, figs 1, 13; – YANG & DAVIES, 1996: 284; – WILSON, 2005: 112, 167 (b/w photo), colour photo on the journal cover.
Aurorachlorus papilio: CARLE, 1995: 391; – CHAO, 1999: 4.
Chlorogomphus (Aurorachlorus) papilio: WILSON, 2002: 66-67, figs 1-10.

Material. – 1 ♂, 20-VII-2008, Xiangzhigou reserve, Guizhou, China, 1200m, Zhang Haomiao leg.

DISTRIBUTION. – China (Guangdong, Guangxi, Fujian, Zhejiang, Sichuan and Guizhou), Laos, Vietnam and Burma.

DISCUSSION. – Both sexes possess wings coloured at the base. Although it is widely distributed in China, only few illustrations are available. The flight period in this area is from June to September. The larva is unknown. The male adult is shown in Figure 54. For the illustrations, see WILSON (2002, 2005).

CHLOROGOMPHUS (*SINOROGOMPHUS*) *N. NASUTUS* NEEDHAM, 1930

Figures 1-6, 56

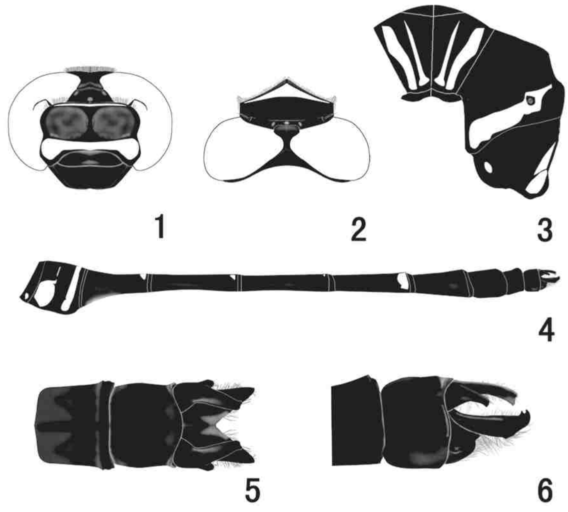
Chlorogomphus nasutus NEEDHAM, 1930: 97; – KLOTS, 1947: 3-4, figs 3-4, 7-8; – CHEN, 1950: 142, 144-147, figs 6, 18; – ASAHINA, 1956: 224-225, figs 42-45.
Chlorogomphus n. nasutus: WILSON, 2005: 112.
Sinorogomphus nasutus: CARLE, 1995: 390; – CHAO, 1999: 2.

Material. – 3 ♂, 20-VII-2008, Mt Fanjing, Guizhou, China, 1100m, Zhang Haomiao leg.

DISTRIBUTION. – China (Guangdong, Guangxi, Fujian and Guizhou) and N. Vietnam.

DISCUSSION. – A rather big montane species with antefrons triangularly protruded forwards. The abdomen is slim with a big yellow ring on segment 6. *Chlorogomphus kitawakii*, described by KARUBE (1995) possess similar protruded triangular antefrons. The two species can be easily separated from other congeners by the structure of antefrons and easily distinguished from each by the structure of caudal appendages.

During the surveys, many individuals were observed in Mt Fanjing. They fly usually very high over the mountains on forage. The males fly near the water in very sunny days for mating. They patrol over steep hill streams with high gradient in very small range, 3-4 m over the streams, and will



Figs 1-6. *Chlorogomphus n. nasutus* Needham, male, Guizhou, China: (1) head, frontal view; – (2) same, dorsal view; – (3) thorax; – (4) abdomen; – (5) caudal appendages, dorsal view; – (6) same, lateral view.

disappear in gloomy condition.

C. n. satoi is known to occur in North Vietnam (ASAHINA, 1995), and can be distinguished from the nominotypical subspecies by the yellow pattern on basal two abdominal segments.

CHLOROGOMPHUS (*SINOROGOMPHUS*) *SUZUKII* (OGUMA, 1926)

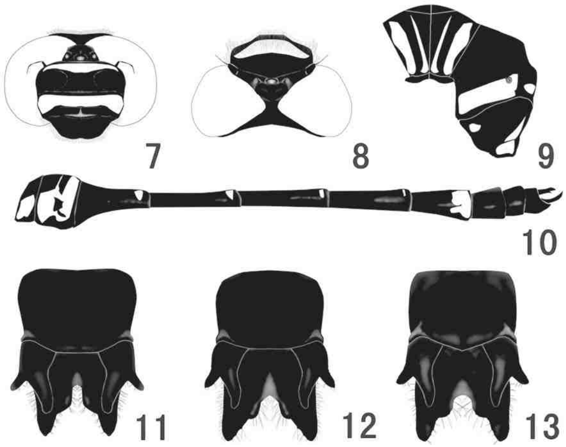
Figures 7-17, 55

Orogomphus suzukii: OGUMA, 1926: 88.
Chlorogomphus suzukii: KOBAYASHI, 1940: 326, fig. 3, pl. 1(1); – CHEN, 1950: 143-144, 146-148, figs 8, 20, 23; – ASAHINA, 1956: 222-224, figs 33-41.
Sinorogomphus suzukii: CARLE, 1995: 390; – CHAO, 1999: 2-3.

Material. – 1 ♂, 15-VII-2008, Mt Fanjingshan, Guizhou, China, 1100 m, Zhang Haomiao leg.

DISTRIBUTION. – China (Zhejiang, Guizhou and Taiwan)

DISCUSSION. – The single male from Mt Fanjing was compared with Taiwanese and Zhejiang *C. suzukii* specimens; its inferior caudal appendage is slightly different (Figs 11-13). This new distribution record is valuable, since *C. suzukii* was originally considered an eastern species known from Zhejiang and Taiwan. Body maculations of the specimens from the three localities is compared in Figures 14-17.



Figs 7-13. *Chlorogomphus suzukii* (Oguma), male, Guizhou, China: (7) head, frontal view; – (8) same, dorsal view; – (9) thorax; – (10) abdomen; – (11) caudal appendages, dorsal view; – (12-13) same, dorsal view: – [12: specimen from Zhejiang; – 13: specimen from Taiwan].

The flight period in Zhejiang lasts from May to September, the emergence takes place in mid May. Fully mature males usually patrol in the shady streams in uplands, flying low above the water surface. The oviposition occurs at noon, on the shallow edges of streams. An egg flock is formed first when the female is flying back and forth along the stream edge, and erect the body to put the eggs into water. When mating, the pairs fly higher and perch on the trees.

Figs 14-17. *Chlorogomphus suzukii* (Oguma): (14) male from Guizhou; – (15) male from Taiwan; – (16) male from Zhejiang; – (17) female from Zhejiang.

CHLOROGOMPHUS (*SINOROGOMPHUS*) *TUNTI* NEEDHAM, 1930

Figures 18-34, 52

Chlorogomphus tunti: NEEDHAM, 1930: 97-98; – KLOTS, 1947: 1-2, figs 1-2, 5-6, 9-10; – ASAHINA, 1956: 224-225, fig. 46.
Sinorogomphus tunti: CARLE, 1995: 390; – CHAO, 1999: 3.

M a t e r i a l. – 1 ♂, 1 ♀, 12-VII-2008, Xiangzhigou reserve, Guizhou, China, 1200 m, Zhang Haomiao leg; – 1 ♂, 1 ♀, 30-VII-2008, same locality and collector; – 1 ♂, 3-VIII-2008, same locality and collector.

1 final final stage larva, 10-V-2007, Xiangzhigou reserve, Guizhou, China, 1200 m, Zhang Haomiao leg; – 1 final stage larva, Mt Doupeng, 3-V-2007, Guizhou, China, 1200 m, Zhang Haomiao leg; – 2 exuviae, 10-V-2007, Xiangzhigou reserve, Guizhou, China, 1200 m, Zhang Haomiao leg. – The larvae emerged from 23-V-2007 to 26-V-2007 in the laboratory.

DESCRIPTION OF LARVA. – Medium sized larva in this family with the ground colour pale yellow (Fig. 18).

H e a d. – Squarish. Labrum and clypeus rectangle shaped. Postclypeus very narrow in width. Frontal shelf clearly projecting to form a trapezoid in dorsal view and triangle shaped in frontal view. Eyes rounded. Antennae short and fine, 7-segmented, its proximal two segment thick. Length ratio of 1-7 segments as follows: 0.28: 0.28: 0.34: 0.22: 0.22: 0.22: 0.22 (Fig. 22). Hind margin of head with thickset setae. Labial mask is of typical Chlorogomphinae type. The mental setae of prementum: 5+3 / 4+5. The median paired process of prementum V-shaped. The palpal lobes strongly developed, their inner margin with irregularly pointed teeth. The apex of all teeth darken in color. The outer margin of the lobes with a row of minute setae. The palpal setae: 4 / 4. Moveable hook long and pointed to the apex.

T h o r a x. – Pronotum strongly developed. Synthorax with long setae. Wing

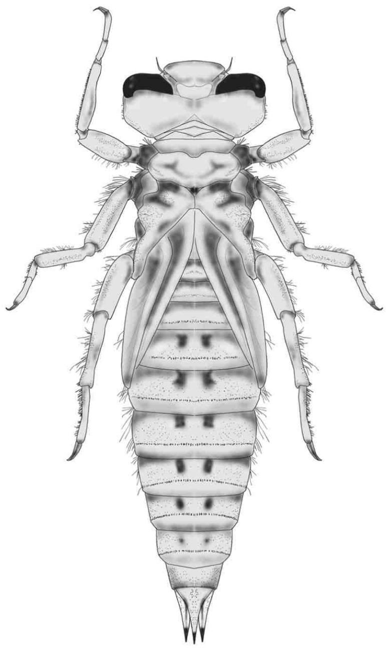
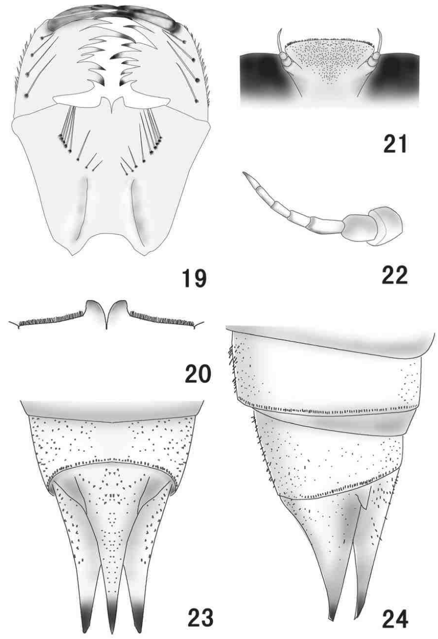


Fig. 18. *Chlorogomphus tunti* Needham, (Guizhou, China): larva, dorsal view.



Figs 19-24. *Chlorogomphus tunti* Needham, larva, Guizhou, China: (19) labial mask dorsal view; – (20) median process of prementum; – (21) frontal shelf, dorsal view; – (22) antenna; – (23) distal abdominal segments and caudal appendages, dorsal view; – (24) same, lateral view.

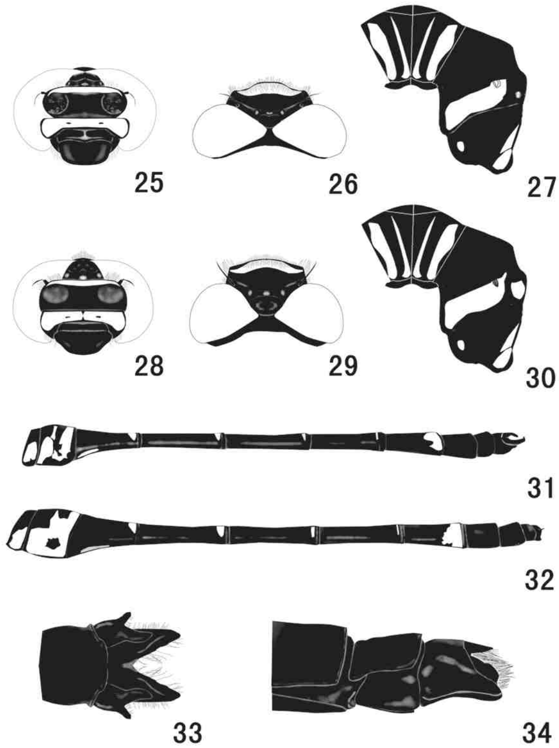
buds divergent, reaching the middle of 5th abdominal segment. Legs short and robust, tibiae and femur with long setae; tarsi 3-segmented with short setae.

A b d o m e n. – Cylindrical, broadest at the fifth segment and tapered to the end. Segments 1-9 with a pair of black dorsal spots. The spots on segment 1-3 and segment 9 ambiguous. Caudal appendages as shown in Figures 23-24. The epiproct and paraprocts are simple and sharply pointed.

M e a s u r e m e n t s (mm). – Body length 35.5-36.0, length of abdomen 23.5-24.0 (including caudal appendages), maximum width of head 8.0; length of hind femur 7.0-7.5; length of hind wing bud 8.0-9.5.

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

DISCUSSION. – *C. tunti* was described by NEEDHAM (1930) from a single female collected from Sichuan. KLOTS (1947) described the male in the American Museum from Mt Omei, Sichuan province. The types were compared with *C. nasutus* Needham, 1930 from which they can be separated by the big yellow ring on segment 7.



Figs 25-34. *Chlorogomphus tunti* Needham, Guizhou, China: (25) male, head, frontal view; – (26) same, dorsal view; – (27) male, thorax; – (28) female, head, frontal view; – (29) same, dorsal view; – (30) female, thorax; – (31) male, abdomen; – (32) female, abdomen; – (33) caudal appendages, male, dorsal view; – (34) same, female, lateral view.

C. tunti is a Chinese endemic species and distributed in western China. ZHANG & ZHANG (2006) recorded it from Shaanxi, and WANG (2007) from Henan. During the surveys conducted in 2007 and 2008, *C. tunti* was collected from the reserve in central Guizhou at an altitude of above 1000 m. The larvae emerged mid May, fully mature adults appear early in June. The males usually patrol along small mountain streams in open areas, in a steady and slow flight, staying less than 1 m above the water, sometimes closely approaching the surface. The females settle at the edge of the stream, searching for a suitable, shallow oviposition site. The flight period lasts in this area from May to September. The adults structural features are shown in Figures 25-34.

WATANABEOPETALIA USIGNATA (CHAO, 1999)

Figures 35-51, 53, 57

Chloropetalia usignata: CHAO, 1999: 8-11, figs 11-19.
Watanabeopetalia usignata: KARUBE, 2002: 84.

Material. – 2 ♂, 1 ♀, 13-VII-2008, Xiangzhigou reserve, Guizhou, China, 1200 m, Zhang Haomiao leg; – 1 ♀, 30-VII-2008, same locality and collector.

2 final stage larvae, 10-V-2007, Xiangzhigou reserve, Guizhou, China, 1200 m, Zhang Haomiao leg; – 1 exuviae, 2-V-2007, same locality and collector. – The larva emerged on 11-V-2007 in the laboratory.

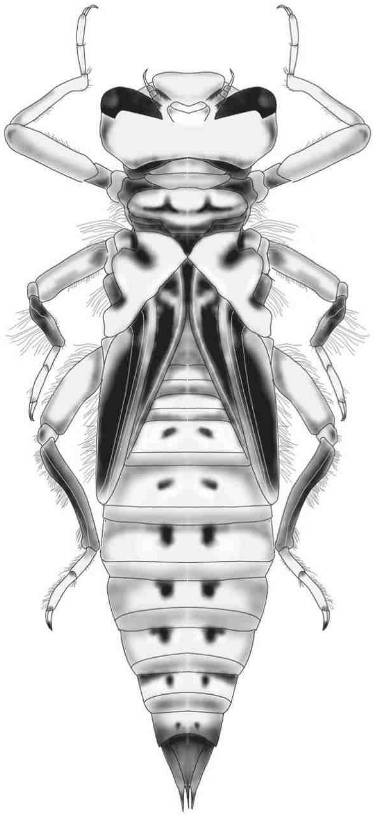


Fig. 35. *Watanabeopetalia usignata* (Chao) (Guizhou, China): larva, dorsal view.

DESCRIPTION OF LARVA. – Medium sized larva in this family with the ground colour ivory-white (Fig. 35).

H e a d. – Squarish. Labrum and clypeus rectangular. Frontal shelf clearly projecting to form a trapezoid in dorsal view with the anterior margin appreciably bent inwards in the middle. Eyes rounded and darkening in colour. Antennae short and fine, 7-segmented, proximal two segments thick. Length ratio of 1-7 segments as follows: 0.31: 0.31: 0.41: 0.23: 0.23: 0.22: 0.22. (Fig. 39). Hind margin of head with thickset setae. Labial mask is of typical Chlorogomphinae type. Mental setae of prementum: 5+4 / 4+5. The median paired process of prementum V-shaped with a dentate margin. Palpal lobes strongly developed, their inner margin with irregularly pointed teeth. Apex in all teeth dark. The outer margin of the lobes with a row of minute setae. Palpal setae: 4 / 4. Moveable hook long and pointed to the apex.

