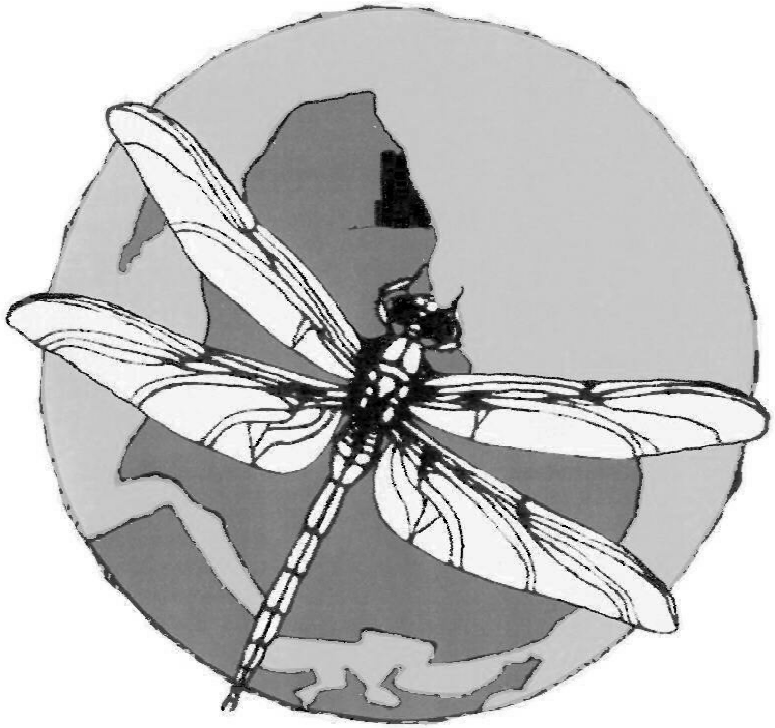
5th WDA International Symposium of Odonatology

ABSTRACTS



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NATIONAL MUSEUM OF NAMIBIA
"Heritage Conservation is our Business"

Worldwide Dragonfly Association

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5th WDA International Symposium of Odonatology, April 2007, Swakopmund, Namibia

Oral presentation

Conspicuous coloration in males of the damselfly *Nehalennia irene* (Zygoptera: Coenagrionidae): do males signal their unprofitability to other males?

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Damselflies in the family Coenagrionidae (Insecta: Odonata) are generally sexually dimorphic: males are conspicuously coloured, while the majority of females are drab. In odonates, as well as in other organisms, sexual colour dimorphism is often explained as a consequence of selection on traits that increase male attractiveness to females or enhance male-male competition. However, males of these damselflies are non-territorial and do not engage in displays, with male competition for mates resembling a "scramble". Thus, in Coenagrionids, the question remains: why are males colourful?

A possible answer has been suggested: that sexual dimorphism has evolved in this group primarily as a form of sex-related warning coloration. In this theory, bright coloration in males signals their "unprofitability" as potential mates to other males, allowing males to avoid unwanted interactions. Here we have evaluated some of the underlying assumptions of this theory by comparing the levels of harassment of males of the species *Nehalennia irene* painted in such a way as to make them look 1) similar to an unaltered male (painted blue), 2) simply different from the male (painted orange) or 3) more like the heteromorphic female (painted black). We also examined the selective pressures associated with harassment, measuring survivorship and body fat mass in males after 24-hours in flight cages.

We found that in cage experiments with painted males and heteromorphic (drab) females, blue-painted males and orange-painted males experienced significantly lower harassment than did black-painted males. No significant difference in survivorship in the different male morphs was found. We also found no significant differences in body fat between colours. Our results therefore confirm that the level of harassment of males is associated with their coloration, although we found no simple fitness correlates of this harassment. If bright coloration serves as a reliable indicator of "maleness" then the behaviour we observed could function to maintain male coloration as a warning signal. Further research on mating opportunities and feeding opportunities, as well as longer-term studies of survivorship, are recommended to explore the selective pressures imposed on males with differing coloration.

Oral presentation

New fossil Odonata from the Lower Cretaceous Crato Formation of Brazil

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The limestones of the Crato Formation from Brazil represents one of the most diverse fossil outcrops from the Lower Cretaceous, and yields a large diversity of fossil plants, arthropods and vertebrates of exceptionally good preservation.

The fossil insect fauna from this locality is documented by several tens of thousand specimens of most modern insect orders. Even though odonates constitute only about 2% of the fossil insects found, damselflies and dragonflies are not very rare in the Crato Formation, so that more than 1.000 specimens of larvae and adults of this order have been discovered so far. They can be attributed to at least 46 different species in more than 15 families of all three suborders. No other fossil locality yields more fossil odonates, either in the number of individuals or in the number of species. Furthermore, the mostly complete and very beautiful preservation of these fossils is unmatched.

Several interesting new discoveries are presented:

1.) The first record of preserved interference colours in a pre-Tertiary fossil insect (Zygoptera – Hemiphlebiidae).
2.) A new damselfly species of Thaumatoneuridae and the first record of colour pattern in the wings of *Euarchistigma atrophium*.
3.) The first record of the odonate suborder "Anisozygoptera" and of the family Stenophlebiidae for the New World. The taxon Nothomacromiidae is identified as the putative larvae of Stenophlebiidae.
4.) A new species of Cretapetaluridae with a strange "mosaic" pattern of characters.
5.) Discovery of a hind wing confirms the previous tentative attribution of *Paramesuropetala gigantea* to Liupanshaniidae.
6.) Two primitive and very large new species of the gomphoid genus *Cordulagomphus* and a new species of the subgenus *Procordulagomphus*.
7.) New data on the strange hind wing structures of *Araripephlebia mirabilis* also provide further clues to the phylogenetic position.
8.) Seven still undescribed new genera and species of Anisoptera of petaluroid and gomphoid affinities.

These new findings, together with a review of all known species from this locality, will be published this year in the forthcoming book "*The Crato Fossil Beds of Brazil: Window into an Ancient World*" (edited by D. Martill, G. Bechly & R. Loveridge, Cambridge University Press, in press 2007).

Poster presentation

Impact evaluation of a chemical contaminant (PFOS) on the survival of damselfly larvae

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There is growing concern about the negative impact of anthropogenic forms of stress on animal and plant life. Contaminants such as nitrates, phosphates, and heavy metals have already been shown a world-wide threat to human and non-human life forms. Also other contaminants have been recognized to be potentially problematic, but need more study to evaluate the risks. Perfluorooctane sulfonic acid (PFOS) has recently been identified as persistent, ubiquitous and potentially harmful for animal and plant life. The objective of this study is to evaluate survival of damselfly larvae under different concentrations of PFOS. We collected 30 females of the damselfly *Enallagma cyathigerum* in a nature reserve area and stimulated these to lay eggs in oviposition chambers. Using this methodology, 18.552 eggs were obtained, which were subsequently studied under controlled laboratory conditions. Offspring was maintained in one of five treatments: 0.01, 0.1, 1 up to 10ppm PFOS or in a contaminant-free control. First, we evaluated whether the egg stage is susceptible to contamination, and second we determined whether variable numbers of larvae hatched in different treatments (about 14.500 larvae hatched). A subset of these larvae was monitored for survival and behavioural activity.

Oral presentation

Seasonal variation in energy storage compounds between female colour morphs of the damselfly, *Enallagma cyathigerum*

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Female-limited colour polymorphism occurs frequently in damselflies. Typically, two distinct female morphs are encountered in natural populations. One female phenotype resembles the conspecific male's body colouration (andromorph), while the other has a distinct colour (gynomorph). Recent studies indicate that selection is involved in the maintenance of both morphs and sexual conflict has been promoted as the main driving force. Several hypotheses suggest that female phenotypes differ in costs and benefits under different male densities and/or female morph frequencies. Densities and frequencies not only differ among populations, but also in time within a population. The objective of this study was to evaluate whether female morph condition is affected by varying densities and frequencies. First, we determined variation in densities and frequencies for a natural population of the damselfly *Enallagma cyathigerum* on a two weekly basis for an entire reproductive season. Second, we related this variation to the absence or presence of differences in measures of female morph condition. As measure of condition we determined available energy storage compounds (proteins, glycogens, lipids), which depend on the current nutritional status and are highly sensitive to recent changes in the environment. Condition differences between morphs will be discussed in relation to the maintenance of this intriguing polymorphism.

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Oral presentation

An overview of the present knowledge and protection of the isolated population of *Coenagrion armatum* in the Netherlands

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Coenagrion armatum is one of the rarest dragonflies in northwestern Europe. It was present in the Netherlands until 1956 when the last individuals were recorded and the species was thought to be extinct in the second half of the twentieth century. Most surprisingly, it was rediscovered in the Netherlands in 1999. It has been present in the area every spring since its discovery and still is one of the few known in northwestern Europe. However, observed yearly figures are low and one of the known subpopulations was accidentally destroyed during management activities. This strongly increased the need for a powerful local protection. Since the species' discovery, research was carried out to elucidate the ecology of the species in the Netherlands and the possibilities for its protection. *C. armatum* is currently known from three subpopulations in a lowland marsh named the Weerribben in the northern part of the Netherlands. This area is probably one of the richest dragonfly nature reserves in Europe. Beside *C. armatum*, other threatened species like *Leucorrhinia pectoralis*, *Sympecma paedisca* and *Aeshna viridis* occur here, often in high densities. After one of the populations of *C. armatum* was destroyed, actions have been taken to create new habitat. These new locations also enlarge suitable habitat for the other Red List species. Together with the local Nature Conservation Organisation, an action plan was made to ensure the presence of suitable habitat for *C. armatum* and other dragonflies. These kinds of actions also have been taken for species like *A. viridis*, for which these actions turned out to be quite effective. We hope that *C. armatum* is able to colonise the newly created habitat and that our efforts will contribute to a long lasting population of this conspicuous dragonfly.

Oral presentation

Odonata inventories in British Columbia, Canada: determining the conservation status of Odonata species

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The changes in the conservation status ranks of British Columbia's Odonata species over an eight-year period demonstrate how inventory provides information for assigning these ranks. Preliminary conservation status ranks were assigned to BC's dragonflies in 1993. Subsequently, inventory efforts focused on species considered at risk in order to determine their status more accurately.

From 1996 to 2003, the Royal British Columbia Museum and the British Columbia Conservation Data Centre of the provincial Ministry of Environment conducted surveys throughout much of the province (area of about 1,000,000 km2). The broad goals of the project were to determine the status and habitat/management needs of the 87 species recorded in the region, with an emphasis on species considered to be at risk; to increase public awareness of the Odonata, their ecology and conservation; and to foster an ongoing, local interest in dragonfly monitoring and research.

During these surveys about 20,000 specimens were collected at 1500 sites. The known ranges of many species were extended, knowledge of habitat requirements increased, and five species were recorded for the province for the first time -- *Calopteryx aequabilis* Say, *Lestes forcipatus* Rambur, *Somatochlora brevicincta* Robert, *S. forcipata* (Scudder) and *S. kennedyi* Walker. Many of the targeted species were more abundant than previously thought; others were found only rarely or not at all. We changed the rank of 23 species -- 20 are now less at risk and 3 are considered more at risk. Distribution maps for each species were produced incorporating newly collected data and a new colour fieldguide to the region was published (2002).

Ranking poorly known species is challenging, particularly if samples are small or habitats are difficult to access. By increasing our knowledge of these species and their requirements, we can assign them more accurate ranks, thus ensuring that conservation efforts will target the species and habitats that truly require them. As of 2005, an expanded Arthropod Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is now empowered to list species of Odonata at risk in Canada. Inventory in BC has helped determine species requiring COSEWIC attention.

Oral presentation – Plenary seminar

Global Dragonfly Assessment – What do we have already and what is needed?

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Michael Samways and Stuart Taylor first introduced the global dragonfly assessment during the 3rd WDA symposium in Australia as potential task to the odonatologist community. The discussion was continued during the 4th WDA symposium in Spain with the attendance of Piotr Naskrecki and Sacha Spector, who were trying to seek funding. The Species Information Service (SIS) developed by IUCN/SSC was discussed as a potential data entry form.

Four years after first being introduced, no funding is in sight and the global dragonfly assessment has not officially started. Nevertheless a high percentage of species has already been included in the SIS through global red listing, regional assessments or the Red List Index. Point locality data is already available for a number of regions/species and could be prepared without too much financial effort.

In this talk I will show at which stage of the global dragonfly assessment we are, what is needed and what could be achieved with only little funding or with the big money.

Oral presentation

The red wing spot of *Hetaerina americana* males as a heightened condition dependent ornament

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Theory indicates that ornamental traits must show heightened condition dependence compared to non-ornamental traits. We tested this idea by using males of the American rubyspot, a species in which pre-copulatory sexual selection is reliant only on male-male competition, and not female choice. At the time of sexual maturity, males of this species develop a red pigmented spot at each wing basis which is sexually selected: males with a larger spot area and higher fat reserves are more successful in winning disputes for territories where females arrive to mate. Consequently, territorial males (with larger spots) obtain a considerably higher mating success than non-territorial males. First, we looked for other traits presumably not shaped by sexual selection, in particular those related to spot and thorax colour properties: red chroma and light reflectance of spots and thorax. We compared the expression of these traits and spot area in winner and loser males after a territorial conflict. The only difference was that the spot area was larger in winner males. Second, we submitted a male set to an experimental immune challenge at an age when spot area and its colour properties are being developed. We inserted one nylon filament to induce a resource re-allocation to immune defence presumably affecting spot area and its colour properties. Having another male set with no challenge as a control, we compared area, red chroma and light reflectance of the spot after the challenge. Area decreased, light reflectance increased and there was no change in red chroma in challenged animals compared to control males. Although there is no explanation for the light reflectance increase, our results corroborate that indeed an ornamental trait, spot area, is more sensitive to stress.

Oral presentation

Odonata in North Rhine-Westphalia, Germany

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North Rhine-Westphalia (NRW) is one of the largest and the most inhabited of the federal states of Germany (34.000 square km, 17 million people). It is situated in a transition area of Atlantic and continental climate in Northwestern Germany. The country has lowlands in the North and West and mountainous regions in the South and East. In the country there is a dense net of running waters (with the main rivers Rhein, Weser and Ems), a high number of springs in the mountainous areas, small and fragmented remnants of bogs in the lowlands and many man-made waterbodies all over the country.

Since 1996 the voluntary "working group Odonata North Rhine-Westphalia" (AK Libellen NRW) has built up a knowledge base on dragonflies in the country.

Currently 73 species (numbers in Germany 81, in Europe about 130) of dragonflies are documented for NRW. Of these 66 species are regarded to be autochthonous, at least breeding temporarily

The most abundant species are (by number of sites, decreasing): *Ischnura elegans, Coenagrion puella, Pyrrhosoma nymphula, Aeshna cyanea, Anax imperator, Calopteryx splendens, Orthetrum cancellatum, Sympetrum sanguineum, Enallagma cyathigerum* and *Lestes viridis*.

Nearly 43 % of the species are vulnerable some even critically endangered. Eight species are regarded as extinct: *Sympecma paedisca, Coenagrion armatum, Nehalennia speciosa, Aeshna viridis, Epitheca bimaculata, Leucorrhinia albifrons* and *Leucorrhinia caudalis*.

Thermophilous species and those of running water bodies show clear positive trends, whereas those depending on oligotrophic water bodies and bogs are critically endangered (e.g. *Aeshna subarctica*). Some of these species are still disregarded by official conservation efforts (e.g. by the Fauna-Flora-Habitat directive of the European Union or the national law for protection of species).

Currently 13 special protection areas for the conservation of dragonflies (but only considering *Coenagrion mercuriale* and *Leucorrhinia pectoralis*) exist in NRW as part of the EU network of "Natura 2000".