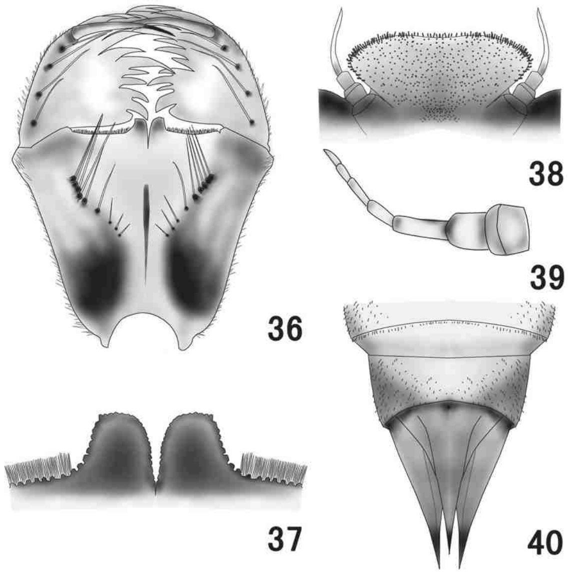
T h o r a x. – Pronotum strongly developed. Synthorax with long setae. Wing buds divergent, reaching the middle of the 5th abdominal segment. Legs short and robust, tibiae and femur with long setae; tarsi 3-segmented with short setae.

A b d o m e n. – Cylindrical, broadest at the fifth segment and tapered to the end. Segments 1-10 with a pair of black dorsal spots. Caudal appendages as shown in Figure 40. The epiproct and paraprocts are simple and sharply pointed.

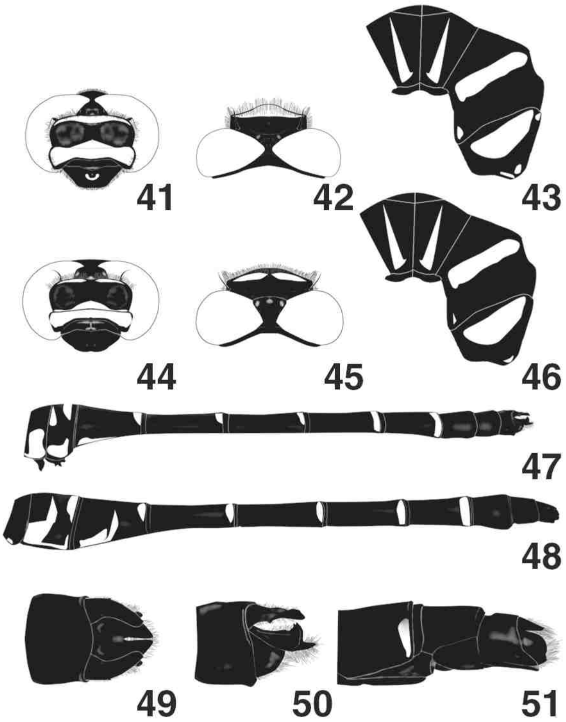
M e a s u r e m e n t s (mm). – Body length 34.0, length of abdomen 22.5 (including caudal appendages), maximum width of head 8.0; length of hind femur 7.0; length of hind wing bud 9.5.

DISTRIBUTION. – China (Shaanxi, Sichuan and Guizhou).

DISCUSSION. – *Watanabeopetalia usignata* is named after the unique U mark on the labrum, though the mark can also be missing in both sexes. The genus *Watanabeopetalia* was established by KARUBE (2002) for *Orogomphus atkinsoni* based on the male genitalia and the female valvula vulvae. *Chloropetalia usignata* was also assigned to this genus, based on the figures in CHAO (1999). The larvae emerge from mid May, and emergence can last to July. Fully mature adults are abundant from June to August. Males usually patrol along small mountain

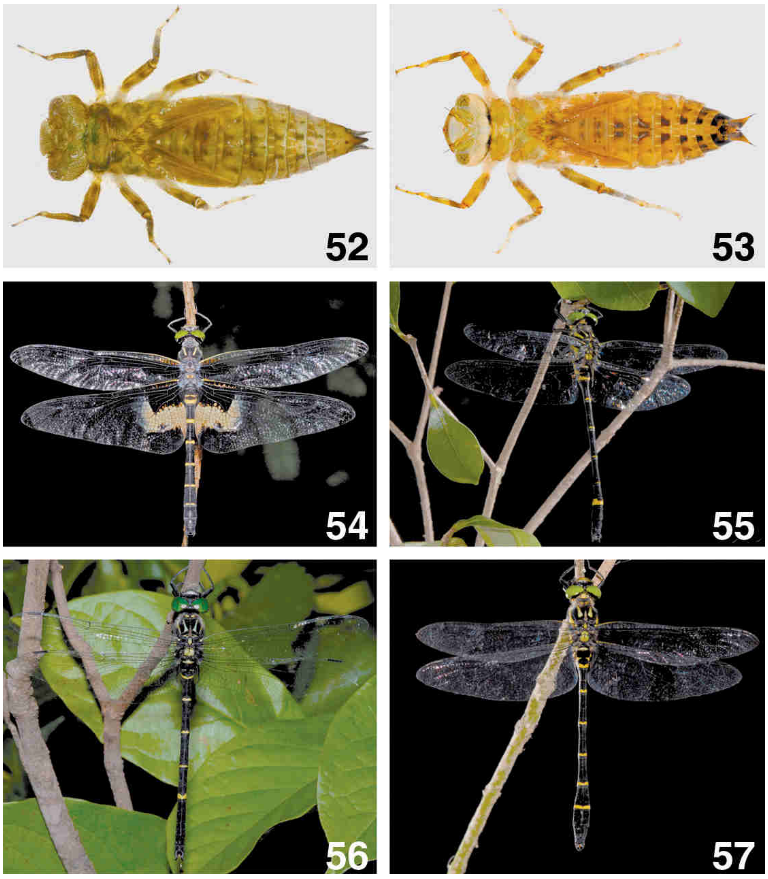


Figs 36-40. *Watanabeopetalia usignata* (Chao), larva, Guizhou, China: (36) labial mask, dorsal view; – (37) median process of prementum; – (38) frontal shelf, dorsal view; – (39) antenna; – (40) distal abdominal segments and caudal appendages, dorsal view.



Figs 41-51. *Watanabeopetalia usignata* (Chao), Guizhou, China: (41) male, head, frontal view; – (42) same, dorsal view; – (43) male, thorax; – (44) female, head, frontal view; – (45) same, dorsal view; – (46) female, thorax; – (47) male, abdomen; – (48) female, abdomen; – (49) male, caudal appendages, dorsal view; – (50) same, lateral view; – (51) female, caudal appendages, lateral view.

streams in open areas in a steady and slow flight, staying very closely above the water surface. The species co-occurs with *Chlorogomphus tunti*. Males of the two species fight for the territories. Females settle at the edge of the streams to choose a suitable place for oviposition in very shallow sections of the stream. Mating pairs fly higher and perch on the trees. The flight period in this area lasts from May to September. The adult structural features are presented in Figures 41-51.



Figs 52-57. (Figs 52-53) Final instar larva: (52) *Chlorogomphus tunti* Needham; – (53) *Watanabeopetalia usignata* (Chao); – (Figs 54-57) Adult male: (54) *Chlorogomphus papilio* Ris; – (55) *C. suzukii* Oguma; – (56) *C. n. nasutus* Needham; – (57) *Watanabeopetalia usignata* (Chao). – [Photos: Mo Shanlian]

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Odonatologica 39(4): 353-356 *December 1, 2010*

SHORT COMMUNICATIONS

OXYAGRION MIRNAE SPEC. NOV. FROM BRAZIL (ZYGOPTERA: COENAGRIONIDAE)

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The new sp. is described, illustrated and compared with the other 25 congeners. Holotype ♂: Virginia, Minas Gerais, Brasil, 3-II-2010; deposited in author´s collection.

INTRODUCTION

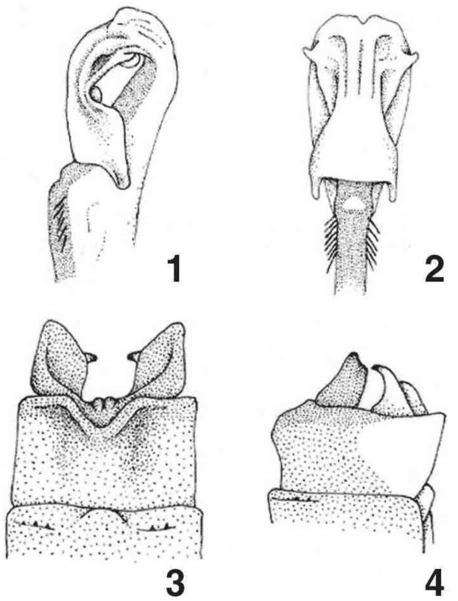
The taxonomy of the coenagrionid genus *Oxyagrion* has been hampered by lack of a clear definition of the characters separating it from its closer genus *Acanthagrion*. This has been recently provided by von ELLENRIEDER & LOZANO (2007) who recognized 25 species in the genus. Out of these 18 are from Brazil as described by SELYS (1876), CALVERT (1909), COSTA (1978, 1988) and COSTA et al. (2000, 2006). We describe herein *O. mirnae* sp. n. from the State of Minas Gerais.

OXYAGRION MIRNAE SP. NOV.

Figures 1-4

M a t e r i a l. – **Holotype** ♂: Brazil, State of Minas Gerais, Virginia, 14-II-2010, Fazenda dos Campos, 1500m, O. Mielke & M. Casagrande leg. – **Paratypes**: 3 ♂, same data as holotype. Specimens deposited in A.B.M. Machado collection, Belo Horizonte, Brazil.

E t y m o l o g y. – I dedicate this species to my good friend, Prof. M i r n a M. C a s a g r a n d e who collected the specimens and whose wanderings throughout South America, in search of butterflies, have very much contributed to my odonatological studies.



Figs 1-4. *Oxyagrion mirnae* sp. n., holotype: (1) penis in lateral view; – (2) same, ventral view; – (3) last abdominal segments, dorsal view; – (4) same, lateral view.

MALE (**holotype**). – Head. – Labium yellow, labrum greyish orange, anteclypeus and postclypeus orange brown, remainder parts of face and upper part of head brownish orange with a trident black markings in front of medium ocellus and an oblique dark stripe between lateral ocelli and eye. Behind this stripe the surface is stippled with black. Antennae black.

Thorax. – Pronotum brownish orange with a middorsal black line and transverse ones separating the lobes; a dorsal C shape dark band and another separating pronotum from propleuron. Propleuron light brown. Mesepisternum brownish orange with middorsal carina and adjacent area dark, mesepimeron and metepisternum brownish orange with a central greyish area. Metepimeron orange yellow. Humeral suture black, with a comma-shaped black elongated spot at its upper part and another at the upper limit of 2nd lateral suture.

Legs brown, lateral surface of femora black.

Wings hyaline, venation black peterostigma light brown trapezoid. Px in Fw 12 in Hw 12, R3 arising near Px 5 in both wings; Petiolation at Ac in both wings.

Abdomen. – S1-S6 greyish yellow with narrow black ring at the transverse sutures. S7 anteroventraly greyish yellow, dorsoposteriorly black, S8 black, S9 brown becoming greyish blue after soaking in 70% alcohol (Figs 1-2). It is most probably blue in the insect alive. After alcohol treatment a pair of black dots becomes visible at the dorsum of S9. S10 black with a pale (blue) dorso-lateral band partially connected medially with that of the other side. Cercus black. Paraprocts light brown.

STRUCTURAL CHARACTERS. – Hind prothoracic lobe bilobed the median lobe two-lipped and medially cleft. Penis (Figs 1-2) with lateral lobes (Fig. 2) at flexure, distally prolonged anterodorsally but not really bilobed (Figs 1-2). Hind border of S10 with a large V-shaped incisure (Fig. 3). Cercus in lateral view (Fig. 4) decumbent, about 2/3 the length of S10, with a short distal incisure. Paraprocts shorter than cercus (Fig. 4).

Measurements (mm). – Total length (31.0), Hw 19.1, abdomen 25.2

FEMALE. – Unknown.

VARIATION IN PARATYPES. – Colour of paratypes uniform. Venation as follows (including holotype). Px in Fw 12 (40%), 13 (60%), Px in Hw 11 (40%), 12 (60%), R3 in Fw and Hw arising near Px 5 (40%), 6 (60%). Petiolation at Ac (100%). Measurements (mm) including holotype. Total length 31.0-34.5 (mean 32.7), Hw 16.5-19.5 (mean 18.3), abdomen (with appendages) 24.7-27.6 (mean 26.2).

DISCUSSION

Oxyagrion mirnae has all diagnostic characters of the genus *Oxyagrion* as recently redefined by VON ELLENRIEDER & LOZANO (2007). It keys out to *O. brevistigma* Selys, 1876 in the general key of COSTA (1978) and in the more recent key of HECKMAN (2008) both based mainly on colour. The penis, the appendages and the shape of the pterostigma are very different from those of *O. brevistigma.* In the key of COSTA (1978), based mainly on the appendages, it keys out to *O. simile* Costa, 1978 but differs from this species by penis structure and by the presence of a pair of black dots on dorsal part of S9 (absent in *simile*). *O. mirnae* can be readily separated from the other species of the genus; except *O. abunae* Leonard, 1977 and *O. hermosae* Leonard, 1977 by its abdominal colour with no trace of red, being greyish yellow from S1-S6 whereas in the other species the genus is majorly red, carmin red or crimeson red or yellowish red in *O. brevistigma.* In *O. abunae* recently transfered to *Oxyagrion* from *Acanthagrion* (VON ELLENRIEDER & LOZANO, 2007), the abdomen also has no trace of red but the dominant colour is black dorsally and blue in the remainder aspects (VON ELLENRIEDER & LOZANO, 2007). In *O. hermosae* the abdomen is predominantly black throughout but in some areas it is deep cherry red or greenish yellow (LEONARD, 1977). Thus by its colour and structural characters *O. mirnae* is no doubt a new species of *Oxyagrion*.

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DESCRIPTION OF MALE *RHYOTHEMIS PHYLLIS APICALIS* KIRBY, 1889 (ANISOPTERA: LIBELLULIDAE)

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The ♂ allotype is described and illustrated from the Northern Province of New Caledonia, and compared with the *R. p. phyllis* from Thailand. The habitats of *R. p. apicalis* are described and a list of odon. spp. recorded during the 1999 and 2000 surveys is added.

INTRODUCTION

Rhyothemis phyllis apicalis is known from New Caledonia and Vanuatu (formerly New Hebrides). KIRBY (1889) described the holotype female from New Hebrides as a separate species, and the female was redescribed by RIS (1913, as a subspecies of *R. phyllis*). LIEFTINCK (1975) confirmed his description. Other references to this taxon were made by TEPPER (1899), MARTIN (1901), RIS (1915), KIMMINS (1936, 1958), DAVIES (2002) and MEURGEY (2006). The male apparently remained so far unknown.

The male allotype is described below. *R. phyllis apicalis* can be separated from the nominotypical subspecies by colour of the face, wing venation, wing spots and by structure of the anal appendages.

In addition, a list is appended of the species recorded from New Caledonia by two surveys, viz. in 1999 (funded by Northern Province, carried out during the dry season) and in 2000 (carried out by Falconbridge NC SAS mining company, during the low water season).

RHYOTHEMIS PHYLLIS APICALIS KIRBY, 1889

Figures 2, 5, 7

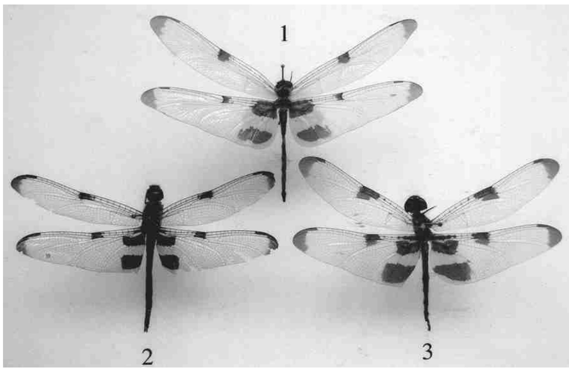
M a t e r i a l. – **Allotype** ♂: New Caledonia, Province Nord, Koné, Barrage anti-sel, 20-XI-1999; deposited in author's collection. – **Other specimens**: 2 ♂, New Caledonia, Province Nord, Koné, Rivière La Confiance, 7-X-2000; – 1 ♀, New Caledonia, Province Nord, Koné, Rivière La Népia, 20-XI-1999. – N o t e: Because of their poor condition of preservation, the 2 Confiance ♂ cannot be considered as paratypes.

FEMALE (**allotype**). – H e a d. – Labium brown-blackish; labrum wholly black; anteclypeus and postclypeus yellow-greenish; antefrons yellow-greenish; postfrons black; vertex black; antennae black; occiput black.

T h o r a x. – Evenly black, with bluish metallic glints.

Legs rather sturdy, black; base of femura brown.

Wings: apex of the wings rather rounded, giving the insect a quite stocky appearance. Number of antenodal cross-veins: Fw 9½ (100%); Hw either 6 (50%) or 7 (50%). Apical spot rather narrow, dark brown, starting at the distal end of the pterostigma. Nodal spot reduced, starting at the eighth antenodal cross-vein and ending halfway between the nodus and the first postnodal cross-vein; it fills the subnodal space up to R2 and beyond, surrounds the bridge cross-vein. Basal spot in Hw: anterior spot brown, covering the posterior half of the costal space between the first and the third antenodal cross-vein, the subcostal space between the first and the second antenodal cross-vein, the cubital space, the triangle, the distal half of the supratriangle, the first cells of the anal loop, the first cells of the anal field up to the membranule, and the first cells between MA and the anal loop; yellow spot, between the two brown spots, filling two rows of long cells of the anal field, and not passing the distal end of the brown spots; posterior spot brown, covering the end of the anal loop and of the anal field, leaving a yellow two-cell margin along the posterior edge of the wing (Figs 2-3, 5).