In the next few years the focal point of our work will be the establishment of special species protection programs for species like: *Coenagrion lunulatum, Coenagrion hastulatum, Somatochlora arctica* and *Somatochlora flavomaculata*.
Further information is available on: www.ak-libellen-nrw.de

Oral presentation

Androchrome females are not preferred by males of *Ischnura elegans* even when they are the majority morph

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Animals searching for prey and males searching for mates share similar problems of detection if their targets are diverse in colour or physical appearance. There is good evidence for predators switching their preferences for prey in a frequency-dependent way; predators focus on the most common form, and the decreased predation on rarer forms allows multiple forms to survive. This mechanism has also been proposed to explain the maintenance of several female colour morphs in damselflies. However, the fact that one of the female morphs is male-coloured (androchrome) and behaves similarly to males, suggests the phenomenon of male-mimicry in this system, an alternative explanation for the polymorphism. Here we compared androchrome frequencies in populations and mating pairs in *Ischnura elegans*, over a range of androchrome frequencies (8-90%). We found that in 22 out of 23 samples androchromes mated less often than expected (significantly in 13 samples). We found no evidence for males switching their preferences in a frequency-dependent way. A test of male preference for female morphs in a population with 85% androchromes indicated that males behave indiscriminately, and do not prefer the commonest (male-like) morph. Our results support androchrome male-mimicry rather than male learned mate recognition (a purely frequency-dependent model) as the main mechanism behind the maintenance of this sex-limited colour polymorphism.

Oral presentation – Plenary seminar

Global Biodiversity Assessments: what is their purpose and what is involved?

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A global biodiversity assessment aims to collate and make freely available existing information relating to the distribution and conservation status of all known species within a selected taxonomic group. The primary objective of such an exercise is to identify species of conservation concern and to provide the baseline information set to feed into planning processes for their conservation. In general, a vast amount of relevant information on species already exists but is widely dispersed, is often not published in the mainstream literature, and is effectively inaccessible to most interested parties. The information collated through a global biodiversity assessment is stored, managed and made widely available in a custom designed database, the IUCN Species Survival Commission's Species Information Service (SIS). Information collated includes species distribution maps, IUCN Red List status, habitat preferences, major threats and conservation recommendations. Global assessments have now been completed for all the world's birds, mammals and amphibians and are either planned or underway for reptiles, fishes, molluscs, selected plant groups and odonates. Outputs from the completed assessments have significantly influenced the funding strategies for international donor agencies, "kick started" global conservation initiatives such as the Amphibian Action Plan, and they feed into biodiversity indicators of major environmental agreements such as the Convention on Biological Diversity. Global Biodiversity Assessments also serve to identify information gaps and thus direct the focus for future research priorities.

Oral presentation

Predicting the distribution of *Calopteryx splendens* in Flanders (Belgium), based on a habitat model

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Until very recently, the distribution of the riverine damselfly *Calopteryx splendens* in Flanders was predominantly restricted to the north-eastern part. The most important unfavourable factor for the species was probably the poor water quality of many rivers in a great part of Flanders. However, the last decade *Calopteryx splendens* has been observed in previously unoccupied areas in the centre and the south of Flanders. To predict which combination(s) of environmental factors are most favourable for the successful dispersal of the species, we build a model based on two sets of variables: chemical (water quality) and structural (river bank and vegetation quality). We obtained the chemical variables from a long-term standardised monitoring network of river water quality of the Flemish environment Agency. We defined structural variables by combining land-use categories adjacent to the riverbanks with vegetation structure information. We used the information on presence of *C. splendens* populations (1x1 UTM gird) from the database of the Dragonfly Society. As a base for all further analysis we combined all the layers in a GIS-environment and after testing, proceeded to the finalisation of the model.

Oral presentation

Demise and rise: the biogeography of the Odonata of tropical Africa

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Africa has a large and almost uninterrupted land surface that is isolated from surrounding continents. In the last 20 million years Africa had a variable and increasingly dry climate. As a result the Afrotropics have only half as many odonatespecies as tropical America or Asia. 'Relict' families are scarce and concentrated in five isolated, climatically stable areas: (1) the Cameroon highlands, (2) locally in East Africa, (3) the Cape region, (4) the granitic Seychelles, and especially (5) Madagascar. Most African odonate species, about two-fifths, are restricted to the Central and West African forests. The remainder is found, in three fairly equal parts, in (1) the highlands from Arabia to the Cape, (2) Madagascar and surrounding archipelagos, and (3) open habitats throughout the region. Most mainland species appear related to the relatively diverse fauna of tropical Asia, but have few relatives on Madagascar, suggesting that the modern continental fauna mostly diversified after the arrival of Asian ancestors. Being best adapted to change, Coenagrionidae and Libellulidae are the largest odonate families on Earth. Only in temperate regions, impacted strongly by the ice ages, is their dominance comparable to that in changeable Africa. The climatic influence is further seen in forest species 'stranded' in highlands by forest reduction, savanna species 'trapped' by forest expansion, and overseas colonisation of East Africa by island species.

Traditional theory is that speciation took place in habitat fragments created by climatic change, especially in forest refuges, but such refuges seem to conserve old species rather than generate new ones. Abrupt habitat gradients in heterogeneous landscapes may be more important in speciation, especially close to areas where potential ancestors are conserved. The habitat mosaic on the Congo-Zambezi watershed is the best modern example of such an area. Phylogenetic research of various African plants and animals indicate that environmental and dispersal barriers are easily straddled, with savanna species radiating from forest ancestors and vice versa. Species were eliminated with climatic change, but new ecological space was also constantly created. Such processes must also have lead to the 'demise' of most of Africa's old odonate diversity and the 'rise' of a rich new fauna.

Oral presentation

Distribution and habitat preferences of peat-bog and fen dragonfly species in Central Europe

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A large dataset of dragonfly samples from 34 Czech and Polish peat bogs in lowland and mountain ecosystems was analysed and discussed with focus on key factors affecting odonate species distribution. There are three main types of peatland occurring in the Czech Republic (CR) and Poland (PL). At first, typical ombrogenous raised bogs. Secondly, mountain or sub-mountain transition mires and finally acid moss-rich fens. A total number of 56 species were recorded during 1997–2006, which is about 80 % of the dragonfly species known for CR and PL.

The degree of "taxocoenosis composition naturalness" was calculated according to Fischer's biocoenosis naturalness indices modified by Czachorowski & Buczyński. The classification of the species specificity was adopted from Czachorowski & Buczyński. Generally, it was found that the highly protected and the most valuable climax habitats show the lowest species richness. Direct gradient analysis (CCA) indicated altitude and acidity of the sites as the main significant factors affecting the species composition. These factors also correlated with species richness. Interactions between acidity, age and size of the habitat and between the "degree of naturalness" and altitude are discussed as well.

Oral presentation

Preliminary results of recent faunal survey work in Sarawak, Malaysian Borneo

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Sarawak, on the large island of Borneo, is part of East Malaysia. Sarawak was originally almost entirely forest covered; much forest remains, but outside of protected areas it is almost all secondary forest. Logging activity is continuing in many of these secondary forests. There has been very little collecting of Odonata in Sarawak since the early 1950s; sampling carried out prior to this time was sporadic and mostly carried out by non-expert collectors. Large areas of the state have never been sampled for Odonata or only sampled in the most superficial manner. In recent years legislation has made collecting of animals in Sarawak extremely difficult, however this situation began to change in 2004/2005.

The authors were granted permits to collect Odonata in Sarawak in 2005 and again in 2006; over this period approximately six months have been spent collecting in many areas of the state, including national parks and other protected areas, but also in secondary, unprotected, habitats and Acacia plantations. Prior to 1980 about 150 species had been recorded from Sarawak; the figure now stands at over 220, including many unnamed species. The results of this collecting are discussed, together with case studies illustrating interesting and/or unexpected findings. The occurrence of forest species in secondary and plantation habitats is discussed. Conservation of Odonata in Sarawak is discussed.

Poster presentation

Predator induced spine length and cuticle thickness in *Leucorrhinia dubia* – a trade-off?

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Many prey species are able to develop different morphological structures as a defence against predators. It is well known that larvae of *Leucorrhinia dubia* develop longer lateral spines on segment 9 in the presence of a fish predator. In spite of numerous experiments little evidence of trade-offs have been found between antipredatory behaviour and elongated spines. We thus chose to examine a very obvious possibility, namely a simple physiological trade-off. Since spines are built of cuticle we hypothesised that adding more cuticle into longer spines might result in less cuticle being formed elsewhere on the larva. We measured the exocuticle thickness on nine locations, namely head, prementum, pronotum, profemur, protibia, fourth segment tergite, fourth segment sternite, ninth segment tergite and ninth segment sternite. We used specimens caught in lakes with fish and fish-free lakes, respectively.