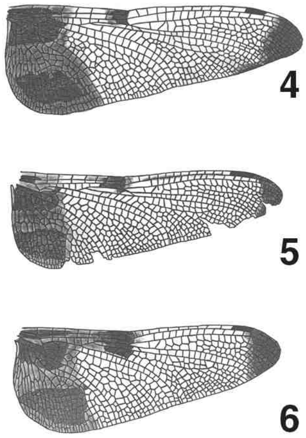


Figs 1-3. Habitus: (1) *Rhyothemis p. phyllis*, male (Thailand: Maetha, Lamphun); – (2) *R. phyllis apicalis*, male (New Caledonia: Koné, anti-salt dam); – (3) same, female (New Caledonia, Koné, Népia).

A b d o m e n. – Cylinder-shaped, evenly dull black, without metallic glints. Anal appendages: cerci black, distal half rather thickened, denticles of the ventral base of the distal half relatively small. Epiproct black, passing clearly the denticles of the cerci (Fig. 7).

Measurements (mm). – Total length 36.5; abdomen 24; Fw 32.5; Hw 30.

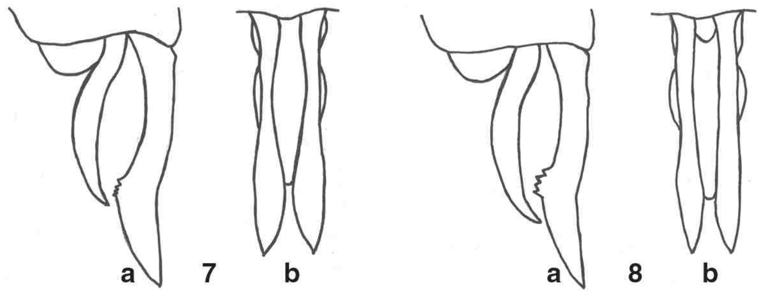
HABITAT. – The three sites (Koné, Confiance and Népia) are located within the Northern Province of New Caledonia, on the lower courses (elevation below 50 m) of the river, draining an area that consists mainly of peridotite and serpentinite rocks, characterized by low turbidity (ca 1 NTU) and a pH close to 8. The Népia and Confiance catchments are small (below 30 km^2) and the land there is uninhabited, hence their organic pollution is small. The Koné locality, on the other hand, lies close to the river mouth, at the anti-salt dam that prevents the intrusion of sea water. The drainage basin exceeds 150 km^2 and the river is subjected to anthropogenic impact from human and animal occupation.



Figs 4-6. Right hindwing: (4) *Rhyothemis p. phyllis*, male; – (5) *R. phyllis apicalis*, male; – (6) same, female.

DISCUSSION

The *R. p. apicalis* male is slightly smaller than the female, the hindwing of which can reach a length of 32 mm. The wing spots of the male are clearly more reduced than those of the female, in which the apical spot counts many more cells, the nodal spot reaches posteriorly R4+5, the anterior basal spot reaches the third antenodal cross-vein in the costal and subcostal spaces, and the posterior basal spot passes clearly the anal loop (Figs 3, 6).



Figs 7-8. Anal appendages: (7) *Rhyothemis phyllis apicalis*, male; – (8) *R. p. phyllis*, male (a) lateral view, (b) dorsal view.

The apex of the wings in *R. p. apicalis* is slightly rounder than that of *R. p. phyllis* which seems more slender. Two features of the wing spots differentiate the two taxa, in agreement with RIS (1913) and KIRBY (1889): (1) the yellow strip crossing the basal spot of the hindwing is narrower in *R. p. apicalis* than in *R. p. phyllis*; (2) in *R. p. apicalis*, only the subcostal and cubital spaces are wholly brown, the costal space being partly coloured, in *R. p. phyllis*, three basal spaces (subcostal, median and cubital) are wholly coloured by brown (Figs 1, 4). RIS (1913) notes that *R. p. apicalis* is a form smaller than *R. p. phyllis*. In addition, *R. p. apicalis* has, on average, fewer antenodal cross-veins, Fw 9½ and Hw 6 or 7, as against Fw 10½ (very rarely 9½) and Hw 7 (very rarely 6) in *R. p. phyllis*. Regarding the face, the labium in *R. p. apicalis* is very dark, brown-blackish, whereas it is bright yellow in *R. p. Phyllis*. Similarly, clypeus and anterior part of the frons are yellow-greenish in *R. p. apicalis* and yellow-whitish in *R. p. phyllis*. Finally, the cerci in *R. p. apicalis* males have a thicker distal part, the denticles on its ventral base are smaller and the epiproct is shorter than in the *R. p. phyllis* male (Figs 7, 8).

LIST OF ODONATA SPECIES COLLECTED DURING THE TWO SURVEYS

The objective of the 1999 and 2000 surveys was the analysis of water quality of the rivers, based on benthic macroinvertebrate fauna. Most of the recorded odonate species are apparently rather common in New Caledonia.

Coenagrionidae:
- *Agriocnemis exsudans* Sélys, 1877: Ile des Pins (6-VII-2000)
- *Ischnura heterosticta* (Burmeister, 1839): Koné (20-XI-1999)

Isostictidae:
- *Isosticta gracilior* Lieftinck, 1975: Yate (5-X-2000)
- *Isosticta tillyardi* Campion, 1921: Koumac (22-XI-1999)

Megapodagrionidae:
- *Caledopteryx maculata* Winstanley & David, 1982: Yate (29-X-1999)
- *Caledopteryx sarasini* (Ris, 1915): Koumac (22-XI-1999)
- *Trineuragrion percostale* Ris, 1915: Mont-Doré (18-X-1999)

Corduliidae:
- *Hemicordulia fidelis* MacLachlan, 1886: Ile des Pins (6-VII-2000); – Koné (7-X-2000)

Libellulidae:
- *Diplacodes haematoides* (Burmeister, 1839): Koumac (22-XI-1999); – Ile des Pins (6-VII-2000); – Kone (7-X-2000); – La foa (22-XI-1999)
- *Rhyothemis phyllis apicalis* Kirby, 1889: Koné (20-XI-1999); – Koné (7-X-2000)
- *Orthetrum caledonicum* (Brauer, 1865): Koumac (22-XI-1999); – Mont-Doré (18-X-1999)
- *Tramea transmarina intersecta* Lieftinck, 1975: Pouembout (8-X-2000)

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EPOPHTHALMIA BANNAENSIS SPEC. NOV., A NEW DRAGONFLY FROM YUNNAN, CHINA (ANISOPTERA: CORDULIIDAE)

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The new sp. is described and illustrated. Holotype ♂: China, Yunnan: Xishuangbanna Tropical Botanical Garden (21.55°N, 101.13°E), 500m, 4-VIII-2004; deposited at the Institute of Zoology, Shaanxi Normal University, Xi'an, China. It is related to *Epophthalmia frontalis* Selys, but is easily separated based on structural differences of the secondary and caudal genitalia and slight differences in colouration.

INTRODUCTION

The genus *Epophthalmia* was erected by Burmeister in 1839 to receive *Epophthalmia vittata*, the type species. To date, the genus includes 11 species and subspecies, which are distributed throughout Asia (VAN TOL, 2009; NEEDHAM, 1930; LIEFTINCK, 1931; FRASER, 1936; ASAHINA, 1987; WILSON, 1995, 2003; JIANG, 1998). *E. elegans* (Brauer, 1865), common in eastern and northern China, and *E. kuani* Jiang, 1998, from Jiangsu, have previously been recorded from China. This paper describes a new species of the genus from Yunnan.

EPOPHTHALMIA BANNAENSIS SP. NOV.

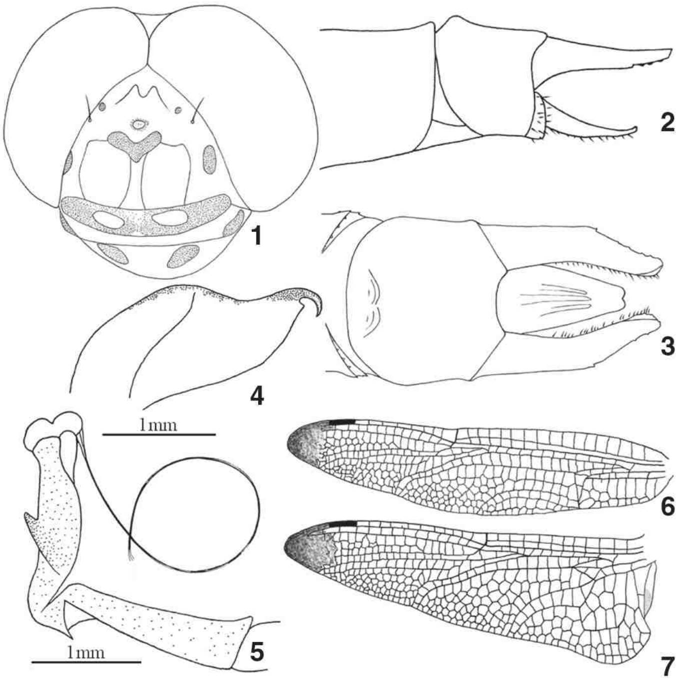
Figures 1-7

M a t e r i a l. – **Holotype** ♂: CHINA: Yunnan prov.: Xishuangbanna Tropical Botanical Garden (21.55°N, 101.13°E), 500m, 4-VIII-2004, L.-S. Zha leg., deposited at the Institute of Zoology, Shaanxi Normal University, Xi'an, China. – **Paratype**: 1 ♂, same locality and date, L.-S. Zha leg.

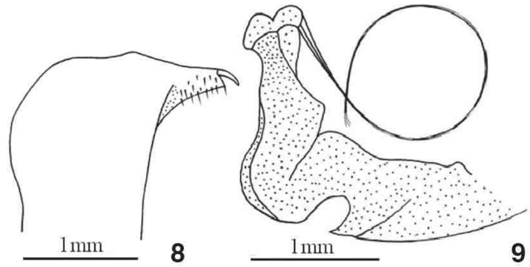
E t y m o l o g y. – The new species is named after Xishuangbanna, Yunnan prov., its type locality.

MALE. – H e a d. – Face with short black hairs. Labium, labrum, and anteclypeus reddish-brown, labrum with two small symmetrical citron-yellow spots which are located close to the anteclypeus. Base of mandible marked with a small yellow spot. Postclypeus citron-yellow, heavily margined below with reddish--brown and enclosing two median symmetrical spots of the same color, and with two small symmetrical quadrate spots of citron-yellow at basal sides. Frons and vesicle dark metallic green, marked on each side in front with a rounded yellow spot and above, on each side of the sulcus, with a rounded yellow spot which are connected together. Between the lateral ocelli there are two small prominences coloured metallic green. Antennae blackish-brown. Eyes reddish-brown. Occiput glossy black, a triangular carina-shaped with brown hairs.

T h o r a x. – Prothorax wholly reddish-brown. Synthorax dark reddish-brown, with some yellowish thin coating of hairs, the upper part of dorsum with dark green metallic reflections, sides brown with a reduced metallic blue reflection marked with yellow as follows: narrow antehumeral stripe slightly tapered above and an oblique narrow stripe, at each side at the level of the spiracle, which is slightly broader above than below, and narrowly interrupted by a transverse protuberant line.



Figs 1-7. *Epophthalmia bannaensis* sp. n., holotype male: (1) head, oblique frontal view; – (2, 3) caudal appendages; – (4) posterior hamule, lateral view; – (5) penis, lateral view; – (6, 7) left wings.



Figs 8-9. *Epophthalmia elegans*: (8) posterior hamule, lateral view; – (9) penis, lateral view.

Wings hyaline, venation black, with slightly smoky tint; membrane white, brownish at its junction with wing-membrane; nodal index of forewings 7:16 /15:7; hindwings 11:11 / 10:9; five cubital nerves in the forewings, three in the hind; anal loop of 9-10 cells, one of which is central; costal nerve with fine yellow line; pterostigma black, covering nearly two cells (see Figs 6-7). Legs black, except the reddish-brown of coxa and trochanter; membranous keels white.

A b d o m e n. – Black with yellow marks. Segments 1-2 inflated, S1 dark reddish-brown, S2 with a narrow bright yellow ring, not meeting the base at the dorsum but expanding obliquely towards it laterally, upper and lower parts slightly narrower than lateral, completely occupying the auricle; S3-7 with a broad yellow ring, S3-4 at the sub-base, S3 lower part suddenly broader ventrally, S5-7 at the base; S8 with a narrow basal triangle of yellow on the dorsum; S7-9 with ventral dark reddish-brown spots, S10 wholly reddish-brown, with but a basal vestige of degeneration, and two basal tubercles.

Anterior hamule short, obtuse; posterior hamule robust, with a distal hook; tip of penile organ with three long flagella, each flagella with a length of 5 mm and curved apically. Caudal appendages reddish-brown, blackish distally, with short black hairs. Superior appendages slightly longer than segment 10, curved slightly toward inside, contracted at mid-point, outer margin with some black teeth on apical half; inferior appendage with long ventral hairs, decidedly shorter than superior appendages, triangular, compressed, narrow, curved slightly upwards, the apex truncate and finely emarginated.

M e a s u r e m e n t s (in mm). – Length of abdomen (including appendages): 55.5; appendage: 3.5; hindwing: 50.5; pterostigma: 3.5.

Table I
Comparison between *Epophthalmia bannaensis* sp. n. and *E. f. frontalis* males

	E. bannaensis sp. nov.	*E. f. frontalis*
Segment 1	Dark reddish-brown without ring	Black with a narrow ring
Appendages	Inferior decidedly shorter than superiors appendages	Inferior appendage decidedly longer than superior appendages
Pterostigma	Black	Blackish-brown
Legs	Black, except the reddish-brown of coxa and trochanter	Blackish-brown

FEMALE and LARVA. – Unknown.

REMARKS. – The new species is similar to *Epophthalmia f. frontalis* Selys, 1871, known from Assam, western Himalaya and northern Thailand (LIEFTINCK, 1931; FRASER, 1936; ASAHINA, 1987), but can be separated by the characters listed in Table I.

In addition the structure of the penile organ and the shape of posterior hamule (Figs 4, 5) of the new species are markedly different from that of *E. f. frontalis* as figured by ASAHINA (1987), *E. elegans* (see Figs 8-9) and *E. kuani* (Jiang, 1998).

DISCUSSION. – Thirteen specimens of *E. elegans* males from Yunnan, Shanxi, Jiangsu, Anhui and Shandong province, China were studied. All their penile organs possessed three long flagella. So we can surmise the description of two flagella for *E. elegans* in SUI & SUN (1984) is incorrect.

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ODONATOLOGICAL ABSTRACTS

1992

(18062) DE MARCO, P., Jr, 1992. *Community structure and co-occurrence of larval odonate species: a morphological approach*. Tese Mestre Ciên. Biol., Univ. Campinas. ix+80 pp. (Port., with Engl. s.). – (Lab. Ecol. Teóretica, Depto Biol. Geral, Univ. Fed. de Goiás, BR-74001-970 Goiánia, GO).

Studies on odon. larvae have shown the existence of feeding territories, suggesting that competition for foraging patches may be an important factor in community structuring. Field studies however have failed to demonstrate competition, and have suggested that fish predation and cannibalism among larvae are important regulating factors. Here, the co-occurrence patterns among larvae in several aquatic plants are examined in order to evaluate the importance of these interactive processes to the explanation of the observed patterns. Odon. were sampled on aquatic plants in the states of Minas Gerais and São Paulo (Brazil). 14 measures were taken of the body, head and labium of each individual. Cluster analysis showed 2 types of communities associated with macrophytes of distinct architecture. The submerged Egeria densa, Myriophyllum brasiliense and the emergent Eleocharis mutata had Ischnura fluviatilis, Micrathyria hesperis, Erythrodiplax sp. and Acanthagrion sp. as dominants, whereas the floating Eichhornia crassipes and Salvinia sp. were dominated by Miathyria simplex and Telebasis filiola. The morphometry data demonstrated convergence within the sets. The spp. characteristic of floating plants have greater eye width and smaller anterior, medium and posterior femur length, when compared to the spp. living in submerged and emergent macrophytes. In order to test the importance of interactive processes as determinants of the morphological patterns of co-occurring spp. (limited similarity hypothesis), null models were built representing the expected patterns if the communities were assembled through random selection from the sampled spp. The Egeria densa community showed smaller morphometric distances among spp. than that expected by chance, suggesting convergence mechanisms in relation to possible colonizing morphologies. The larvae in Myriophyllum brasiliense tended to separate more than expected by chance, suggesting an effect of interspecific competition. The consistency between 2 different null model constructions was an interesting way to evaluate the behaviour of the statistical test, in the identification of non-random patterns. It is suggested as an important methodological approach.

2000

(18063) PONTA, U., 2000. Makrozoobenthische Bestandsaufnahme an zwei Kärntner Bäche (Wölfnitz und Wimitz) und deren Analyse. *Carinthia* (II) 190/110: 635-640. – (Kärntner Inst. Seenforschung, Flatschacher Str. 70, A-9021 Klagenfurt).

Includes a reference to the recorded Calopteryx splendens and Onychogomphus forcipatus, but without the exact localities (central Carinthia, Austria).

(18064) PORNSIN-SIRIRAK, T.N., S.W. LEE, H. NASSEF, J. GRASSMEYER, Y.C. TAI, C.M. HO & M. KEENNON, 2000. MEMS wing technology for a battery-powered ornithopter. *Proc. 13th IEEE annu. int. Conf. MEMS*, Miyazaki, 6 pp. (not paged). – (First Author: Caltech Micromachining Lab., 136-93, Pasadena, CA 91125, USA).

The "ornithopter" is a technical term for a Micro Aerial Vehicle (MAV), flying by flapping wings (total wingspan less than 15 cm, weight 7-10 g). A novel wing technology, developed using titanium-alloy metal as wingframe and parylene C as wing membrane, is described. A reference is made to the earlier fabricated silicon dragonfly wings. However, silicon wingframes were too fragile, therefore it was now replaced by a new process using titanium-alloy.