We found that larvae from lakes with fish, and hence with long spines, had significantly thinner exocuticle on their protibia, fourth segment tergite and fourth segment sternite than short-spined larvae from fishless lakes. We assume that the mechanism behind this trade-off is a simple relocation of building material. Individuals that develop longer spines as a defence against predatory fish, had a thinner exocuticle in some parts of the body where cuticle stability is not that important. Hence we observed a reduction in cuticle thickness in abdominal segment four, but not on segment nine where thick structures are needed to support the spines.

Poster presentation

Will the real *Argia difficilis* please stand up?

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The name *Argia difficilis* Selys has been applied to at least three or more different species in the literature. As part of our on-going analysis of neotropical components of this genus, we clarify the status of *Argia difficilis* and describe another species which has been associated with this name.

A new species close to *Argia difficilis* is described. *Argia extranea forficula* Fraser and *A. machadina* Förster, are considered junior synonyms of *A. difficilis*, and the latter is re-described. Both species are illustrated and diagnosed and their distributions mapped.

Argia sp. nov. is recognizable from *A. difficilis* by shape of male tori and cerci and in females, depressions of prothoracic medial lobe and morphology of mesostigmal plates.

Both species seem to be parapatric; distribution range of *A. difficilis* is included within the Amazon biogeographic province of the Neotropical region, from Amazonas department in Venezuela to Loreto department in Peru and Mato Grosso State in Brazil, and preferred habitats are streams within rain forest between 97-980 m a.s.l. Distribution range of *Argia* sp. nov. is included within foothill jungle (ca 300-900 m) of the Yungas biogeographic province of the Neotropical region from Jujuy province in Argentina to Junín department in Peru. Preferred environments are shady and narrow streams or creeks enclosed within the forest. As in other *Argia* species, after landing adults of this new species open and close their wings two or three times. Adults perch on leaves in small patches of dappled sunlight. Oviposition has not been observed, and larva is still unknown.

Oral presentation- WDA Award

Research on the Neotropical Odonata: Results and challenges ahead

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Knowledge of the Neotropical fauna of Odonata has arguably lagged behind those of other faunal regions. However, this region possesses the highest diversity of odonate species in the world and basic information on their taxonomy, life history and biology is still fragmentary.

Knowledge of the Neotropical Odonata can be stated to have begun in earnest in the early 1900's with Philip Calvert's monumental Neuroptera volume of the *Biologia Centrali Americana*. In ensuing years, the Neotropical region has become the focal point of taxonomic and biological studies by González and Novelo (Mexico), Maes (Nicaragua), Esquivel (Costa Rica), De Marmels (Venezuela), Santos, Machado, Costa, and Lencioni (Brazil), Muzón and von Ellenrieder (Argentina) as well as others. Certain groups, such as the magnificent Pseudostigmatidae, have been the subject of intensive studies by Fincke and some Neotropical odonates have been prominently featured in the recently produced *Life in the Undergrowth* by David Attenborough.

In my presentation I will review my past ecological and systematic work on the odonates of this fascinating region. My past work has included fieldwork in Mexico on the population dynamics of platystictid damselflies to synoptic studies of various neotropical representatives of the Gomphidae, Calopterygidae, Protoneuridae, and Coenagrionidae. Perhaps the culmination of these and other past studies has been the partial fruition of my dream for a completely illustrated treatise of the Neotropical genera of Odonata. Part one, the Anisoptera, has just been published, and we are now embarking on the completion of Volume 2, the Zygoptera, as well as a synopsis of one of the most difficult and speciose genera of odonates, the genus *Argia*.

Oral presentation

Conservation Value for Odonata: an intra - site investigation at Gibraltar Point National Nature Reserve, Skegness, UK

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Global warming with its resultant droughts, sea level rise and the intrusion of salt water are all challenges to nature reserves adjacent to the sea. Gibraltar Point NNR suffered a severe drought in 1973, which caused many ponds to dry out completely. In 1978 the reserve then suffered a breach in the barrier between the saltmarsh and the freshwater marsh. This resulted in the salination of many of the freshwater ponds that were the breeding habitats of dragonflies and damselflies.

Odonata surveys over the last 30 years have demonstrated the value of utilizing artificial water bodies as rescue havens and building new freshwater ponds to facilitate recovery of the dragonfly populations at Gibraltar Point. Breeding colonies of six species were recorded in the 1980's. The development of an artificial pond after the breaching of the dyke and the intrusion of seawater, followed by a new freshwater pond, resulted in recovery of the breeding species number to five and initial movement of populations to the artificial pond.

Currently breeding populations of Odonata on the reserve have increased to 12, with at least 14 Odonata species being recorded at the site annually. The vagrants included the Banded Demoiselle, Hairy Dragonfly, Red – veined Darter in 2003 and 2004, indicating that the strategy which combined the use of artificial and new freshwater ponds has been successful.

Oral presentation – Plenary talk

Dragonfly morphology revisited: its relevance for taxonomy, ecology and bionics

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Functional morphology is a branch of biological science integrating data from several disciplines: classical descriptive morphology, modern microscopy techniques, biomechanics, and various experimental methods. In this contribution, based on our previous studies of the dragonfly arresting systems, we will present results of comparative morphology, electrophysiology, and various preparation techniques. The head arrester in adult Odonata is unique among arthropods. This system involves the organs of two body segments: the head and the neck. It consists of a skeleton-muscle apparatus that sets the arrester parts in motion. The parts comprise formations covered with complicated microstructures, fields of microtrichia on the rear surface of the head, and post-cervical sclerites of the neck. The arrester immobilizes the head during feeding or when the dragonfly is in tandem flight. Thus, it may serve as an adaptation to save the head from violent mechanical disturbance and to stabilize gaze in a variety of behavioural situations. By using scanning electron microscopy and measurements of arrester structures in 227 species from 26 odonate families, an evolutionary trend of the arrester in the order Odonata is suggested. Two convergent pathways of head-arrester evolution among Zygoptera and Anisoptera are proposed.

The microstructure patterns of both surfaces of the system works as probabilistic fasteners. They are called probabilistic, because the outgrowths on both surfaces do not correspond exactly to each other, and the interlocking takes place without precise positioning of both surfaces. Probabilistic fasteners demonstrate high frictional forces when the surfaces come into contact. Attachment in this case is based on the use of the surface profile and the mechanical properties of the materials, and is fast, precise and reversible. The single outgrowths, which will be called elements, are not necessarily designed as hooks in a similar fashion to those of Velcro fasteners. The mechanism of attachment in such systems is also different from the hook-and-loop principle. The functional morphology data are discussed according to their relevance to evolution and ecology of Odonata, as well as to their potential significance to bionics/biomimetics. Additionally some results on (a) resilin-joints between veins of wings, (b) crystalline wax coverage of wings, and (c) ovipositor mechanics will be presented.

Oral presentation

From zero to full protection in five years: the case of *Somatochlora arctica* in the Netherlands

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Somatochlora arctica is regarded as one of the least known dragonflies in northwestern Europe. It is a typical species of bogs and wet heaths and a classic example of an arctic-alpine fauna element. It is quite rare in the western parts of its range. On the other hand, it is found more regular in the mountains of central Europe and across the northern parts of Eurasia eastwards to Japan. In the Netherlands, it declined during the last century, and at the moment, only five populations are left. These are situated in the eastern and southern parts of the country. The species is listed as endangered on the national Red List and a Species Protection Plan, with a term of five years was published recently. During the time allotted to this Species Protection Plan (2006-2010), the aims are 1) to know more about the ecology of *S. arctica* and the measures required for its conservation; 2) to convey this knowledge to those concerned with nature conservation in the field; and 3) to integrate this new knowledge into hydrological parts of peat restoration projects and into scientific visions on the functioning of peat ecosystems. The future of *S. arctica* in the Netherlands is precarious. Important causes are desiccation of peatland habitat, eutrophication of its habitats by nitrogen from agriculture and traffic, habitat loss and fragmentation, reducing population size and isolation of populations. In addition, lack of knowledge concerning the ecology of *S. arctica* and the hydrology of wet heaths and peat bogs, is also a main cause. This lack of knowledge exists also at the level of practical management, illustrating the difficulty of assessing the probability and possibility of raised bog restoration in the Netherlands. Climate change may also affect this species negatively, but measures taken to minimise any of its effects are beyond the scope of the Species Protection Plan. In this presentation we will summarise the results of the first year and focus on how new ecological knowledge is implemented at the level of practical management, so that effective measures can be taken.

Oral presentation

The use of dragonfly trends from the Dutch Monitoring Scheme in a broader context

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The Dutch Dragonfly Monitoring Scheme started in 1997 with a probationary year. From 1998 onwards the number of monitoring plots increased quickly to circa 350 plots counted yearly and spread over the most important areas in the Netherlands. About 40% of the plots are single species sites, which are counted three times a year during the peak flight period of the counted species. At all other sites, all dragonfly species are counted every fortnight, a total of nine times a year. Counting are usually done by volunteers of whom about a hundred are active in the Monitoring Scheme. Counting take place between May and September using a standardised method. Results are national trends and indices for each species, calculated by using the computer programme TRIM (Trends and Indices for Monitoring Schemes). This programme was developed by Statistics Netherlands for the analysis of time series of repeated counts with missing observations. Some of the most eye-catching results are the strong increase of *Lestes virens* and *Pyrrhosoma nymphula*, the latter being best explained by the increase in temperature due to climate change in the Netherlands. On the other hand, *Coenagrion hastulatum* and *Aeshna viridis* displayed a strong decrease. The calculated indices can be used for overall evaluation of Dutch nature policy and conservation, and for the protection of endangered species like *Leucorrhinia pectoralis* and *Calopteryx virgo*. Currently, national trends can be calculated for nearly all Dutch dragonfly species. However, we aim to calculate trends for species in a special habitat type or parts of the country in future. It is concluded that the Dutch Dragonfly Monitoring Scheme is a useful tool in the conservation and protection of dragonflies and their habitats in the Netherlands.

Oral presentation

The ornaments are similar but something is different - threat display in Sulawesian *Rhinocypha* and *Heliocypha perforata*

André Günther

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Males of both the Sulawesian *Rhinocypha* and *Heliocypha perforata* have iridescent areas on the wings combined with conspicuous lateral blue markings on thorax and abdomen as main ornaments. Territorial males perform extensive threatening flights.

In *H. perforata* the most important antagonistic display is that rival males are flying parallel, side by side with alternate wing beats and a strongly reduced beat frequency. In this flight-style the wing markings and the body coloration are conspicuous optical signals against the rival. Threatening flights serve to occupy and defend territories around oviposition sites or to hold the rival away from searching for females and courtship behaviour. Analogous to the well-known results in the *Calopteryx* species, only the winner of the contests can monopolize the oviposition site as a requirement for successful mating.

In the Sulawesian *Rhinocypha* species the most frequent and the most protracted threatening flights were observed between males inhabiting neighbouring territories. In contrast, penetrating non-territorial males were driven away by short pursuit flights. As a result, the males do not compete for territories but hold each other away from courtship. Threatening flights were found to occupy sometimes most of the daily time of activity, but varied considerably in duration for following days. There was a negative correlation between the duration of threatening flights on a particular day and the mating success for this day. During these flights two males face each other and display all 4 wings synchronously. The blue markings on thorax and abdomen have no function in antagonistic as well as in courtship behaviour. The display with the conspicuous markings on wings, thorax and abdomen is probably highly effective in the attraction of females. Males were found to be very stationary their whole life. The presence of males therefore indicates the reproduction success to arriving females. As the females are returning for many days to attractive sites for a territorial male, it is presumably more effective to prevent occupants of neighbouring territories from searching for arriving females than to defend oviposition sites which are not really limiting under the low population densities. Thus, in these *Rhinocypha* species one can expect that threat display has the exceptional function of coherence of groups with effects on the population level.

Oral presentation

Telemetry of freshly emerged dragonflies (Anisoptera)

Sönke Hardersen

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The biology of the European Odonata is generally well known. However, the behaviour of dragonflies in the time between emergence and the onset of sexual activity is poorly studied. Investigating dragonflies during this period is difficult because they do not live in a well-defined and accessible habitat (as most sexually active Odonata do) and are sometimes "out of reach" of the human observer. For example, it is known that habitats occupied by immature adults include the canopy of forest trees.

In order to follow freshly emerged adult dragonflies (Anisoptera) and investigate behaviour and habitat usage in the time following emergence, the "RECCO Rescue System" was used for telemetry. A micro-antenna (Schottky diode with a dipole antenna), which weighed 0.025 g and allowed for detection of dragonflies from distances of up to 100 m, was attached to the abdomen shortly after emergence.

Ten individuals of *Libellula fulva* (5 females, 5 males) were followed for up to five consecutive days. During the first day the dragonflies moved only for short distances (average 34 m). During the second day flight activity increased and the distances covered reached up to 178 m. *L. fulva* utilized almost exclusively trees and shrubs for perching, registered heights ranging from 1.2 to 31 m (average 11.2m). In contrast, meadows and riparian vegetation, which were also present close to the release site, were never used by *L. fulva*. Considering that a human observer can reasonably detect dragonflies up to a height of approximately 3 m, 92.5 % of all registered perch sites were "out of reach".

Five tracked individuals of *Aeshna mixta* (1 female, 4 males) showed a very different behaviour. Already in the first hours after release, all flew for long distances (> 200 m) and were lost. The system used for telemetry was not suitable to study the behaviour of this species immediately after emergence.

Poster presentation

The Congress: Dragonflies in Italy - Research and Conservation

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The first Congress on Italian Odonata, organized by "Ticino Valley Park, Piedmont", "National Centre for the Study and Conservation of Forest Biodiversity – Bosco della Fontana", and "University of Pavia", was held on 10/11-02-2007 in the headquarters of the "Ticino Valley Park".

The congress was planned as an occasion for exchange of information on research and conservation of dragonflies in Italy, also from an European perspective. Apart from the Italian specialists, some odonatologists from other European countries were invited to present their specific experiences.

With a total of 80 participants, 24 oral presentations and five posters, the congress was a success. The subjects of the talks ranged from a tribute to E. Bucciarelli to the presentation of the "Atlas of the Odonata of Piedmont and Aosta Valley", and to the discovery of a new species for the fauna of Italy: *Cordulegaster heros*.

The congress was organized with the aid of the website www.odonata.it, which currently contains the programme, the abstracts and a group photo. It is planned to use this site in the future to provide information for people interested in Italian Odonata, such as bibliography of Italian Odonata, a checklist of Italian Odonata, newsletters, etc.

Oral presentation

Larval ecology and morphology as determinants of the spatial distribution of Gomphids (Odonata) in streams of northern Victoria, Australia

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Nine species, in four genera, of dragonflies from the family Gomphidae were recorded from northern Victoria. Spatial separation occurred at the generic level and discrete distribution patterns were observed at the species level. The larvae were riverine, mainly occurring in the main channel, however, several species preferred the more lentic waters of the floodplain billabongs. The species of *Austrogomphus* and *Hemigomphus* were found to exhibit discrete spatial patterns along the streams and generally when two species distributions overlap, they occupied separate microhabitats. The larva of each species was morphologically adapted to the substrate type of the habitat where they occurred. Studies of the biology showed large variations in the egg morphology and method of adhesion to the substrate between the genera. The eggs of *Austrogomphus* developed at a slightly lower temperature threshold than those of *Hemigomphus*. Most species appeared to have a semivoltine life cycle and the studies of the larval diet of some species showed that the larvae consumed what prey was the most abundant in a habitat. The findings suggest that a combination of larval biological, ecological and morphological parameters determine the most suitable habitat for each species.

Oral presentation

Why do not males catch up with females in pursuing flight in *Calopteryx splendens*?

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In high densities males of *Calopteryx splendens* show alternative reproductive behaviour (ARB) at the river Oker in Northern Germany. One of several tactics is to pursue females. Pursuing flight was filmed in summer 2006 in slow motion with more than 300 frames per second using a 16 mm LOCAM camera. Frame by frame analysis showed that males fly in irregular flight patterns: they switch between wingbeats and pauses of the wingbeats in backward position while females fly more steadily. They show a significantly lower wingbeat frequency than males. Males show different flight performances depending on the position to the female and to other pursuing males. Several explanations for these differences are discussed on the background of the film analysis.