2001

(18065) KAGAN, J. et al., 2001. *Rare, threatened and endangered plants and animals of Oregon*. Oregon Natural Heritage Program, Portland/OR. 94 pp. ISBN none. – (Publishers: 1322 S.E. Morrison St., Portland, OR 97214-2531, USA).
Includes a commented list of 4 odon. spp., of which 3 spp. are considered too common, while for Gomphus lynnae the Heritage Rank and Federal Status are stated.

(18066) MEADS, M.J. & B.M. FITZGERALD, 2001. List of invertebrates on Mokoia Island, Lake Rotorua. *Conserv. advisory Sci. Notes* 341: ii+9 pp. – (Ecol. Res. Associates of New Zealand, P.O. Box 48-147, Silverstream, Upper Hutt, NZ).
Hemicordulia australiae is the only odon. sp. encountered during a 3-day survey in Feb. 2000; – North Island, New Zealand.

(18067) PERRON, J.-M. & Y. RUEL, 2001. Addition à la faune odonatologique du territoire du marais Léon-Provancher, Neuville, Québec. *Naturaliste can.* 125(1): 37-38. – (First Author: 506-963, rue Gradjean, Sainte Foy, QC, G1X 4P9, CA).
8 spp. are added to the paper listed in *OA* 13309, bringing the number of the spp. known from this locality up to 50.

(18068) YAGI, T. & K. KITAGAWA, 2001. A survey of the dragonflies in the Klias and Binsulok Forest Reserves, Sabah, Malaysia. *Nature & human Activities* 6: 31-39. – (First Author: Div. Nat. Hist., Mus. Nature & Human Activities, Hyogo, Yayoigaoka 6, Sanda, Hyogo, 669-1546, JA).
A commented list of 28 spp., of which 22 spp. from the Klias Forest Reserve and 21 spp. from that of Binsulok.

2002

(18069) FELLOWES, J.R. et al., [Eds], 2002. Report of a rapid biodiversity assessment at Huaping National Nature Reserve, Northeast Guangxi, China, 15 to 20 August 1998. *Sth China Forest Biodiv. Surv. Rep. Ser.* 15 (Online Simplified Version): ii+22 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
A commented checklist of 26 recorded odon. spp.

(18070) PERRON, J.-M. & Y. RUEL, 2002. Saison de vol des odonates du territoire du marais Léon-Provancher, Neuville, division de recensement de Fortneuf (Québec). *Naturaliste can.* 126(2): 13-17. – (First Author: 506-963, rue Gradjean, Sainte Foy, QC, G1X 4P9, CA).
The first and last sighting dates are given for adults of the 50 spp. in the Provancher marsh (cf. *OA* 13309 and 18067) and compared with those hitherto known from Quebec, Canada.

2003

(18071) CHAN, B.P.L. et al., [Eds], 2003. Summary of findings from some rapid biodiversity assessments in West Guangxi, China, July 1999. *Sth China Forest Biodiv. Surv. Rep. Ser.* 36 (Online Simplified Version): ii+15 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
Includes lists of Odon. recorded from Gulongshan Nature Reserve (9 spp.), Nongxin Nature Reserve (2 spp.), Nonghua Nature Reserve (6 spp.), Bailing Tun (5 spp.), and from Daxin Nature Reserve (12 spp.).

(18072) DOODY, K. & O. HAMERLYNCK, 2003. Biodiversity of Rufiji district. *Rufiji Envir. Mngmt Project tech. Rep.* 44: 11+101 pp. – (Rufiji Environment Management Project, P.O. Box 13513, Dar es Salaam, Tanzania).
The district is situated S of Dar es Salaam, Tanzania. 69 odon. spp. were hitherto recorded, including Ceriagrion mourae and Gynacantha immaculifrons that are here recorded for the first time since their type description (from Mozambique and Democratic Republic of Congo, respectively). 8 spp. are of conservation concern. All spp. are listed in a table, along with the types of habitat where they occur.

(18073) FELLOWES, J.R. et al., [Eds], 2003. Report of rapid biodiversity assessment at Shiwandashan National Nature Reserve and National Forest Park, Southwest Guangxi, China, 2000 and 2001. *Sth China Forest Biodiv. Surv. Rep. Ser.* 35 (Online Simplified Version): ii+30 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
During the survey only 4 odon. spp. were recorded, including Megalestes sp. n., which is different from another undescribed congener, collected in Damingshan in 2000 and in Xidamingshan in 1998. Many more spp. were recorded in 1997; some of these (forest-associated) are listed.

(18074) SAMSON, N., 2003. *Étude du degree de dispersion et des facteurs favorables à la reproduction de la Cordulie à corps fin, Oxygastra curtisii (Dale, 1834), dans les Mauges (49)*. Centre permanent d'initiatives pour l'environnement, Beaupreau. 73 pp. – (Publishers: Maison de Pays "La Loge", F-49600 Beaupreau).
A study of O. curtisii population biology and dispersal in the department of Mauges, France, based on mark-recapture of adults and on exuviae. The life history is described and the distribution of the sp. in France and in the department is mapped.

2004

(18075) CHAN, B.P.L. et al., [Eds], 2004. Report of rapid biodiversity assessment at Dachouding and Sanyue Nature Reserves, Northwest Guangdon, China, April 2001. *Sth China Forest Biodiv. Surv. Rep. Ser.* 37 (Online Simplified Version): ii+33 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
A checklist of 9 recorded odon. spp.

(18076) CHAN, B.P.L. et al., [Eds], 2004. Report of a rapid biodiversity assessment at Dawuling Nature Reserve, Southwest Guangdong, China, June/July 2002. *Sth China Forest Biodiv. Surv. Rep. Ser.* 38 (Online Simplified Version): ii+19 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
A checklist of 13 recorded odon. spp.

(18077) CHAN, B.P.L. et al., [Eds], 2004. Report of a rapid biodiversity assessment at Heishiding Nature Reserve, West Guangdong, China, July 2002. *Sth China Forest Biodiv. Surv. Rep. Ser.* 39 (Online Simplified Version): ii+19 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
A habitat annotated list of 37 recorded odon. spp.

(18078) CHAN, B.P.L. et al., [Eds], 2004. Report of a rapid biodiversity assessment at Luokeng Nature Reserve, North Guangdong, China, September 2002. *Sth China Forest Biodiv. Surv. Rep. Ser.* 40 (Online Simplified Version): ii+19 pp. – (Kadoorie Farm & Bot. Garden, Lam Kam Rd, Tai Po, N.T., Hongkong, SAR, China).
A checklist of 23 recorded odon. spp.

(18079) RAMANUJAM, M.E. & B. VERZHUTSKII, 2004. On the prey of spotted owlet Athene brama (Temminck), in a forested ravine in Auroville, Pondicherry. *Zoos' Print J.* 19(10): 1654-1655. – (First Author: Pitchandikulam Bio-Resour. Cent., Auroville, Pondicherry-605101, India).
In the 197 pellets of a nesting pair, collected during 2 breeding seasons at its habitual nesting site, 2122 food items (pertaining mostly to insects of 11 orders and mice), including the remains of a single odon. individual, were identified.

(18080) RAMANUJAM, M.E. & B. VERZHUTSKII, 2004. The prey of the greater false vampire bat, Megaderma lyra E. geoofroy, at Kaliveli, Tamil Nadu. *Zoos' Print J.* 19(10): 1655-1656. – (First Author: Pitchandikulam Bio-Resour. Cent., Auroville, Pondicherry-605101, India).
Kaliveli is dominated by a lake that is said to be one of the 2 most important wetlands along the Coromandel Coast of S India. In a random sample of faeces, 3936 prey items were identified, including the remains of 15 odon. individuals.

(18081) RAMANUJAM, M.E. & B. VERZHUTSKII, 2004. Prey of the Indian pipistrelle bat, Pipisstrellus coromandra (Gray), at Auroville, southern India. *Zoos' Print J.* 19(12): 1720. – (First Author: Pitchandikulam Bio-Resour. Cent., Auroville, Pondicherry-605101, India).
Among 267 araneid and insect prey items, 2 odon. specimens were identified in the faeces.

2005

(18082) *KAWARTHA HIGHLANDS SIGNATURE*

SITE [PARK]: Management plan background information, 2005. Ontario Parks. 104 pp. ISBN 0-7794-9039-8. – (Kawartha Highlands Signature Site Park, P.O. Box 500, 106 Monck St., Bancroft, ON, K0L 1C0, CA).
Based on the Atlas of Ontario Odonata database (2001), 74 odon. spp. are known to have been recorded from Kawartha Highlands or from within 3 km of the boundary (a checklist is not provided here). The Park is located 50 km N of Peterborough, Ontario, Canada.

(18083) PERRON, J.-M., L.-J. JOBIN & A. MOCHON, 2005. Odonatofaune de la Yamaska, division de recensement de Shefford, Québec. *Naturalist can.* 129(2): 17-25. – (First Author: 506-963, rue Gradjean, Sainte Foy, QC, G1X 4P9, CA).
A commented list of the 68 spp. known from the Yamaska National Park. The fauna is compared with species lists from 3 other regions in southern Quebec, Canada.

(18084) TOTH, S., 2005. Monitoring dragonflies on the section of the Dráva between Ortilos and Vizvár (Insecta: Odonata). *Natura somogyensis* 7: 35-48. (With Hung. s.). – (Széchenyi u. 2, HU-8420 Zirc).
The operation of a power plant projected on the Croatian section of the Drava (at Novo Virje) could trigger unfavourable changes in the odon. fauna on the Hungarian side, where the shallow wetlands are particularly vulnerable. Here, the results are presented of a 5-yr monitoring (2000-2004), with particular reference to the current status of the 14 in Hungary red-listed spp. and to 5 spp. listed in the Berne Convention.

(18085) TOURENQ, C., I. BARCELO, A. KUMARI & C. DREW, 2005. *The terrestrial mammals, reptiles and invertebrates of Al Wathba wetland reserve: species list and status report*. Terrestrial Envir. Res. Cent., Abu Dhabi. 11+26 pp. – (Publishers: Environmental Research & Wildlife Development Agency, P.O. Box 45553, Abu Dhabi).
Presents a checklist of 9 odon. spp. recorded from the Reserve; – Abu Dhabi.

(18086) VANAPPELGHEM, C., 2005. Statut de Sympetrum flaveolum (L., 1758) dans la région Nord – Pas-de-Calais. *Héron* 38(1/2): 107-113. – (15 rue Brulé Maison, F-59000 Lille).
The status of S. flaveolum in the region Nord – Pas-de-Calais (France) is reviewed, and the known localities are mapped.

(18087) VENTURELLI, P.A. & W.M. TONN, 2005. Invertivory by northern pike (Esox lucius) structures communities of littoral macroinvertebrates in small boreal lakes. *Jl N. Am. benthol. Soc.* 24(4): 904-918. – (Second Author: Dept Biol. Sci., Univ. Alberta, Edmonton, AB, T6G 2E9, CA).
Although the pike is normally piscivorous, its occurrence triggers a shift in the macroinvertebrate community from large conspicuous taxa (e.g. odon.) toward less conspicuous taxa such as dipterans and trichopterans, as it is shown here experimentally on a small boreal lake in N-central Alberta, Canada.

2006

(18088) KARSCH, A., 2006. *Naturschutzfachliches Rahmenkonzept für das Westliche Dachauer Moos. Grundlagenplanung für ein Projekt im BayernNetz Natur*. Diplomarbeit. Hochschule Anhalt. 204 pp.
31 odon. spp. are listed from the area, including the locally important Calopteryx splendens, C. virgo, Sympecma fusca and Orthetrum coerulescens.

(18089) PFEIFFER, B.M., 2006. *The dragonflies and damselflies of Teal Farm, Huntington, Vermont*. Wings Environmental, Plainfield/VT. iv+10 pp. – (113 Bartlett Rd, Plainfield, VT 05667, USA).
The fauna is described (36 spp. + 2 on genus level only) and annotations are provided on some notable taxa.

(18090) SKILSKY, I.V., L.N. KHLUS & L.I. MELESHCHUK, 2006. Trophic relations of Stonechat of the Prut-Dniester interfluve of Ukraine and Bukovinian Carpathians. *Ekologiya*, Berkut 15(1/2): 132-137. (Russ., with Engl. s.). – (First Author: P.O. Box 532, UKR-58001 Chernivtsi).
In the stomachs of the birds (Saxicola torquata) from the Chernivtsi region (W Ukraine), Coenagrion hastulatum, Gomphus vulgatissimus and Aeshna cyanea were found among the remnants of 164 animal food components.

(18091) TOSH, C.R. & G.D. RUXTON, 2006. Artificial neural network properties associated with wiring patterns in the visual projections of vertebrates and arthropods. *Am. Nat.* 168(2): E38-E52.

– (Div. Envir. & Evol. Biol., Inst. Biomed. & Life Sci., Univ. Glasgow, Glasgow, G12 8QQ, UK).
The functioning is modelled of different wiring schemes in visual projections, using artificial neural networks and it is speculated on selective factors underlying taxonomic variation in neural architecture. Generally, arthropod networks are as efficient or more efficient in functioning compared to vertebrate networks. They do not show the confusion effect (decreasing targeting accuracy with increasing input group size). Unfortunately, little is known on the detailed neuroanatomy of the insect spp. in which the confusion effect is best established (Aeshna cyanea) and, generally, the peripheral visual and optic lobe neuroanatomy of Odon. is less well characterized than that of Diptera and Crustacea.

(18092) TULONEN, T., M. PIHLSTRÖM, L. ARVOLA & M. RASK, 2006. Concentrations of heavy metals in food web components of small boreal lakes. *Boreal Envrmt Res.* 11: 185-194. – (First Author: Lammi Biol. Stn, Univ. Helsinki, Pääjärvent 320, FI-16900 Lammi).
The Cd, Cr and Pb concentrations in Odon. from the Tavilampi and Horkkajärvi lakes (S Finland) are stated.

(18093) VAN SWAAY, C., D. GROENENDIJK & C. PLATE, 2006. *Monitoring butterflies and dragonflies in the Netherlands in 2005*. Rapp. VS2006.020, De Vlinderstichting, Wageningen. 29 pp. (Dutch, with Engl. s.). – (De Vlinderstichting, P.O. Box 506, NL-6700 AM Wageningen).
The odon. were counted every fortnight (May-Sept) at 328 sites. Enallagma cyathigerum was the most common sp. (over 70.000 individuals) and Ischnura elegans was the most widespread sp. (almost 20.000 individuals). An alarming decrease in Aeshna viridis and Coenagrion hastulatum was noticed, whereas another Red List sp., Calopteryx virgo, shows a positive trend.

2007

(18094) BESSE-LOTOTSKAYA, A., R.C.M. VERDONSCHOT, P.F.M. VERDONSCHOT & J. KLOSTERMANN, 2007. Doorwerking klimaatverandering in KRM-keuzen: casus beken en beekdalen (literatuurtudie). – [Effect of climate change on the Netherlands government policies: the case of brooks and brook valleys (a study of literature)]. *Alterra-Rapp.* 1536: 1-134. (Dutch). – (Alterra, P.O. Box 47, NL-6700 AA Wageningen).
Includes a review of ecological preferences and tolerances of selected odon. spp.

(18095) BOTELHO, M.L.L.A., L.M. GOMIERO & F.M.S. BRAGA, 2007. Feeding of Oligosarcus hepsetus (Cuvier, 1829) (Characiformes) in the Serra do Mar State Park, Santa Virginia Unit, São Paulo, Brazil. *Braz. J. Biol.* 67(4): 741-748. (With Port. s.). – (Depto Zool., Inst. Biociênc., Univ. Estad. Paulista, Av. 24 A, No. 1515, C.P. 199, BR-13506-900 Rio Claro, SP).
The O. hepsetus diet is described. The Alimentary Preference Degree and the frequency of occurrence indices were used in analysis of the food items. The fish is carnivorous: the smaller individuals are principally insectivorous (incl. odon.), while the larger ones are ichthyophagous. The importance of the streamside forests is emphasized.

(18096) SETHY, P.G.S. & S.Z. SIDDIQI, 2007. Observations on odonates in Similipal Biosphere Reserve, Mayurbhanj, North Orissa. *Zoos' Print J.* 22(11): 2893-2894. – (At-Kadei, Po-Uchapada, Via-Kotsahi, Cuttack distr., Orissa-754022, India).
A checklist of 16 spp., recorded (2003-2004) from the Reserve (Orissa, India).

(18097) TONG, J., Y. ZHAO, J. SUN & D. CHEN, 2007. Nanomechanical properties of the stigma of dragonfly Anax parthenope julius Brauer. *J. Mater. Sci.* 42: 2894-2898. – (First Author: Coll. Biol. & Agric. Eng., Jilin Univ., Nanling Campus, Changchun-130025, China).
The mass of the wings of a dragonfly is only 1-2% of its whole body mass, but the wings can stabilize its body and have a high load-bearing ability during flight. A wing is composed of veins, membranes, nodus and pterostigma. The veins are mainly made up of chitin material, which is a kind of crystalline polymer with similar characteristics as cellulose or teflon. There is some resilin, a rubberlike protein, in the vein joints, which is used for controlling torsion. The nodus lies in the centre of the leading edge, whereas the pterostigma is situated near the wing tip. The nodus and the pterostigma may not only improve the flexibility but also prevent fatique fracture of the wings. The pterostigma plays such roles as balance of the mass centre, stabilization

of high-speed flight and elimination of the airflow vibration. If it is cut off the wings, the dragonfly can still fly, but the flight becomes unstable. Here, the pterostigma nanomechanical properties were investigated using a nanoindenter.