Poster presentation

Notes on the distribution of *Cordulegaster* spp. in Central Europe

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Cordulegaster bidentata and *C. boltonii* occur in the Czech Republic. From Slovakia, according to literature, all three species – *C. boltonii*, *C. bidentata* and recently *C.heros* are recorded. The aim of my revisions at Slovak museums and private collections and also by own research was to find out if all three Central-European species are really occurring in Slovakia.

The occurrence of *Cordulegaster bidentata* in Slovakia is in the submontane regions of Velká Fatra Mts., Kysucké vrchy Mts., Malá Fatra Mts.; the most numerous populations are in the region of flysch Carpathians Mts. – Bukovské vrchy hills in Eastern Slovakia. The area of occurrence continues into Ukraine, where numerous populations were found in the uplands of Horhany Mts.

Cordulegaster heros is so far found in the Borská lowland and in the Malé Karpaty Mts. It is the most northern occurrence in its area, which reaches from Austria through Hungaria and further into the Balkans. The species will be probably occurring in the whole territory of the Pannonian lowland and the area will also reach to the southern part of Slovakia and pannonian Ukraine.

The occurrence of *Cordulegaster boltonii* in Slovakia is still controversial. It is known from the whole territory of Slovakia according to data in the literature. When the accessible material was checked I above all found misidentifications with *C. bidentata*, and partly there was probably "historical" lack of knowledge of *C. heros*. *C. boltonii* is very common in the western part of the CZ, and in the Westcarpathian part of the CZ it was found very rarely. On the base of present knowledge its eastern border lies along the West Carpathians Mts., i.e., the border goes from Austria, continues outside the Carpathian Mts. through the CZ into Poland. It is not found on Slovak's territory.

The species *C. boltonii* and *C. heros* are very close; they are members of one group of this genus, i.e., they can be regarded as geographical vicariants in Central Europe.

Poster presentation

Shift of the northern limit of *Somatochlora meridionalis* (Odonata: Corduliidae) in Central Europe?

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Somatochlora meridionalis inhabits slowly running waters of narrow, shallow shaded streams and streamlets with rich vegetation on the banks. It occurs in lowlands (with optimum ca 200 m a.s.l.), in Slovenia it inhabits localities from 100 m to 800 m a.s.l.; in the southern part of the area in the karst lands of Balkans it rises up to 1000 m a.s.l.

Somatochlora meridionalis is an eastern Mediterranean species. Most records are published from Italy, ten localities are known in Slovenia. Single localities are known from Montenegro, Croatia and Greece. The species is also found in the northeastern part of Bulgaria and in the southern part of the coast of the Black Sea. From Austria it is known from the SW part and from localities near the border to Slovenia. The western limit of the area lies in southwestern France.

The northernmost records of the species are from Slovakia – the surroundings of Šahy village and the most northern record in the region of the East-Slovak lowland.

In 2006 I found several specimens of *S. meridionalis* near the village Vlachovice-Vrbětice in the northern part of White Carpathians Mts. (code of grid mapping 6873). They occurred at a narrow shadowy and shallow ditch with slow running water and muddy bottom with dead leaves. I noted several males and also a female during egg laying. Larvae were not found.

S. meridionalis probably inhabits the whole Pannonian lowlands up to the arc of the Carpathians Mts.; in the southern part of Balkans there is an isolated area of occurrence.

Records from the Czech Republic are in the most northern hook of the distribution of this species. If this is a permanent population or if it was only a temporary expansion of the area, will be the focus of my next research.

Oral presentation

Notes on the diurnal activity of adults of *Cordulegaster bidentata*

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Cordulegaster bidentata Selys is a European species occurring in forest spring areas and very small streamlets. In the Czech Republic the centre of occurrence of the species is in the Western Carpathian Mts.

Our study was conducted in a small spring area in the Moravskoslezské Beskydy Mts. (Ostravice village - valley of Mazák, altitude 680 m a.s.l.) in the eastern part of the Czech Republic. The spring area and contiguous streamlet (with total length 70 m) are in a small valley in large complex of forests (stemwoods). The abundance of imagoes was noted during three days at the end of July and at the beginning of August. All imagoes were marked and released. Daily observations took place from 7.30 to the dusk at 20.30 (CET).

During the 3 days we found 76 males and 32 females (during the consecutive days we marked 42-14-10 males and 15-11-7 females respectively).

Diurnal activity of males was recorded from 8.30 until 19.00, when the locality was shaded. The highest abundance per hour was recorded between 10.00-11.00 and between 16.30-18.00. The maximum number of males per hour (including reappearence of previously marked males) was up to 80. During 1 minute we recorded the passage of up to 5 specimens, in some cases in 3-member "groups" with a distance of about 1 m between specimens. The periods with intensive transit flights of males "up and down the streamlet " was up till 20 minutes.

Diurnal flight of females was recorded from 9.10 until 17.30. Egg laying was recorded between 9.40 to 17.30. The highest female abundance per hour was between 10.00-11.00, and between 15.00-16.00. The maximum number of females recorded per hour was 8. Male attacks on females occurred during the first female visit. Egg laying was observed from the top of the spring area to a distance of 25 m downstream.

Poster presentation

The impact of area, productivity and forestry on dragonfly species richness in small boreal forest lakes (Research plan)

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One of the few general laws in ecology is that species richness is a positive function of area. It is however unclear whether the primary reason for species richness is area *per se*, habitat heterogeneity, energy or interactions of these factors. Also, our knowledge of mechanisms producing this species-area relationship is limited. Dragonflies (Odonata) are semi-aquatic, predatory insects. Their species richness is correlated with species richness of vascular plants of the lake which, for one, is correlated with productivity. Therefore, the primary reason for dragonfly species richness could be productivity of the lake, but the subject has remained largely unexplored.

As the boreal forest landscape is a combination of water and land, and forestry has become the primary disturbance factor on the forest landscape, it is necessary to study the impact of timber management also in freshwater species. Human activities in watersides, particularly forestry, can have an impact on dragonfly fauna but it remains unclear what the mechanism are.

Our study has two main questions: (i) is the dragonfly species richness (i.e. the number of species present in an area) in small boreal forest lakes a primary function of area, energy, habitat heterogeneity or a combination of these factors; and (ii) what is the impact of forestry on dragonfly species richness in small boreal forest lakes. Results from this project provide new insights to interactions between terrestrial and aquatic ecosystems as well as to mechanisms determining species richness in local communities and regional species pool. In addition, the results will also yield important understanding how to manage forest landscapes while taking into account both the forest dwelling species and the freshwater species.

Poster presentation

Factors affecting egg load in relation to food intake for *Sympetrum infuscatum* females in forest gaps during interval oviposition

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The destination of maiden flight in *Sympetrum infuscatum* is a forest gap near the rice paddy fields that are the larval habitat. The adults stay there throughout their life span with intermittently visiting the rice paddy fields for oviposition. During the reproductive season, a lot of females remained perching in the forest gaps, exclusively to forage. They might develop eggs in the ovaries until the next visiting the rice paddy fields to oviposit. In order to estimate their daily food intake in the forest gaps, we compared quantity of the faeces excreted by a female captured in the forest gaps with that by a female fed on in the laboratory. Females captured in the early morning in the forest gaps excreted faeces of 2.64 mg (dry weight) within the twenty-four hours rearing, the faeces which must be undigested food taken on the previous day. Females fed on 0, 1, 2, 3 and 4 sheep blowflies (dry weight: 6.24 mg/individual) excreted faeces of 0.74, 1.60, 2.00, 2.60 and 3.09 mg (dry weight) during the following twenty-four hours in the laboratory. Therefore, the quantity of daily food intake in females staying in the forest gaps was estimated to the biomass of 3.1 individuals of the fly. The number of mature eggs in a female in the laboratory was increased with the number of flies fed. Females that fed on only water produced about 190 mature eggs, while females that fed on 3 flies produced about 310 mature eggs, indicating that the nutrition of 3 flies is corresponded to about 120 mature eggs developed. Since a female laid 500 eggs once visited the rice paddy fields and exhausted all mature eggs in her ovaries, about 4 days must be needed for egg production staying in the forest gaps, in order to visit for a single oviposition.