(18098) WALDHAUSER, M. & I. WALDHAUSEROVÁ, 2007. Interesting findings of dragonflies (Odonata) in the Liberec region. *Sb. severočesk Muz.* (Přir. Vědy) 25: 39-48. (Czech, with Engl. s.). – (Petrovice 136, CZ-471 25 Jablonné v Podještědi).
The 1999-2006 records of 15 Anisoptera spp. are presented and discussed (Czech Republic). Among these, Aeshna caerulea, Cordulegaster bidentata, Somatochlora arctica, Sympetrum depressiusculum and S. meridionale are considered most remarkable spp.

2008

(18099) COLLEN, B., M. RAM, N. DEWHURST, V. CLAUSNITZER, V. KALKMAN, N. CUMBERLIDGE & J.E.M. BAILLIE, 2008. Broadening the coverage of biodiversity assessments. [A chapter of 9 pp.] *in*: J.-C. Vie et al., [Eds], *The 2008 review of the IUCN Red List of threatened species*. IUCN, Gland. ISBN 978-2-8317-1063-1. – (Publishers: Rue Mauverney 28, CH-1196 Gland).
Contains information on 3 restricted-range spp. (Platycnemis pembipes, Amanipodagrion gilliesi, Oreocnemis phoenix), on climate change impact on Hemiphlebia mirabilis, and a reference to Viridithemis viridula (known from a single ♀, Madagascar).

(18100) CONTRERAS-GARDUÑO, J., B.A. BUZATTO, M.S. SERRANO-MENESES, K. NÁJERA-CORDERO & A. CÓRDOBA-AGUILAR, 2008. The size of the red wing spot of the American rubyspot as a heightened condition-dependent ornament. *Behav. Ecol.* 2008: 9 pp.; – DOI: 10.1093/beheco/arn026. – (Last Author: Depto Ecol. Evolutiva, Inst. Ecol., UNAM, Apdo Postal 70-275, MX-04510 Ciudad Universitaria, Goyoacán, DF).
An ornamental trait known to reflect ♂-fighting ability is investigated and it is tested whether it shows heightened condition dependence compared with non-ornamental traits in Hetaerina americana. Adult ♂♂ bear red wing spots, the size of which is sexually selected: large-spotted and fatter ♂♂ are more successful in territorial competition and obtain more matings than are non-territorial ♂♂. First, to see whether spot area may signal fighting ability at a particular age (to discriminate animals that are unlikely to compete), the age was investigated at which ♂♂ engaged more in fighting and compared their fat reserves and muscle mass at 3 ages (young, middle aged, and old) and territorial status. Middle-aged ♂♂ showed the highest fat and muscle values, engaged more in fighting, and were predominantly territorial. Second, it was looked for traits not shaped by sexual selection: comparing red chroma and brightness of spot and thorax, spot area, muscle mass, and fat reserves in winner and loser ♂♂ after a territorial contest. The only difference was that winners had larger spot areas and higher fat reserves. Finally, an immune challenge-based experiment was performed during the development of spot area and its colour properties (chroma and brightness). Compared with a control (unchallenged) group, the results revealed that area decreased, brightness increased, and there was no change in red chroma, muscle mass, and fat reserves in challenged animals. Thus, spot area is a stress-sensitive, energy-reflecting trait that is likely to be used for communication during territorial competition in this zygopteran.

(18101) MOOG, O. et al., [Eds], 2008. Proceedings of the scientific conference "*Rivers in the Hindu Kush-Himalaya: ecology and environmental assessment*". ASSESS-HKH project, Univ. Natur. Resour. & Applied Life Sci., Vienna. vi+202 pp. ISBN 978-3-00-024806-1. – (Ed.: Abt. Hydrobiol., Inst. Wasservorsorge, Univ. Bodenkultur, Feistmantelstr. 4, A-1180 Wien).
The vol. contains papers presented at the Conference held in Kathmandu and Dhulikhel (Nepal), 3-7 March 2008. Those including references to the Odon. are: *Hartmann, A. & O. Moog*: Development of a field screening methodology to evaluate the ecological status of the streams in the HKH region (pp. 17-24); – *Ofenböck, T., O. Moog & S. Sharma*: Development and application of the HKH Biotic Score to assess the river quality in the Hindu Kush-Himalaya (pp. 25-32); – *Sharma, S., O. Moog, A. Schmidt-Kloiber & K. Brabec*: Contribution to the knowledge of aquatic macroinvertebrates from Hindu Kush-Himalaya (pp. 41-48); – *Sharma, S., R.M. Bajracharya, H. Nesemann, R.D. Tachamo, D.N. Shah & S. Timalsina*: Results and consequences of

the ASSESS-HKH research project in Nepal (pp. 55-63); – *Bari, M.F., A.B.M. Badruzzaman, M.S. Alam, M.M. Hoque, M. Saha, T. Huber, B. Fliedl & M.A. Rahman*: Results and consequences of the ASSESS-HKH research project in Bangladesh (pp. 65-76); – *Shrestha, M., B. Pradhan, D.N. Shah, R.D. Tachamo, S. Sharma & O. Moog*: Water quality mapping of the Bagmati river basin, Kathmandu valley (pp. 189-197).

(18102) NUCKOWSKA, K., L. AGAPOW & J. NADOBNIK, 2008. Preliminary evaluation of the quality of water in the Mierzecka Struga river by a biological method. *In*: R. Goldyn et al., [Eds], *The functioning and protection of water systems*, pp. 11-16, Dept Water Prot., Fac. Biol., A. Mickiewicz Univ., Poznan. – (First Author: Owocowa 28a, PO-66-400 Gorców Wlkp.).
Calopteryx splendens is recorded from the river, i.e. the right tributary of the lower Drawa river, Poland.

(18103) OTT, J., 2008. Libellen als Indikatoren der Klimaänderung: Ergebnisse aus Deutschland und Konsequenzen für den Naturschutz. *Insecta* 11: 75-89. – (LUPO, Friedhofstr. 28, D-67705 Trippstadt).
A review of Author's recent (1988-2008) research on dragonflies as indicators of climatic change in Germany and on implications of the latter for nature conservation.

(18104) PETERS, G., 2008. Abnahme der Grosslibelle Aeshna subarctica auf den Rheinsberger Hochmooren und mögliche Ursachen. *Sber. Ges. Naturf. Freunde Berl.* (N.F.) 47: 119-125. (With Engl. s.). – (Dürerstr. 17, D-16341 Panketal).
The A. subarctica populations have been monitored at 4 Sphagnum lakes in the N of Brandenburg (Germany) since 1966 (a 5th lake was added in 1988). During the 1990s they declined drastically: in recent years only single specimens could be observed. This is ascribed to the recent long-lasting periods of summer heat ("climate warming"), which severely affect A. subarctica younger larvae. No decline was observed in populations of the accompanying A. cyanea, A. grandis, A. juncea and A. mixta.

(18105) POPOVA, O.N. & A.Yu. KHARITONOV, 2008. Interannual changes in the fauna of dragonflies and damselflies (Insecta, Odonata) in the southern Urals. *Russ. J. Ecol.* 39(6): 405-413. [Originally published in Russian in *Ekologiya* 2008(6): 427-435]. – (Inst. Anim. Syst. & Ecol., Russ. Acad. Sci., Frunze 11, Novosibirsk-630091, Russia).
Data on the occurrence and abundance of 64 spp. are considered. A comparative analysis of the odon. fauna in the early 20th century, in the 1960s and 1970s, and in the early 21st century is performed. On this basis, it is concluded that its structure has been markedly changing with time, the magnitude of the changes is comparable to that of regional faunistic differences. The causes of these changes are discussed. The apparent enrichment of the odon. fauna is attributed primarily to the appearance of new anthropogenic habitats.

(18106) ROBINSON, H., C. McALLISTER, C. CARLTON & G. TUCKER, 2008. The Arkansas endemic biota: an update with additions and deletions. *J. Ark. Acad. Sci.* 62: 84-96. – (First Author: Dept Biol. Sci., Southern Arkansas Univ., Magnolia, AR 71754-9354, USA).
Cordulegaster talaria is added to the list as published (1995) by H.W. Robinson & R.T. Allen (*Only in Arkansas: a study of the endemic plants and animals of the state*, Univ. Ark. Press, Fayetteville, 121 pp.). It was described in 2004 (see *OA* 15721) and is considered to be endemic to the Ouachita Mts of W Arkansas.

(18107) ROCHA, V.J., L.M. AGUIAR, J.E. SILVA-PEREIRA, R.F. MORO-RIOS & F.C. PASSOS, 2008. Feeding habits of the crab-eating fox, Cerdocyon thous (Carnivora: Canidae), in southern Brazil. *Revta brasil. Zool.* 25(4): 594-600. (With Port. s.). – (First Author: Bioecologia, Pesquisa Florestal, Klabin S.A. Avenida Araucária, BR-48279-000 Lagoa, Paraná).
The stomach contents of 30 foxes were examined. In a single specimen coenagrionid wings were found.

(18108) SADEGHI, S, 2008. *Aspects of infraspecific phylogeography of Calopteryx splendens*. PhD Thesis, Univ. Ghent. iv+166 pp., 1 pl. excl. (With Persian s.). – (Biol. Dept, Fac. Sci., Shiraz Univ., Shiraz, Iran).
C. splendens is a widespread damselfly, found in most of Europe, large parts of Siberia and much of W and central Asia. There is great variation among ♂♂ in wing coloration. Traditionally subspecific taxa have been distinguished by the size and posi-

tion of the pigmented wing spot, and by (mating) behaviour. About a dozen of sspp. have been recognized. Many of these refer to putative sspp., all of which are more or less geographically confined, but often with overlapping ranges and strong variation in wing spot size. For more than a century wing and wing spot characters have been used as criteria for Calopteryx spp. and sspp. identification. Most results suggest that wing pigmentation is a reliable signal of quality and plays a role in mate recognition by ♀♀. Size and density of wing pigmentation is also correlated with immunological condition and animal resistance against disease. In spite of these indications, the question arises whether variation in wing spot is really a taxonomically valid discriminator. Here, 2 morphological (traditional and geometric morphometrics) and one molecular (AFLP) method are used to quantify and analyze morphological and molecular data. Comparing the results of these methods helped to show some unclear and ambiguous relations between the populations and lighted some aspects of phylogeography of the (s) spp. In morphological study, the question was how well populations (sspp.) are recognizable based on wing and wing spot sizes and wing shape (irrespective of wing spot). In both morphological methods, left forewing of the ♂ specimens were evaluated because generally only ♂♂ bear wing spot. For traditional morphometry, 10 different wing characters were measured using a semi-automatic image analysis program. Geometric morphometric study was implemented based on collected superimposed data from 19 digitized landmarks following the procrustes method. AFLP was used as molecular method because of its low start-up time and cost effective generation of data from a large number of distributed loci in the whole genome. In this part, the first aim was to investigate patterns of C. splendens population structure and the spatial distribution of genetic diversity, and the second aim was to determine whether there is a consistent spatial distribution pattern of C. splendens based on genetic and morphological diversity of wings, in other words whether the genetic differences are compatible with morphological differences of wings. The results in traditional and geometric morphometrics (regardless of wing spot) confirmed differentiation of C. s. waterstoni from other populations. Likewise, a relationship between 2 populations from the NE border of Turkey (C. s. tschaldirica) and Ireland, both with a small wing spot, was supported. Populations of C. s. orientalis from N Iran and S Turkmenistan (I6 and Tm254, respectively) also showed close relationships, which differentiate them from other groups in both morphometric techniques. The relationship between C. s. xanthostoma and C. s. amasina (from Turkey) was more remarkable than European populations in both morphometric methods. However, the results of these 2 morphometric methods were not consistent in many cases, while geometric morphometric analysis showed wing shape differences between entire populations; traditional morphometry did not reveal such differences based on linear measurements of wing characters between most populations. In general, geometric morphometric analysis of Eurasian populations showed that 2 almost separate European and Asian groups of C. splendens are recognizable except some relations of C. s. waterstoni (from Turkey) to E European populations, and C. s. xanthostoma (from Spain) to Asian populations. These conclusions were partly confirmed by AFLP results, but were not consistent with the results of traditional morphometry which is mainly affected by linear size and area of wing and wing spot. Hence, use of wing spot patterns must be studied critically before those are used up as systematic characters at any taxonomic level. The AFLP results of the samples studied showed low levels of gene flow between populations except one case in central Asia between Russian and Kazakhstani populations which is partly due to lack of effective obstacles and the presence of the Irtysh river. Many populations showed double or more geographical origin, a circumstance that can reflect rapid diversification and introgression. The reasons of this situation and likely relations between 3 main sspp., C. s. waterstoni, C. s. intermedia and C. s. xanthostoma are discussed. The deepest split in the phylogeogrpahy of C. splendens populations was found within the unglaciated areas at the E border of Turkey and Azerbaijan. The isolation of C. s waterstoni is discussed. The unexpected relation between Azerbaijani and French populations is interpreted as an intrusion of intermedia-genes in both. The conclusion drawn from comparison of the data in all 3 analyses is that the result of shape analysis between populations was more akin to molecular data and more reliable than linear measurements of wing characteristics, although some populations showed the same result in both methods. These observations suggest that wing spot similarity necessarily cannot capture the full genetic grouping of populations and therefore is not an infallible character in Calopteryx splendens sspp.

(18109) SOLOMON, C.T., S.R. CARPENTER, J.J. COLE & M.L. PACE, 2008. Support of benthic invertebrates by detrital resources and current autochthonous primary production results from a whole-lake ^{13}C addition. *Freshw. Biol.* 53: 42-54. – (First Author: Cent. Limnol., Univ. Wisconsin, Madison, WI 53706, USA).
Secondary production of benthic invertebrates in lakes is supported by current autochthonous primary production and by detritus derived from a combination of terrestrial inputs and old autochthonous production from prior seasons. Here, the importance of these 2 resources for the dominant benthic insects in Crampton Lake, a 26 ha clearwater system on the Wisconsin-Michigan border (USA), is quantified. The libellulid and corduliid larvae, collected at 1.5 m depth, derived 75% of their C from current autochthonous primary production.

(18110) STEWART, T.W. & J.A. DOWNING, 2008. Macroinvertebrate communities and environmental conditions in recently constructed wetlands. *Wetlands* 28(1): 141-150. – (First Author: Dept Nat. Resour. Ecol & Mngmt, Iowa St. Univ., Ames, IA 50011, USA).
The macroinvertebrate community characteristics in 9 temporary or permanent wetlands in the Ada Hayden Lake area (N Ames, Iowa, USA) are quantified and related to environmental conditions. The mean density of Coenagrionidae and Libellulidae is family-wise presented, but a list of spp. is not provided.

(18111) SURUGIU, V. & A.E. CRISTEA, 2008. Spatial and temporal analysis of aquatic invertebrate fauna from the Ozana river. *Anal. stiint. Univ. Al. I. Cuza* (Biol. anim.) 54: 169-176. (With Roman. s.). – (Fac. Biol., "Al. I. Cuza" Univ., Bd. Carol I 20A, RO-700505 Iasi).
2 Gomphus flavipes larvae are recorded (July 2004) from Blebea on the Ozana river, one of the main tributaries of the Moldova (Romania). The habitat are pebbles mixed with coarse sand.

(18112) TRAPERO-QUINTANA, A.D. & B. REYES-TUR, 2008. Description of the last instar larva of Erythrodiplax fervida (Erichson, 1848) (Anisoptera: Libellulidae), with notes on the biology of the species. *Zootaxa* 1688: 66-68. – (Depto Biol., Univ. Oriente, ave. Patricio Lumomba, Santiago de Cuba-90500, Cuba).
The larva is described and illustrated. It can be distinguished from those of the other 4 Cuban congeners by the reduced number of palpal and premental setae (6 and 10, respectively).

(18113) UBONI, C., 2008. *Contributo alla conoscenza degli odonati nella provincia di Trieste (Hexapoda, Odonata)*. Diss. Corso di Laurea, Univ. Trieste, Trieste. 91 pp. – (Author: Mus. civ. Stor. nat., Piazza Hortis 4, I-34123 Trieste).
48 spp., collected during 2007-2008 from 22 localities in the province of Trieste (NE Italy).

(18114) VERBEEK, W.C.E.P., 2008. *Matching species to a changing landscape. Aquatic macroinvertebrates in a heterogeneous landscape*. PhD Diss., Radboud Univ., Nijmegen. 150 pp. ISBN 978-90-9022753-5. (With Dutch s.).
Human activities profoundly influence the landscape. Changes in land use, acidification, desiccation and eutrophication have resulted in a biodiversity crisis. Knowledge on the relationship between a sp. and its environment is needed to understand the impact of degradation and to derive sound possibilities for restoring the original biodiversity. This issue is addressed in a case study on the aquatic macroinvertebrates of the Korenburgerveen, a heterogeneous bog remnant located in the eastern Netherlands. 19(20) odon. spp. are also considered.

(18115) WHITFIELD, J.B. & K.M KJER, 2008. Ancient rapid radiation of insects: challenges for phylogenetic analysis. *Annu. Rev. Ent.* 53: 449-472. – (First Author: Dept Ent., Univ. Illinois, Urbna, IL 61821, USA).
Dwells in detail also on Paleozoic and post-Paleozoic diversification of Odon.

(18116) ZHANG, D. & J. DAI, 2008. Odonata species diversity of Yinchuan. *J. Ningxia Univ.* (Nat. Sci.) 29(4): 343-347. (Chin., with Engl. s.). – (Sch. Life Sci., Ningxia Univ., Yinchuan-750021, China).
The May-Sept 2006 survey, conducted at 5 selected plots, yielded 24 spp. Their abundance and the diversity of the fauna are analysed.

(18117) ŽIVIĆ, N., V. VUKANIĆ, T. BABOVIĆ-JAKŠIĆ & B. MILJANOVIĆ, 2008. Distribution of macrozoobenthos in the tributaries of the river Ibar in the northern part of Kosovo and Metohija. *Natura montenegrina* 7(2): 401-411. (With Serb. s.). – (First Author: Fac. Sci. & Math., Univ. Pristina, Kosovska Mitrovica, Kosovo).
5 odon. sp. are recorded from the Sočanska, Jošanička and Ibar rivers.

2009

(18118) AL-HOUTY, W., 2009. Insect biodiversity in Kuwait. *Int. J. Biodiv. Conserv.* 1(8): 251-257. – (Dept Biol. Sci., Fac. Sci., Univ. Kuwait, Kuwait).
A comparison is made of the numbers of insect spp. collected from Kuwait in the decade prior to the Gulf War (1980-1990) and thereafter (1992-2008). During both periods the odon. stand at 11 spp. Their names are not stated. Temporary rain pools are the only freshwater bodies in the desert ecosystem of Kuwait.

(18119) BABU, R. & S.B. MONDAL, 2009. First record of Rhinocypha trifasciata Selys from Maharashtra, India (Odonata: Zygoptera: Chlorocyphidae). *Rec. zool. Surv. India* 109(3): 115-116. – (Zool. Surv. India, M-Block, New Alipore, Kolkata-700053, India).
2♂, 1♀ from Burgaon, Nagpur, 26-III-2004. Their detailed description is included.

(18120) BABU, R. & S. NANDY, 2009. A comparative review of three closely related Calicnemia species: C. pulverulans Selys, C. imitans Lieftinck and C. sudhane Mitra (Odonata: Zygoptera: Platycnemididae). *Rec. zool. Surv. India* 109(3): 79-84. – (Zool. Surv. India, M-Block, New Alipore, Kolkata-700053, India).
A detailed comparison of structural features of the 3 spp. Figs of their terminalia are also included.

(18121) BAFU [Publishers], 2009. *List of the species of Switzerland: Dragonflies (Odonata), 1997-2008*. Bundesamt für Umwelt BAFU, Berne. 4 pp. (Trilingual: Germ./Fr./Engl.).
Issued by the Swiss Federal Office for the Environment, the spp. that were occurring in Switzerland permanently during the said period are listed and their occurrence in the 6 regions of the country is specified (Jura, Central Plateau, Northern Alps, Western Central Alps, Eastern Central Alps, Southern Central Alps).

(18122) BEREZINA, N.A., S.M. GOLUBKOV & Yu.I. GUBELIT, 2009. Structure of littoral zoocenoses in the macroalgae zones of the Neva river estuary. *Inland Water Biol.* 2(4): 340-347. – (Zool. Inst., Russ. Acad. Sci., Universitetskaya nab. 1, St Petersburg-199034, Russia).
The biodiversity and spatial distribution of macrofauna biomass were studied for 12 sites in the Neva Estuary (Russia). The odon. were represented in samples, but they are not further considered in the text.

(18123) BERMÚDEZ, D. et al., 2009. *Preferencias alimenticias de Rhionaeschna sp. (Odonata: Aeshnidae) en el Parque Zoologico Santa Fe y su capacidad depredadora sobre mosquitos Culex sp. (Diptera: Culicidae)*. Feria explora & Parque Zoologico Santa Fe, Medellin/Colombia. 12 pp.
The predatory efficiency of Rhionaeschna larvae was examined in the laboratory, where they were kept along with the potential prey, co-inhabiting a pond in the Parque Zoologico Santa Fe (Medelin, Colombia). Culex sp. was their preferential prey: 90% of larvae were consumed witin 24 h. – See also e.g. *OA* 7421.

(18124) COLDING, J., J. LUNDBERG, S. LUNDBERG & E. ANDERSSON, 2009. Golf courses and wetland fauna. *Ecol. Applications* 19(6): 1481-1491. – (First Author: Beijer Inst. Ecol. Economics, Roy. Swed. Acad. Sci., Box 50005, SE-104 05 Stockholm).
The field study was conducted in the area of Stockholm (Sweden), where the fauna of 12 golf course ponds and of 12 off-course ponds was examined. A total of 11 odon. spp. were identified: 6 of these recorded in golf course ponds and 8 in the off-course ponds. Enallagma cyathigerum and Leucorrhinia pectoralis were only recorded in golf course ponds. It is asserted that golf courses have the potential to contribute to the wetland fauna support, particularly in urban settings.

(18125) CSORDÁS, L., A. FERINCZ, A. LÖKKÖS & G. ROZNER, 2009. New data on the distribution of Cordulegaster heros Theischinger, 1979 (Odonata) in Zselic hills. *Natura somogyiensis* 15: 53-56. – (First Author: Inst. Forest Prot. & Forest Cultiv.,

Western Hungary Univ., Bajcsy-Zsilinszky Endre 4, H-9400 Sopron).
Based on the 2008-2009 survey, a detailed list of records (mainly larvae and exuviae) is provided. The ecology of the sp. is briefly outlined. The Zselic (Hungary) populations are strong and the required habitat conservation measures are enumerated.

(18126) DA SILVA DIAS, A., J. MOLOZZI & A. PINHEIRO, 2009. Distribution and occurrence of benthic macroinvertebrates in rivers with rice culture in Itajal valley, SC. *HOLOS Environment* 9(1): 45-64. (Port., with Engl.s.). — (First Author: Univ. Reg. Blumenau, FURB, rua Antônio da Veiga 140, Bairro Victor Konder, BR-89012-900 Blumenau, SC).
Calopterygidae and Libellulidae are family-wise mentioned; — Santa Catarina, Brazil.

(18127) DE ARAUJO, N.A. & C.U.B. PINHEIRO, 2009. Ecological relations between the ichthyologic fauna and the cilliary vegetation of the lacustrine area of Low Pindaré river in the Beixada Maranhense region and their implications on the sustainability of regional fishing. *Bolm Lab. Hidrobiol.* 22: 55-68. (Port., with Engl. s.). — (Second Author: Depto Oceanogr. & Limnol., Av. dos Portugueses s/n, Campus do Bacanga, BR-65080-040 São Luis, MA).
In the stomach contents of various fish spp., notably in representatives of the genera Apteronodus, Hoplerythrimus, Leporinus, Platydoras, Sternopygus and Triportheus etc., from the Cajari and Capivari lakes (Penalva, Brazil), odon. were identified among the food items.

(18128) FONTANAPROSA, M.S., M.B. COLLANTES & A.O. BACHMANN, 2009. Seasonal patterns of the insect community structure in urban rain pools of temperate Argentina. *J. Insect Sci.* 9(1): 17 pp. — Available online: Insectscience. org/o.10. — (First Author: Depto Ecol., Genet. Evol., Fac. Cien. Exactas, Univ. Buenos Aires, CONICET, Argentina).
4 temporary pools in Buenos Aires city were studied during a 1-yr period. Monthly and total relative abundance (numbers of individuals per litre) is tabulated (family-wise) for the coenagrionid, aeshnid and libellulid larvae. Lestes sp. is the only gen. mentioned. The total relative abundance of odon. in the community structure amounted to 3%. See also *OA* 15821.

(18129) GEISTER, I., 2009. *Naravoslovni sprehodi na Brdu pri Kranju*. — [*Natural history walks at Brdo-pri-Kranju*]. Zavod za favnistiko, Koper. 96 pp., map excl. ISBN 978-961-91043-7-8. (Slovene). — (Author: Kocjančiči 18. SI-6276 Fobegi).
Includes concise descriptions (and definitions) of wetland habitat types on the country-seat of Brdo-pri-Kranju (Slovenia), and presents short and very well styled portraits of 21 local odon. spp. — (For the complete list of the odon. fauna of this locality, see *OA* 16029).

(18130) *IDF-REPORT*. Newsletter of the International Dragonfly Fund (ISSN 1435-3393), Vols 16 (2009), 17 (2009). — (c/o M. Schorr, Schulstr. 7/B, D-54314 Zerf).
[Vol. 16]: *Hoffmann, J.*: Summary catalogue of the Odonata of Peru. Kommentiertes Faksimile des Manuskriptes von J. Cowley, Cambridge, 20.05.1933 und aktuelle Liste der Odonaten Perus mit Fundortangaben sowie Historie zu Sammlern und Odonatologen in Peru (pp. 1-115); — [Vol. 17]: *Villanueva, R.J.T.*: Dragonflies of Babuyan and Batanes group of islands, Philippines (pp. 1-16).

(18131) JANŽEKOVIČ, B., 2009. The bibliography of the journal Acta biologica slovenica (1997-), formerly Biološki Vestnik (1952-1995). *Acta biol. slovenica* 52(2): 115-176. (Slovene, with Engl. s.). — (Library Univ. Maribor, Gospejna 10, SI-2000 Maribor).
A complete bibliography of 918 papers, published by 642 authors from 29 countries during 1952-2008. It includes some odonatol. publications, but the titles are not cross-referenced to a list of treated subjects.

(18132) MARCONI, A. & F. TERZANI, 2009. Odonati del Kenya depositati nel Museo di Storia Naturale dell' Università di Firenze, Sezione do Zoologia "La Specola" (Odonata). *Onychium* 8: 36-43. (With Engl. s.). — (Mus. Stor. Nat. "La Specola", Univ. Firenze, Via Romana 17, I-50125 Firenze).
A collection of 134 specimens of 28 spp. from 14 localities in Kenya is brought on record. The annotations on and figs of structural characters of some spp. are provided.

(18133) MÜLLER, Z., B. KISS & P. JUHÁSZ, 2009. Faunistical data to complete the nationwide occurrence of Coenagrion ornatum (Selys-Longchamps,

1850). *Folia hist. nat. Mus. matraensis* 33: 97-101. – (BioAqua Pro Kft., Soó R. 21, H-4032 Debrecen).
Based on the evidence derived from the larvae and exuviae, C. ornatum is documented from the additional 42 watercourses. So far the sp. is known to occur in 105 watercourses in Hungary.

(18134) MURÁNYI, D., N. TARJÁNYI & K. SCHÖLL, 2009. First record of the genus Atrichops Verrall, 1909 in Hungary (Diptera: Athericidae). *Opusc. zool. Bpest* 40(2): 103-105. – (First Author: Dept Zool., Hungarian Nat. Hist. Mus., Baross u. 13, H-1088 Budapest).
Calopteryx virgo and Onychogomphus forcipatus are recorded from the Morgó stream, Pest co., Hungary; 28-X-2008.

(18135) NANDY, S. & R. BABU, 2009. On a collection of dragonflies (Odonata: Anisoptera) from Andaman and Nicobar islands. *Rec. zool. Surv. India* 109(4): 35-51. – (Zool. Surv. India, M-Block, New Alipore, Kolkata-700053, India).
The history of odonatol. exploration of the archipelago is reviewed and the 44 known Anisoptera spp. are listed with reference to the islands where they occur (North Andaman, Middle Andaman, South Andaman, Little Andaman, Nicobar). Neurothemis intermedia atlanta and Tramea basilaris burmeisteri are new for the archipelago. Orthetrum pruinosum neglectum was known from Nicobar but it is new for N & S Andaman, whereas Trithemis aurora was known from all Andaman isls and it is for the first time recorded from Nicobar.

(18136) SONG, H. & S.R. BUCHELI, 2009. Comparison of phylogenetic signal between male genitalia and non-genital characters in insect systematics. *Cladistics* 25: 1-13. – (First Author: Dept Biol., Brigham Young Univ., Provo, UT 84602, USA).
It is generally accepted that ♂ genitalia evolve more rapidly and divergently relative to non-genital traits due to sexual selection, but there is little quantitative comparison of the pattern of evolution between these character sets. Moreover, despite the fact that genitalia are still among the most widely used characters in insect systematics, there is an idea that the rate of evolution is too rapid for genital characters to be useful in forming clades. Based on standard measures of fit used in cladistic analyses, here levels of homoplasy and synapomorphy between genital and non-genital characters of published data sets are compared and it is demonstrated that phylogenetic signal between these 2 character sets is statistically similar. This pattern is found consistently across different insect orders at different taxonomic hierarchical levels. The odon. are represented by Enallagma spp., based on the paper listed in *OA* 14630. It is argued that the fact that ♂ genitalia are under sexual selection and thus diverge rapidly does not necessarily equate with the lack of phylogenetic signal, because characters that evolve by descent with modification make appropriate characters for a phylogenetic analysis, regardless of the rate of evolution. It is concluded that ♂ genitalia are a composite character consisting of different components diverging separately, which make them ideal characters for phylogenetic analyses, providing information for resolving varying levels of hierarchy.

(18137) SUUTARI, E., J. SALMELA, L. PAASIVIRTA, M.J. RANTALA, K. TYNKKYNEN, M. LUOJUMÄKI & J. SUHONEN, 2009. Macroarthropod species richness and conservation priorities in Stratiotes aloides (L.) lakes. *J. Insect Conserv.* 13: 413-419. – (First Author: Dept Biol. & Envir. Sci., Univ. Jyväskylä, P.O. Box 35, FI-40014 Jyväskylä).
The study was conducted in S Finland, where 14 lakes were sampled, 8 of them supporting S. aloides. 17 odon. spp. were recorded from S. aloides lakes and 14 from those without it. Aeshna viridis, Leucorrhinia caudalis and L. pectoralis occurred in the Stratiotes lakes only.

(18138) TERZANI, F., 2009. Monitoraggio dell'entomofauna di una pozza astatica in provincia di Firenze, 2: odonati (Odonata: Lestidae, Coenagrionidae, Aeshnidae, Libellulidae). *Onychium* 7: 17-19. (With Engl. s.). – (Mus. Stor. Nat. "La Specola", Univ. Firenze, Via Roma 17, I-50125 Firenze).
8 spp. are listed from an astatic pool (Il Ferrone, Impruneta) in the province of Firenze, Italy. A figure of an unusual abdominal pattern in ♂ Coenagrion puella is included.

(18139) TERZANI, F., 2009. Odonati raccolti nell'Alto Appennino reggiano, parmense e massese (Emilia-Romagna, Toscana) (Odonata). *Onychium* 7: 29-35. (With Engl. s.). – (Mus. Stor. Nat. "La

Specola", Univ. Firenze, Via Romana 17, I-50125 Firenze).
The records are presented of 21 spp., collected from 18 localities in the High Apennines of the provinces of Parma, Reggio Emilia and Massa-Carrara (Emilia-Romagna, Tuscany); – Italy.

(18140) VON ELLENRIEDER, N., 2009. Los tipos de Insecta depositados en el Museo de Ciencias Naturales de Salta, Argentina. *Revta Soc. ent. argent.* 68(3/4): 253-262. (With Engl. s.). – (IbiGeo, Mus. Cien. Nat., Univ. Nac. Salta, Mendoza 2, AR-4400 Salta).
A catalogue of the type specimens deposited in the Museum, with the respective bibliography. The odon. are represented solely by 2 ♂ Oligoclada rubribasalis von Ellenrieder & Garrison, 2008 paratypes.

(18141) XU, Q.-H., Z. CHEN & Z.-P. QIU, 2009. A new species of the genus Planaeschna McLachlan from Fujian, China (Odonata, Aeshnidae). *Acta zootaxon. sin.* 34(3): 439-442. (With Chin. s.). – (First Author: Zhangzhou City Univ., Zhangzhou, Fujian-263000, China).
P. liui sp. n. is described and illustrated from a single ♂: China, Fujian prov., Wuyi Mtn, 16-VII-2008; deposited at Inst. Biol. Control Res., Fujian Agric. & Forestry Univ., Fuzhou, Fujian, China. Although it is similar in body colour pattern to P. suichangensis, the new sp. can be separated from all known congeners by the shape of caudal appendages and penile organ.

2010

(18142) *AGRION, WDA*. Newsletter of the Worldwide Dragonfly Association (ISSN 1476-2552), Vol. 14, No. 2 (July 2010). – (c/o Dr N. von Ellenrieder, California State Collection of Arthropods, CDFA, 3294 Meadowview Rd, Sacramento, CA 05832, USA).
[Selected articles]: *Reels, G.*: The curious case of the cannibal coenagrionid (p. 27); – *Dow, R. & G. Reels*: Finding the Holy Grail: the rediscovery of Rhinoneura caerulea in the Hose Mountains, Sarawak, Borneo (pp. 28-29); – *Roland, H.-J. & U. Roland*: new records of Odonata on a birding trip to Cambodia (pp. 30-33); – *Reels, G.*: Dragonfly survey in Hainan, China, 2007-2008 (pp. 34-38); – *Taylor, J.*: Dragonflies caught in flight (pp. 40-41).

(18143) ANDERSON, C.N. & G.F. GRETHER, 2010. Interspecific aggression and character displacement of competitor recognition in Hetaerina damselflies. *Proc. R. Soc.* (B) 277: 549-555. – (Second Author: Dept Ecol. & Evol. Biol., Univ. California, 621 Charles E. Young Dr. South, Los Angeles, CA-90095-1606, USA).
In zones of sympatry between closely related spp., species recognition errors in a competitive context can cause character displacement in agonistic signals and competitor recognition functions, just as species recognition errors in a mating context can cause character displacement in mating signals and mate recognition. These 2 processes are difficult to distinguish because the same traits can serve as both agonistic and mating signals. One solution is to test for sympatric shifts in recognition functions. Here, competitor recognition in Hetaerina was studied by challenging territory holders with live tethered conspecific and heterospecific intruders. Heterospecific intruders elicited less aggression than conspecific intruders in spp. pairs with dissimilar wing coloration (H. occisa / H. titia, H. americana / H. titia) but not in spp. pairs with similar wing coloration (H. occisa / H. cruentata, H. americana / H. cruentata). Natural variation in the area of black wing pigmentation on H. titia intruders correlated negatively with heterospecific aggression. To directly examine the role of wing coloration, the wings of H. occisa or H. americana intruders were blackened and the responses of conspecific territory holders measured. This treatment reduced territorial aggression at multiple sites where H. titia is present, but not at allopatric sites. These results provide strong evidence for agonistic character displacement.