Oral presentation – Plenary talk

Coping with stress: Strategies to deal with different conditions along environmental gradients

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Freshwater systems show a great variation in water permanence ranging from temporary to permanent. These waters vary in abiotic and biotic factors that organisms must adapt to. From an organism's point of view, temporary waters typically have very hard physical conditions with a more or less regular drying, and a short but highly productive period with water. In contrast, lack of water is no problem in permanent waters; instead these waters may be less productive and inhabited by large predators that are absent in temporary waters. Temporary waters should therefore select for small rapidly growing organisms and permanent waters should select for larger organism with a high ability to withstand competition and predation. Dragonflies are excellent organism to test these predictions, since species are distributed along the continuum of the water permanence. I will provide a review from three different systems, showing how dragonfly larvae have adapted in behaviour, growth and development to different environments along the gradient. The result shows support for predictions and that a clear trade-offs exists with regard to trait adaptations.

Oral presentation

Stressed damselflies: Effects of natural enemies on immunity

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Odonate larvae live under a constant risk of predation, parasitism and cannibalism. All of these are stressors, which – if successful – cause death or at least injury. It is known that odonate larvae can sense the presence of predators, parasites and conspecifics via olfactory cues. Therefore they can sense the risk level, which is in itself likely to cause stress. Behavioral studies have shown that species develop varying strategies to avoid these risks. However sometimes these strategies are not possible and never absolutely secure.

Therefore here it is asked: (i) whether odonate larvae react towards these risks by altering their immune functions depending on the risk present (predation, parasitism or cannibalism); and (ii) what happens to the immune system if the stress becomes higher, that is, if several risks are present at the same time.

As study species the damselfly *Coenagrion puella* (Coenagrionidae) was chosen. Fish and dragonfly larvae were used as natural predators, and watermites as common parasites on damselflies. We found that the immune response depends on the risk level, the immune parameter measured and sex.

Oral presentation

Mapping European dragonflies

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In 2006 a start was made with the work on an atlas of the European dragonflies. This project is sponsored by the Invertebrate Survey The Netherlands and should result in a distribution atlas of all European dragonflies in 2010. In this atlas information on distribution will be presented based on a grid of 50 by 50 km for all European countries except for Russia. In 2006 coordinators for most European countries were found and projects for poorly known countries such as the Ukraine and Romania were initiated.

During the presentation an overview of current activities will be given and some first results will be presented.

Poster presentation

Studies on Old World Megapodagrionidae

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In 2005 a study on the Old World Megapodagriondae was started. The main aim of the project is to unravel the taxonomy and biogeography of this tropical family. Besides fieldwork will be undertaken to study the habitat preference and behaviour of the species. The poster gives an overview of the species in the Old World and shows the distribution of the species in the Australasian region. Some examples of the work undertaken are given.

Poster presentation

Ovariole arrangements in Libellulidae

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Several studies deal with the ovary morphology in different insect groups. However, none of these studies compared morphological traits like ovariole number and diameter with the function of the ovaries like the egg production. So far all odonates are believed to have continuous oocyte production during their whole mature life span. We studied sixteen species from ten different genera caught in three countries: Germany, Japan and Namibia. The posterior halves of the ovaries were embedded in paraffin or plastic, the ovariole number per female was counted and the ovariole diameter was measured.

The mean number of ovarioles per female varied from 30 in *Sympetrum vulgatum* to 171.3 in *Trithemis kirbyi*. Compared to other insect groups these numbers were high, four to eight being typical for the average insect. The ovariole arrangement fell into two distinct groups: 1) all developing oocytes mature (eggs contained within a layer of nurse cells, more or less ready to be deposited) and rather equal in size, sometimes enclosed in a thick layer of connective tissue. 2) Oocytes displaying gradual maturation, with the outermost (closest to the abdominal tergite) two to three layers of ovarioles mature, while numerous immature ovarioles of increasing size from the centre of the abdomen and outwards could be observed beneath these layers.

We believe that the process of ovariole maturation differs between these two groups. In the first group there is what we call stepwise egg production; these species will lay one or more egg clutches, after which an interclutch interval of ovariole regrowth will follow. In the second group there is continuous egg production where the species are able to lay at least some eggs all the time, reducing the length of interclutch intervals. These different ovariole arrangements might have a crucial impact on the reproductive ecology of the species.

Oral presentation

Long-term changes in dragonfly communities of the Okavango Delta, Botswana

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The Okavango Delta is a large African wetland pulsed by the annual flood of the Okavango River. The permanent and seasonal flooding creates a highly dynamic ecosystem in stark contrast to the surrounding rain-fed savannah of the Kalahari. Seasonal flooding is influenced equally by local rainfall and inflow from the catchment to the north, but also depends on global influences. Rainfall and especially inflow have declined since 1980 but there is an evident increase in very recent years.

The author shows how dragonfly communities in the seasonal flooded part of the Okavango Delta are able to response to their dramatically changing environment. Due to the unusual permanent presence of floodwater since June 2005 in and around Maun at the southern outflow of the Delta, the dragonfly species composition changed completely. Compared to the situation in former years around 2000, many species of the more permanent swamps resettled in former abandoned areas very quickly and in large numbers. Species, which were completely absent in the former seven years, like *Pseudagrion deningi*, *Agriocnemis ruberrima* or *Ceriagrion katamborae* became dominant in some habitats.

On the other hand, few species with historical records from Maun haven't been confirmed despite intense search. The absence of the running water species *Pseudagrion glaucescens*, *P. sjoestedti* and *P. sudanicum* shows the decline of floodwater since the early 1980s.

This indicates that the frequency and duration of flooding are key factors, which change the dragonfly species composition in the Okavango Delta. Areas with a rapidly growing human population, like Maun, are highly affected by land-use changes leading to deforestation, water extraction and increasing pressure by grazing livestock. One example is given how a dragonfly community suffer from increasing grazing by cattle and other livestock.

Oral presentation – Plenary talk

Odonata phylogeny: Update and prospects

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The phylogeny of Odonata has been a matter of controversy since early in the 20th Century. Modern advances in phylogenetic analysis have begun to be applied, but problems of taxon sampling and extensive morphological homoplasy have made progress difficult. Here we provide an update on our study of the order, which incorporates molecular data from nuclear ribosomal and protein coding genes and mitochondrial sequences and encompasses nearly all recognized subfamilies of Odonata. We recover monophyletic Zygoptera and Anisoptera and most, but not all, of the traditional families. Anisoptera comprises a largely pectinate array of families with Aeshnoidea at the base. Three principal clades are found in Zygoptera, corresponding approximately to Lestoidea, Calopterygoidea, and Coenagrionoidea. Within superfamilies and families, however, molecular analysis implies many differences from relationships inferred from morphological data alone. Although neither class of characters is inherently preferable, we believe, in agreement with some recent results of others, that many current problems are the result of widespread homoplasy in morphological features, especially venation. We discuss some examples, compare relationships inferred from different data partitions, and suggest areas where future work is especially needed.

Oral presentation

Natural selection: a major impetus for the evolution of two reproductive strategies in Libellulidae?

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The study of mating systems is the study of the behavioural, physiological, and ecological factors that underlie predictable patterns of male and female interactions during reproduction. In dragonflies mate-guarding, sperm competition, oviposition behaviour, habitat selection and offspring conditions are well-studied issues since a long time. However, numerous gaps in the knowledge of mating systems have been left. Most studies discussed mating systems under the main focus of sexual selection. To focus more on natural selection might bring some new insights into the discussion of mating systems. How do habitat selection, oviposition behaviour, offspring conditions, morphological traits, and migration patterns interact? The talk is mainly based on data from Namibia.

Oral presentation

Odonata of the Amur River (Far East of Russia) and the problem of their conservation

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One of the world's largest rivers, the Amur River, remains one of the least investigated in the Palaearctic. For almost 3000 km, the river is a boundary between Russia and China; scientific investigations in this territory are difficult not only due to the severe natural conditions and limited transport possibilities but also through the political and administrative restrictions.