(18144) BOGUT, I., D. ČERBA, J. VIDAKOVIĆ & V. GVOZDIĆ, 2010. Interactions of weed-bed invertebrates and Ceratophyllum demorsum stands in a floodplain lake. *Biologia, Bratislava* 65(1): 113-121. – (Second Author: Dept Biol., Strossmayer Univ., Trg Ljudevita Gaja 6, Osijek, Croatia).
The abundance of weed-bed invertebrates associated with the submerged C. demorsum in Lake Sakadaš (Kopački rit Nature Park, Croatia) is reported. The chironomids were dominant (79%), followed by nematodes and large Zygoptera larvae (6%); July-Sept. 2004. Weed-bed invertebrates were more abundant on C. demorsum than on Myriophyllum spicatum, due to different morphology of the host plants.

(18145) BROŽIČ, A., 2010. *Inventarizacija kačjih pastirjev (Insecta: Odonata) na območju bajerja Pristava z okolico (Mengeš, osrednja Slovenija)*. — [*Dragonfly (Insecta: Odonata) survey of the Pristava pond and its environs (Mengeš, central Slov enia)*]. Individualna naloga Anim. Ecol., Biol. Dept, Univ. Ljubljana. ii+17 pp. (Slovene).
30 spp. are recorded and their seasonal abundance is analysed. — See also *OA* 18041.

(18146) COBBAERT, D., S.E. BAYLEY & J.-L. GRETER, 2010. Effects of a top invertebrate predator (Dytiscus alaskanus; Coleoptera: Dytiscidae) on fishless pond ecosystems. *Hydrobiologia* 644: 103-114. — (Dept Biol. Sci., Univ. Alberta, Edmonton, AB, T6G 2E9, CA).
The predatory effects of D. alaskanus on the biomass, species composition and diversity of fishless pond communities were investigated using presence and absence treatments in 24 mesocosms distributed among 5 ponds in N-central Alberta, Canada. Its preferred prey were large mobile predaceous macroinvertebrates, including Corixidae, Zygoptera and Chaoborus, the consumption of which causes a cascade effect, reducing grazing pressure on zooplankton.

(18147) COMBES, S.A., J.D. CRALL & S. MUKHERJEE, 2010. Dynamics of animal movement in an ecological context: dragonfly wing damage reduces flight performance and predation success. *Biol. Lett.* 6: 426-429. — (Dept Organismic & Evol. Biol., Concord Fld Stn, Harvard Univ., 100 Old Causeway Rd, Bedford, MA 01730, USA).
The effects of wing damage on dragonfly flight performance were examined in both a laboratory drop-escape response (Sympetrum rubicundulum) and in a more natural context of aerial predation in a greenhouse (S. vicinum). The laboratory experiment shows that hindwing area loss reduces vertical acceleration and average flight velocity, and the predation experiment in greenhouse demonstrates that this type of wing damage results in a significant decline in capture success. Taken together, these results suggest that wing damage may take a serious toll on dragonflies, potentially reducing both reproductive success and survival.

(18148) CRANSHAW, W., C. THOMAS, B. KONDRATIEFF & G. WALKER, 2010. *Life in Colorado water garden: insects and other invertebrates associated with water features*. Colorado St. Univ. Extension Ent. Program, Fort Collins. iv+28 pp. — (Available from the first Author: Dept Bioagric. Sci. & Pest Mngmt, Colorado St. Univ., Fort Collins, CO 80523, USA).
Presents various odon. spp. Each of these is briefly described, its life history and habits are outlined, and water garden features it requires are stated.

(18149) DE JONG-STEENLAND, C., 2010. *Een dagje Siebengewald en Kasteeltuinen Arcen, 11 augustus 2010*. — [*A day in Siebengewald and in the Castle Gardens of Arcen*]. Albelli, The Hague, 24 pp. 21.5×21.5 cm. ISBN none. (Dutch). — (Author: Souburghlaan 22, NL-2741 EL Waddinxveen).
A photographic record of Author's visit at the Kiautas horse farm in Siebengewald and the Arcen Castle gardens (Limburg, the Netherlands). Includes a photograph of a dragonfly copula statue (braided iron wire, height above water surface ca 3.5 m; artist unknown) in the Arcen gardens.

(18150) DE MENDOZA, G. & J. CATALAN, 2010. Lake macroinvertebrates and the altitudinal environmental gradient in the Pyrenees. *Hydrobiologia* 648: 51-72. — (Limnol. Gr., Cent. d'Estudis Avançats de Blanes, c/Acc. Cala St. Francesco 14, ES-17300 Blanes, Girona).
The distribution of macroinvertebrate genera inhabiting the littoral zone of 82 mountain lakes was investigated in relation to the altitudinal environmental gradient. Enallagma and Aeshna are considered.

(18151) [DIJKSTRA, K.-D.B.] VAN CALMTHOUT, M., 2010. Libellen vangen langs de Congo. — [Dragonfly catching along the Congo river]. *De Volkskrant*, issue of 29 June, p. 18 (Dutch). — (c/o Dr K.-D.B. Dijkstra, Naturalis, P.O. Box 9517, NL-2300 RA Leiden).
Based on an interview with K.-D.B.D., the article in a Netherlands national newspaper describes some of the objectives and achievements of the international multidisciplinary research expedition along a 350 km stretch of the Congo river, conducted in a celebration of the 50th anniversary of the independence of the former Belgian colony. 162 odon. spp. are collected, incl. 6 or 7 that are still undescribed. — (*Abstractor's note*: Dr K.-D.B. Dijkstra is the greatest odon. taxonomist of the younger Netherlands generation. The volume and excellence of his

published work are in the best tradition of those of the late Dr M.A. Lieftinck. At the moment he is a freelance researcher, associated with Naturalis in Leiden).

(18152) ESENKO, I., 2010. *Vrt, učilnica življenja*. – [*Garden, the school of life*]. Oka otroška knjiga, Ljubljana. 251 pp. ISBN 978-961-7685-29-7. (Slovene).
Includes a short text and photographs of 9 dragonfly spp. occurring in garden ponds.

(18153) *FIRST EUROPEAN CONGRESS ON ODONATOLOGY*: Programme and abstracts. 2-5 July 2010. Vairão – Vila do Conde, Portugal. 77 pp. – (c/o S. Ferreira, CIBIO, Univ. Porto, Campus Agrario de Vairão, PT-4485-661 Vairão).
The 82 registered participants came from 26 European and 2 non-European countries. For the *1st European Symposium of Odonatology* (Ghent, 1971) see *OA* 2. – [Abstracts of p a p e r s]: *Boudot, J.-P.*: Outside European borders: the Odonata from palearctic Africa (p. 8); – *Conze, K.-J.*: Dragonflies in Germany: the Atlas-project of the GdO (p. 9); – *Conze, K.-J., N. Menke & M. Olthoff*: Nature conservation response to climate change: some ideas from Northrhine Westphalia, Germany (p. 10); – *De Knijf, G., U. Flenker, C. Vanappelghem, C.O. Manci & V.J. Kalkman*: The impact of climatic change on two boreo-alpine dragonfly species, Somatochlora alpestris and S. arctica, at the edge of their range (p. 11); – *Dijkstra, K.-D.B.*: The biogeography of European dragonflies, with an emphasis on afrotropial species in the Palaearctic (p. 12); – *Dumont, H.J.*: Towards an understanding of Calopteryx splendens (p. 13); – *Dyatlova, E.S. & V.L. Kormyzhenko*: Dragonflies of Moldova: state of knowledge and personal observations (2005, 2009) (p. 14); – *Froufe, E., S. Ferreira, J.-P. Boudot, P.C. Alves & D.J. Harris*: Phylogeny of Cordulegaster in West Palearctic with phylogeographic insights for some species (p. 15); – *Gordon, L.K.*: Range-wide genetic diversity of the rare odonate Coenagrion mercuriale: influence of latitude and isolation (p. 16); – *Groenendijk, P. & T. Termaat*: Protection of Red List species in the Netherlands: ecological research, monitoring and conservation (p. 17); – *Günther, A.*: Construction of a new stream (even) for dragonflies (p. 18); – *Gyulavári, H.A., T. Feldföldi, T. Benken, L.J. Szabó, M. Miskolczi, C. Cserháti, V. Horvai, K. Márialigeti & G. Dévai*: Preliminary morphometric and molecular investigations on adult specimens of two Lestes (Chalcolestes) taxa (p. 19); – *Hardersen, S.*: The influence of season on wing morphology of Calopteryx splendens (Harris, 1782) (p. 20); – *Holuša O.*: Notes on the ecological demands of Cordulegaster heros (Cordulegastridae) in its northern part of area in Slovakia (p. 21); – *Jović, M., M. Marinov, B. Gligorović, N. Hacet, D. Kitanova & D. Kulijer*: A project named BOB, Balkan OdoBase (p. 22); – *Kalkman, V.J.*: An atlas of the European dragonflies: will it ever happen? (p. 23); – *Kalkman, V.J., J.-P. Boudot, R. Bernard, K.-J. Conze, G. De Knijf, E. Dyatlova, S. Ferreira, M. Jović, J. Ott, E. Riservato & G. Sahlén*: European Red List of dragonflies (p. 24); – *Kalmár, A.F., G. Dévai & T. Jakab*: Preliminary study to monitoring the dragonfly fauna (Odonata) in the ET 56 UTM grid square (South-Nyirség, Hungary) (p. 25); – *Karjalainen, S.*: New records of Somatochlora sahlbergi from Finland (p. 26); – *Kitanova, D. & M. Jović*: Review of Macedonian Odonata (p. 27); – *Kosterin, O.E.*: Siberian taxonomical problems concerning European odonate species (p. 28); – *Kulijer, D.*: Odonata in Bosnia and Herzegovina (p. 29); – *Lambret, P.H.*: Identifying keys to the conservation of Lestes macrostigma (Eversmann, 1836): to a European monitoring? (p. 30); – *Leipelt, K.G.*: Cordulegaster insignis and C. picta on Aegean islands: longitudinal distribution patterns and the mechanism behind them (p 31); – *Lorenzo-Carballa, M.O., H. Hadrys, A. Cordero-Rivera & J.A. Andrés*: Geographic parthenogenesis in the damselfly Ischnura hastata: a role for metapopulation structure? (p. 32); – *Luque, P., E. Soler & M. Lockwood*: The atlas of dragonflies and damselflies of Catalonia (p. 33); – *Manci, C.-O.*: An overview of dragonfly (Insecta: Odonata) fauna of Romania (p. 34); – *Martens, A.*: Ecology of the Odonata at the westernmost spot of Africa, the island of Santo Antão, Cape Verde (p. 35); – An overview of exotic dragonflies found in Europe (p. 36); – *Mihoković, N. & M. Matejčić*: Toward the atlas of Croatian dragonflies (p. 37); – *Murányi, D.*: The Odonata fauna of Albania (p. 38); – *Nelson, B.*: Dragonflies on the western fringe: Red List and important dragonfly areas of Ireland (p. 39); – *Ott, J.*: Climate change and Alien Invasive Species (AIS): a deadly cocktail for dragonflies? (p. 40); – *Ott, J., R.A. Sánchez-Guillén & A. Cordero-Rivera*: Microevolution through climatic changes? The example of the expansion of Crocothemis erythraea in Europe (p. 41); – *Outomuro,*

D., S. Rodriguez-Martinez & F.J. Ocharan: Fluctuating asymmetry in wings of Calopteryx damselflies at species population and latitudinal levels (p. 42); – *Parr, A.J.*: Migrant dragonflies in the UK: distributions are flexible, especially in times of climate change (p. 43); – *Nielsen, E.R.*: Danish Odonata Atlas an newly arrived species (p. 44); – *Reimer, R.W.*: Recent advances in UAE and Oman (p. 45); – *Riservato, E., J. Bouwman, C. Grieco & R. Ketelaar*: About dragonflies and dragon blood ! Odonata on the island of Socotra (Yemen) (p. 46); – *Riservato, E. & S. Hardersen*: Odonatology in Italy: state of the art (p. 47); – *Cordero Rivera, A. & M.O. Lorenzo Carballa*: Reproductive behaviour of Calopteryx haemorrhoidalis: a species with a surprising phenotypic variation (p. 48); – *Cordero Rivera, A., P. Luque Pino, M. Azpilicueta Amorin, F. Blanco Garrido, F.J. Cano Villegas, G. da Silva, O. Gavira Romero, A.F. Herrera Grao, A. Nieto, J. Pérez Cordillo, A. Torralba Burrial & F.J. Ocharan Larondo*: Macromia splendens in the Iberian peninsula: status and priorities for research (p. 49); – *Šacha, D.*: Project "Popularizácia odonatológie na Slovensku": its outputs and inspiration for the participants of the Congress (p. 50); – Notes to conservation of dragonflies in northern Slovakia (p. 51); – *Sahlen, G. & I. Suhling*: Communities in forest lakes show ecological shifts: indirect effects of climate change (p. 52); – *Šalamun, A., M. Kotarac, M. Podgorelec & M. Govedič*: Research on Cordulegaster heros in Slovenia (p. 53); – *Sánchez-Guillén, R.A., M. Wellenreuther, A. Cordero-Rivera, E.I. Svensson & B. Hansson*: Genetic diversity and introgression between Ischnura elegans and I. graellsii (Odonata: Coenagrionidae) (p. 54); – *Sillero, N.*: How to record and store species locations? The use of Geographical Information Systems, GPS and Free/Open Source software (p. 55); – *Soler, E. & M. Méndez*: The dragonflies of temporary pools in Menorca (p. 56); – *Stoks, R.*: Latitude patterns in life history, physiology and behaviour (p. 57); – *Suhling, F., I. Suhling & O. Richter*: Rising temperatures, altered life cycles and their consequences for dragonflies in Europe (p. 58); – *Termaat, T., D. Groenendijk, A. van Strien*: A European dragonfly monitoring scheme: how to get started? (p. 59); – *Torralba-Burrial, A., F.J. Ocharan, D. Outomuro, M. Azpilicueta Amorin & A. Cordero Rivera*: VOPHI: an index to asses threatened dragonfly populations and habitats (p. 60); – *van der Ploeg, E.*: Photographic guide to the exuviae of European dragonflies (p. 61); – *Vilenica, M., V. Mičetić, M. Franković & M. Kučinić*: Dragonfly composition in wetland area of Turopolje region, Croatia (p. 62); – *Watts, P.C. & D.J. Thompson*: Developmental plasticity as a cohesive evolutionary force between alternate-year odonate cohorts (p. 63); – *Weihrauch, F. & R. Malkmus*: Distribution and ecology of Sympetrum nigrifemur in the Macaronesian islands (Odonata: Libellulidae) (p. 64); – [Abstracts of p o s t e r s]: 13 of these follow on pp. 65-74. – The Second European Congress on Odonatology is scheduled to take place in 2012 in Belgrade (Serbia); the organizer is Dr M. Jović (Nat. Hist. Mus., Njegoševa 5, RS-11000 Belgrade).

(18154) GARRISON, R.W. & N. VON ELLENRIEDER, 2010. Redifinition of Leptobasis Selys with the synonymy of Chrysobasis Rácenis and description of L. mauffrayi sp. nov. from Peru (Odonata: Coenagrionidae). *Zootaxa* 2438: 1-36. – (First Author: Plant Pest Diagnostics, California Dept Food & Agric., 3294 Meadowview Rd, Sacramento, CA 95832-1448, USA).
Chrysobasis is synonymised with Leptobasis. The latter is diagnosed by the combination of rounded frons, CuP reaching hind margin of wing, CuA relatively short, and supplementary pretarsal claw reduced to vestigial, and by the presence on the distal segment of the genital ligula of a pair of chitinized, flap-like, movable processes directed posteriorly. L. mauffrayi sp. n. is described and illustrated. Holotype ♂: Peru, Madre de Dios dept, Manu, Aguajal, ca 5 km S Pakitza, alt. 200 m, 19-IX-1988; deposited in USNM. Maps and keys for all Leptobasis spp. are provided.

(18155) GLIGOROVIĆ, B., V. PEŠIĆ & A. ZEKOVIĆ, 2010. A contribution to the knowledge of the dragonflies (Odonata) of the river Brestica (Montenegro). *Natura montenegrina* 9(2): 151-159. (With Serb. s.). – (Dept Biol., Fac. Sci., Univ. Montenegro, Cetinjski put b.b., ME-81000 Podgorica).
Records of 19 spp.

(18156) HACET, N., 2010. An anomalous connection in the genus Aeshna Fabricius, 1775 (Odonata: Aeshnidae) with an additional record of Aeshna cyanea (Müller, 1764) from Turkish Thrace. *Acta ent. serb.* 15(1): 1-6. (With Serb. s.). – (Dept Biol., Fac. Arts & Sci., Trakya Univ., TR-22030 Edirne).
A heterospecific tandem between A. affinis ♂ and

A cyanea ♀ is reported from Igneada, Kirklareli prov., Turkey. This is the second record of the latter sp. from the region.

(18157) HARRISON, J.F., A. KAISER & J.M. VANDENBROOKS, 2010. Atmospheric oxygen level and the evolution of insect body size. *Proc. R. Soc.* (B) 2010: 10 pp.; – DOI: 10.1098/rspb.2010.0001. – (First Author: Sch. Life Sci., Arizona St. Univ., Tempe, AZ 85287-4501, USA).
Insects are small relative to vertebrates, possibly owing to limitations or costs associated with their blind-ended tracheal respiratory system. The giant insects of the late Palaeozoic occurred when atmospheric PO_2 (aPO_2) was hyperoxic, supporting a role for oxygen in the evolution of insect body size. The paucity of the insect fossil record and the complex interactions between atmospheric oxygen level, organisms and their communities makes it impossible to definitively accept or reject the historical oxygen-size link, and multiple alternative hypotheses exist. However, a variety of recent empirical findings support a link between oxygen and insect size, including: (i) most insects develop smaller body sizes in hypoxia, and some develop and evolve larger sizes in hyperoxia; (ii) insects developmentally and evolutionarily reduce their proportional investment in the tracheal system when living in higher aPO_2, suggesting that there are significant costs associated with tracheal system structure and function; and (iii) larger insects invest more of their body in the tracheal system, potentially leading to greater effects of aPO_2 on larger insects. Together, these provide a wealth of plausible mechanisms by which tracheal oxygen delivery may be centrally involved in setting the relatively small size of insects and for hyperoxia-enabled Palaeozoic gigantism.

(18158) [HORVÁTH, G.] MOELIKER, K., 2010. Graflibellen. – [Churchyard dragonflies]. *NRC Weekblad*, Rotterdam 2010 (22-28 May): 4. (Dutch).
A weekly's summary of the results presented in the paper listed in *OA* 16823.

(18159) JONIAK, T., [Ed.], 2010. *Bezkregowce denne wód parków narodowych Polski*. – [*Aquatic invertebrates in national parks of Poland*]. Zakład Ochrony Wód, Adam Mickiewicz Univ., Poznań. ISBN 978-83-62298-09-9. (Pol., with Engl. s's). – Publishers: Umultowska 89, PO-61-614 Poznań).
[Papers containing odon. information]: *Joniak, T.*: Benthic fauna of humic lakes of Drawieński National Park: history of research and state of knowledge (pp. 40-46); – *Kownacki, A.*: Benthic macroinvertebrates from waters of the Tayra National Park: present state, threats, protection (pp. 54-60); – *Michalskiewicz, M.*: Long-term changes of macrozoobenthos of Rosnowskie Duże Lake (pp. 61-68); – *Tończyk, G. & M. Osóbka*: Macrofauna colonising yellow water-lily, Nuphar lutea (L.) Sibth. & Sm.: distribution and structure analysis (pp. 74-79); – *Hallmann, E., J. Vandekerkhove, L. Namiotko & T. Namiotko*: Selective predation of Odonata-Anisoptera and Hemiptera larvae on Ostracoda in periodical reservoirs (p. 94).

(18160) JOVIĆ, M., B. GLIGOROVIĆ & M. STANKOVIĆ, 2010. Review of faunistical data on Odonata in Bosnia & Hercegovina. *Acta ent. serb.* 15(1): 7-27. (With Serb. s.). – (First Author: Nat. Hist. Mus., Njegoševa 51, RS-11000 Belgrade).
A review is presented of all published and hitherto unpublished records covering 57 spp. The information on the occurrence of Lestes macrostigma, L. parvidens, Erythromma viridulum, Aeshna grandis, Lindenia tetraphylla and Somatochlora flavomaculata in Bosnia & Hercegovina is provided here for the first time. A comprehensive bibliography and the list of previously unpublished localities (with UTM MGRS grids) are appended.

(18161) KARUBE, H., H. MORIYA & F. HAYASHI, 2010. Distribution of calopterygid damselflies of the genus Mnais in Kanagawa prefecture and its adjacent areas, central Japan. *Bull. Kanagawa prefect. Mus.* (Nat. Sci.) 39: 25-34. (Jap., with Engl. s.). – (First Author: Kanagawa Prefect. Mus. Nat. Hist., 499 Iryuda, Odawara, Kanagawa, 250-0031, JA).
3 Mnais types were established by sequencing 223-bp of ITSI region in 543 specimens from Kanagawa, Shizuoka, Yamanashi, Tokyo and Saitama prefectures, viz. M. pruinosa, M. costalis and another one. The latter occurs in the central part of the region studied and appears morphologically intermediate between the 2 spp., hence it seems to represent a hybrid between these. The distributions are mapped (Jap. captions only) and the paleogeographical events that could affect the distribution patterns are discussed.

(18162) KÜCK, P., K. MEUSEMANN, J. DAMBACH, B. THORMANN, B.M. VON REUMONT, J.W. WÄGELE & B. MISOF, 2010. Parametric and non-parametric masking of randomness in sequence alignments can be improved and leads to better resolved trees. *Frontiers in Zoology* 2010, 7: 10, 12 pp.; − DOI: 10.1186/1742-9994-7-10. − (First Author: Zool. Forschungsmus. A. Koenig, Adenauerallee 160, D-53113 Bonn).

Methods of alignment masking, which refers to the technique of excluding alignment blocks prior to tree reconstructions, have been successful in improving the signal-to-noise ratio in sequence alignments. However, the lack of formally well-defined methods to identify randomness in sequence alignments has prevented a routine application of alignment masking. Here, the effects on tree reconstructions of the most commonly used profiling method (GBLOCKS), which uses a predefined set of rules in combination with alignment masking, are compared with a new profiling approach (ALISCORE) based on Monte Carlo resampling within a sliding window, using different data sets and alignment methods. While the GBLOCKS approach excludes variable sections above a certain threshold which choice is left arbitrary, the ALISCORE algorithm is free of a priori rating of parameter space and therefore more objective. ALISCORE was successfully extended to amino acids using a proportional model and empirical substitution matrices to score randomness in multiple sequence alignments. A complex bootstrap resampling leads to an even distribution of scores of randomly similar sequences to assess randomness of the observed sequence similarity. Testing performance on real data, both masking methods, GBLOCKS and ALISCORE, helped to improve tree resolution. The sliding window approach was less sensitive to different alignments of identical data sets and performed equally well on all data sets. Concurrently, ALISCORE is capable of dealing with different substitution patterns and heterogeneous base composition. ALISCORE and the most relaxed GBLOCKS gap parameter setting performed best on all data sets. Correspondingly, Neighbor-Net analyses showed the most decrease in conflict. Alignment masking improves signal-to-noise ratio in multiple sequence alignments prior to phylogenetic reconstruction. Given the robust performance of alignment profiling, alignment masking should routinely be used to improve tree reconstructions. Parametric methods of alignment profiling can be easily extended to more complex likelihood based models of sequence evolution which opens the possibility of further improvements.

(18163) LOCKLIN, J.L., 2010. *Gregarine parasitism in dragonfly populations of central Texas with an assessment of fitness costs in Erythemis simplicicollis*. PhD Diss., Baylor Univ., Waco/TX. xi+88 pp. − (Dept Biol., Temple Coll., MBS, Temple, TX 76504, USA).

Odon. parasites are widespread and frequently include gregarines (Apicomplexa) in the gut of the host. Gregarines are ubiquitous protozoan parasites that infect arthropods worldwide. More than 1600 gregarine spp. have been described, but only a small percentage of invertebrates have been surveyed for these parasites. Some consider gregarines rather harmless, but recent studies suggest otherwise. Odonate-gregarine studies have more commonly involved zygopterans, and some have considered gregarines to rarely infect Anisoptera. In this study, anisopteran populations were surveyed for gregarines and an assessment of fitness costs was made in a common and widespread host sp., Erythemis simplicicollis. Adult Anisoptera populations were surveyed weekly at 2 reservoirs in close proximity to one another and at a flow-through wetland system. Gregarine prevalences and intensities were compared within host populations between genders, among locations, among wing loads and through time. Host fitness parameters measured included wing load, egg size, clutch size, and total egg count. Of the 37 spp. surveyed, 14 spp. (38%) hosted gregarines. 13 of those spp. were previously unreported as hosts. Gregarine prevalences ranged from 2-52%. Intensities ranged from 1-201. Parasites were aggregated among their hosts. Gregarines were found only in individuals exceeding a minimum wing load, indicating that gregarines are likely not transferred from the larva to adult during emergence. Prevalence and intensity exhibited strong seasonality during both years at one of the reservoirs, but no seasonal trend was detected at the wetland. The seasonal trend at the reservoir suggests that gregarine oocyst viability parallels increasing host population densities and may be short-lived. Prevalence and intensity also differed between anisopteran populations at the locations. Regression analyses revealed that host sp., host gender, month, and year were significant explanatory variables related to gregarine prevalence and intensity. The fitness parameters measured were not correlated with presence or intensity of gregarines, suggesting that either gregarines do not affect wing loading and egg production in E. simplicicollis, or that virulence depends on parasite intensity and/or the specific gregarine spp. infecting the hosts. The results emphasize the importance of considering season, hosts, and habitat when studying gregarine-dragonfly ecology.

(18164) LOCKLIN, J.L. & D.S. VODOPICH, 2010. Patterns of gregarine parasitism in dragonflies: host, habitat, and seasonality. *Parasitol. Res.* 107: 75-87. – (First Author: Dept Biol., Temple Coll., MBS, Temple, TX 76504, USA).
Gregarines are ubiquitous protozoan parasites that infect arthropods worldwide. More than 1600 spp.. have been described, but only a small percentage of invertebrates have been surveyed for these apicomplexan parasites. Adult anisopteran populations were surveyed for gregarines at 2 reservoirs in Texas, USA for 2 yr. Gregarine prevalence and intensity were compared intra-specifically between host genders and reservoirs among wing loads and through time. Of the 29 odon. spp. collected, 41% hosted gregarines. 9 of these were previously undocumented as hosts. Among the commonly collected hosts, prevalence ranged from 18 to 52%. Parasites were aggregated among hosts and had a median intensity of 5 parasites per host. Gregarines were found only in hosts exceeding a minimum wing load, indicating that gregarines are likely not transferred from the larva to adult during emergence. Prevalence and intensity increased during both years, suggesting that gregarine oocyst viability parallels increasing host population densities and may be short-lived. Prevalence and intensity also differed between odon. populations at 2 reservoirs. Regression analyses revealed that host species, host gender, month, and year were significant explanatory variables related to gregarine prevalence and intensity. Abundant information on odon. distributions, diversity, and mating activities makes dragonfly-gregarine systems excellent avenues for ecological, evolutionary, and parasitological research. These results emphasize the importance of considering season, hosts, and habitat when studying gregarine-dragonfly ecology.

(18165) MACHADO, A.B.M., 2010. Four new species of Phoeniciagrion von Ellenrieder, 2008 from Brazil (Odonata, Coenagrionidae). *Zootaxa* 2517: 44-52. – (Dept Zool., UFMG, C.P. 486, BR-31270-901 Belo Horizonte, MG).
Described and illustrated are: P. flavescens sp. n. (holotype ♂, allotype ♀: Anapá, Serra do Navio, pool below a fall in Igarapé Agua Fria, I-1957; deposition not stated), P. ibseni sp. n. (holotype ♂: Pará, Conceição do Araguaia, date not stated; deposited in Author's coll.), P. karaja sp. n. (holotype ♂, allotype ♀: Pará, Conceição do Araguaia, date not stated; deposited in Author's coll.), and P. megalobos sp. n. (holotype ♂, allotype ♀: Pará, Cachimbo, X-1955; deposited in Author's coll.). Keys to both sexes of the known spp. are provided.

(18166) NEKREP, I., T. GREGORC & P. MOHAR, 2010. *Študija možnosti in vpliv umestitve odpiranja kamnolomov na območju doline Bele v občini Poljčane za usmeritve občini Poljčane pri pripravi OPN-ja*. – [*Study on the possibilities and impact of the opening of stone-pits in the Bela valley, municipality of Poljčane*]. Lutra, Ljubljana. 3 pp. (Slovene). – (c/o Lutra, Pot ilegalcev 17, SI-1210 Ljubljana).
The Bela stream is a breeding habitat of Cordulegaster heros; – Poljčane, Slovenia.

(18167) PALACINO-RODRIGUEZ, F. & C.A. MILLAN-OCAMPO, 2010. Diversidad de libélulas: potencial inexplorado de control biológico. *Arroz* 58(484): 12-17. – (First Author: Inst. Cienc. Nat., Univ. Nac. Colombia, Bogota-7495, Colombia).
A list of 35 spp. known to occur in Soldaña and Llanos Orientales (Colombia), with field observations on some of them.

(18168) PETRULEVIČIUS, J.F., A. NEL & J.-F. VOISIN, 2010. A new genus and species of darner dragonfly (Aeshnidae: Odonata) from the Lower Eocene of Laguna del Hunco, Patagonia, Argentina. *Annls Soc. ent. Fr.* (N.S.) 46(1/2): 271-275. (With Fr. s.). – (First Author; Depto Paleozool. Invert., Mus. La Plata, Paseo del Bosque s/n, AR-1900 La Plata).
Huncoaeshna corrupta gen. n., sp. n. is described and illustrated from Ypresian of Laguna del Hunco.

(18169) POSCHMANN, M., T. SCHINDLER & D. UHL, 2010. Fossil-Lagerstätte Enspel: a short

review of current knowledge, the fossil association, and a bibliography. *Palaeobio Palaeoenvir.* 90: 3-20. – (First Author: Referat Erdgeschichte, Direktion Landesarchäologie, Generaldirektion Kulturelles Erbe RLP, Grosse Langgasse 29, D-55116 Mainz).
A complete, to the bibliography cross-referenced list of the organisms known from the "Fossil-Lagerstätte Enspel", an Upper Oligocene crater lake in Rhineland-Palatinate, Germany. The geology is outlined and the higher taxa are briefly reviewed.

(18170) PROKOP, J. & A. NEL, 2010. New griffenfly, Bohemiatupus elegans from the Late Carboniferous of western Bohemia in the Czech Republic (Odonatoptera: Meganisoptera: Meganeuridae). *Annls Soc. ent. Fr.* (N.S.) 46(1/2): 183-188. (With Fr. s.). – (First Author: Dept Zool., Fac. Sci., Charles Univ., Vinična 7, CZ-12844 Praha-2).
Bohemiatupus elegans gen. n., sp. n. is described and illustrated from the Bosovian deposits of Ovčin nr Radnice and compared with the other meganeurid genera.

(18171) RAĐA, B. & S. PULJAS, 2010. Do karst rivers "deserve" their own biotic index? A ten year study on macrozoobenthos in Croatia. *Int. J. Speleol.* 39(2): 137-147. – (Dept Biol., Fac. Sci., Univ. Split, Teslina 12/III, HR-21000 Split).
The Dalmatian rivers Jadro, Žrnovnica, Grab and Ruda were studied, In the macrozoobenthos samples Calopteryx virgo, Pyrrhosoma sp., Anax imperator and Cordulegaster boltonii were identified. It is stated that odon. have no indicator values for karst rivers.

(18172) RAEBEL, E.M., T. MERCKX, P. RIORDAN, D.W. MACDONALD & D.J. THOMPSON, 2010. The dragonfly delusion: why it is essential to sample exuviae to avoid biased surveys. *J. Insect Conserv.* 2010: 11 pp.; – DOI: 10.1007/s10841-010-9281-7. – (Last Author: Sch. Biol. Sci., Univ. Liverpool, Biosciences Bldg, Crown St., Liverpool, L69 7ZB, UK).
Odon. populations and spp. numbers are declining globally. Successful conservation requires sound assessments of both odon. distributions and habitat requirements. Most surveys that are used to inform conservation managers are undertaken of the adult stage. This study investigates whether this bias towards adult records in odon. recording is misinterpreting the environmental quality of sites. The habitat focus is farmland ponds, a key feature of agricultural landscapes. It was tested whether or not, adult, larval and exuvial surveys lead to similar conclusions on species richness and hence on pond quality. Results showed that pond surveys based upon larvae and exuviae are equally suitable for the reliable assessment of presence/absence of odon., but that adult surveys are not interchangeable with surveys of larvae/exuviae. Larvae were also found at ponds with no emerging individuals due to changes in habitat quality, therefore presence of exuviae remains the only proof of life-cycle completion at a site. Ovipositing ♀♀ were recorded at all ponds where exuviae were totally absent hence adult surveys over-estimate pond quality and low-quality ponds are functioning as ecological traps. Highly mobile and generalist spp. were recorded at more locations than other spp. Adult surveys also bias recording towards gen., spp. and populations with non-territorial mate-location strategies. Odon. biodiversity monitoring would benefit from applying the best survey method (exuviae) to avoid wasting valuable financial resources while providing unbiased data, necessary to achieve conservation objectives.

(18173) SENEGAČNIK, A. et al., 2010. *Močeradova pot*. – [*Salamander trek*]. Fold. brochure, 6 pp. Občina Slovenska Bistrica. (Slovene). – (c/o M. Bedjanič, Kolodvorska 21/b, SI-2310 Slovenska Bistrica).
A brochure on plant and animal life in the forest of Črnec near Slovenska Bistrica (Slovenia). A stream there is a breeding habitat of Cordulegaster heros.

(18174) TÜZÜN, A., F. FABIRI & S. YÜKSEL, 2010. Preliminary study and identification of insects' species of forensic importance in Urmia, Iran. *Afr. J. Biotechnol.* 9(24): 3649-3658. – (Dept Biol., Fac. Sci., Univ. Ankara, TR-06100 Tandogan/Ankara).
It presents a tab. of aquatic insects that come to the pig corpses in aquatic environment, listing Argia, Calopteryx and Zoniagrion. The tab. is based on the work by G. Vance et al., 2005, *J. forensic Sci.* (bibl. reference incomplete).

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

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

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