The data obtained by the author during three field trips to the Upper and Middle Amur in 2005 – 2006 indicate a good enough state of the dragonfly fauna. This is also shown by observations made in the Lower Amur by the expedition of Institute of Water and Ecological Problems (Khabarovsk) in 2006. Hitherto 13 species of stream dwellers are known from the Amur River, including the rare *Anisogomphus maacki* (Selys), *Shaogomphus postocularis epophthalmus* (Selys), *S. schmidti* (Asahina) and the newly recorded *Stylurus occultus* (Selys). There is a high possibility that *Macromia daimoji* (Okumura), *M. manchurica* (Asahina) and *Stylurus annulatus* (Djak.) also inhabit the river. *Nihonogomphus ruptus* Selys is the dominant species along the whole course from Pokrovka to Nikolaevsk; *Calopteryx japonica* Selys, *Stylurus flavipes* (Charp.) and *Macromia amphigena fraenata* Martin are common in the Middle Amur, while *Epophthalmia elegans* (Brauer) and *Gomphidia confluens* Selys occur sporadically. *Anisogomphus maacki* and *Ophiogomphus obscurus* Bart. have higher abundance in the Upper Amur, *Calopteryx atrata* Selys*, Shaogomphus schmidti* (Asahina) and *Sieboldius albardae* Selys are characteristic for the Lower Amur. More than 50 limnophilic species occur in creeks, oxbows and swamps in the Amur valley.

Low human population density and stagnation in the economy during the last decades provided a good environment for Odonata, but the threat in near future is severe owing to increasing economic activity, especially on the Chinese side of the river. From the Russian side, the intended ten to twelve hydroelectric power plants to be constructed at the Amur may be one of the major threats. Measures to preserve the natural landscapes should be started as soon as possible.

Oral presentation

Dragonfly larvae with scoop-shaped labium as effective predators on adult dytiscid beetles: from field data on strict habitat segregation on a tropical island to experimental evidence

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The Indian Ocean island of Rodrigues is marked by deforestation and erosion. In August 2005 and April 2006 the freshwater fauna of the island has been surveyed in detail. Except the enigmatic endemic *Argiocnemis solitaria* all five previously known species could be recorded as well as three species new for the island. *Tramea limbata* and *Pantala flavescens* are dominant. There has been a strict habitat seggregation of odonate larvae and aquatic beetles. Beetles occurs mostly in ephemeral pools only, where anisopteran larvae are absent.

To explain the field evidence of a strict habitat seggregation between anisopteran larvae and dytiscid beetle adults laboratory experiments were carried out. The study focussed on the hypothesis that the dichotomy in the functional morphology of the odonate labium suffered differences in predatory success. Beetle adults have a hard cuticle and a smooth and rounded body which suffers some support from the grasp of a dragonfly larvae. The experiments demonstrated clearly that large larvae of *Tramea limbata* (Libellulidae), being widespread on the island and having a scoop-shaped labium, were much more effective in catching *Copelatus insularis* (Coleoptera: Dytiscidae) and other aquatic beetles than those of *Gynacantha bispina* (Aeshnidae) having a flattened labium.

Oral presentation – Plenary talk

Fliers and perchers among Odonata: dichotomy or continuum? A reappraisal

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In 1962 it was hypothesised that, with regard to their means of thermoregulation and overt behaviour, two types of Odonata can be recognised. *Fliers* are those that, when active (during adult foraging or reproduction) remain on the wing, whereas *perchers*, when similarly engaged, spend most of the time on a perch from which they make short flights. At the time this difference was rationalised in terms of the dragonfly's need to avoid overheating the body. Since 1962 direct measurements of body temperature, coupled with activity budgets, have made it possible to revisit this hypothesis and to test its premises, with particular reference to a recent suggestion that fliers and perchers may occupy opposite ends of a continuum rather than constituting a dichotomy.

We review existing knowledge concerning the thermoregulatory strategies exhibited by species that operate primarily as endotherms, ectotherms or heterotherms, having regard to the behaviour characteristic of species at different latitudes and to examples of behaviour that appear to constitute anomalies, i.e. departures from the otherwise predictable correlation between flight behaviour and thermoregulatory strategy.

We conclude (1) that there is merit in retaining the dichotomous classification into fliers and perchers, together with the thermoregulatory capabilities assigned to each category; and (2) that the distinction between fliers and perchers among Odonata constitutes a dichotomy sufficiently discrete to be a useful predictor of the suite of thermoregulatory strategies that representatives of each category employ. Occasional departures from a close correlation can readily be rationalised in terms of the effects on behaviour of (a) adult density and (b) of body size and a consequent degree of reliance on endothermy. This being so, the flier/percher dichotomy is likely to be especially useful heuristically by pointing up anomalies (with respect to expectation based on taxonomic affinity, e.g. the Pseudostigmatidae, Trameinae and Zygonichinae) because this will encourage examination of species that face anomalous circumstances or that make special arrangements to thermoregulate in atypical ways.

Oral presentation

Increase of *Sympetrum pedemontanum* in the Netherlands: the knowledge of volunteers incorporated in local water board management

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In the last century the Banded darter *Sympetrum pedemontanum* (Allioni, 1766) was a very rare species in The Netherlands. Only a few populations in the south of The Netherlands were known since the eighties, mostly in nature reserves. In 1996 and 1997 an influx occurred and individuals of *S. pedemontanum* have been recorded at about 20 places all over the country.

In August 2000 a large new population of *S. pedemontanum* was discovered in the eastern part of the country where over 200 individuals were recorded. An extensive survey of all streams and waters in the surrounding agricultural area was done, to describe the whole population. Most of the populated streams were slow moving and well vegetated, including a riparian component. The water quality was rather eutrophic or mesotrophic and was, in most cases, influenced by seepage. Most likely this population was a result of the influx of 1996-1997. However, the area in which the new population was discovered was visited several times between 1997 and 2000 and *S. pedemontanum* was not seen during these visits.

In the eastern part of the country a large area consists of suitable habitat. In addition to the discovery of 2000, two new populations were discovered in 2002 in the north of the province of Overijssel, approximately 30 km north of the location of the first discovery. Furthermore, since 2002 new sites were each year discovered in the direct surroundings. Many volunteers were involved in this project and spend their time searching for new sites. Because of the habitat characteristics of *S. pedemontanum,* it is easy to recognize streams that have high conservation potential. Therefore, the local water board is interested in this species and is willing to consider the ecological qualities of the Banded darter in their local management.

Poster presentation

The use of digital techniques for providing scientific drawings in arthropod taxonomy

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In arthropod taxonomy the production of scientific illustrations takes a lot of time and the results are often unsatisfactory. One possibility to speed up the task and obtain high quality results is the use of digital tools, such as WACOM pen tablets and several kinds of photo management software. A simple but promising method is described from an example of odonate larvae or exuviae. The body shape and illustrations of details can be generated from a scanned photo or a line drawing by using a pen tablet. With the help of the software mistakes could be deleted and parts of the drawing substituted easily.

Poster presentation

Odonata diversity in western Mexico

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Odonates were collected over a two-year period (2005-2006) in the Coalcoman Mountain Range, in the state of Michoacan, Mexico. Collections were made twice per season during the first year and once per season the second year (except in winter, where 11 field trips in total were made). Surveys occurred in 8 streams located along an altitudinal gradient from 10 to 1130 masl. Collecting occurred in tropical deciduous forest, tropical sub-deciduous forest, cloud forest, and pine-oak forest. Three sites were located on the windward slope, one on the top of the mountain range, and the remaining four sites on the leeward slope. Adults and larvae were collected at each site from 10:00-16:00 h. Species accumulation curves were constructed for each stream and for the whole area, and species richness was estimated using bootstrapping provided in EstimateS, version 7.5.0.

The assemblages were compared to each other using similarity indices, and species turnover was estimated using Whittaker's β_w. The entire area yielded 116 species (gamma diversity), 44 genera and 9 families. The highest and lowest alpha diversity was recorded at El Ticuiz (10 masl) and El Colorin (1050 masl) with 66 and 28 species, respectively. Total species turnover was observed between these two localities (β_w = 2.0). One site achieved nearly 57% of the gamma diversity (El Ticuiz). Both slopes were complementary in 43%. Twenty-five species were present in all collections, suggesting they are flying throughout the year, while 17 species were collected only once. No single species inhabited all the streams studied, although 33 species occurred at more than half (eurytopic). Forty-five species were found in just one stream and 18 species in only two streams (stenotopic).

Twelve species exhibited strong seasonality, with 10 during the rainy season (summer), one at the beginning of spring, and one more during the last third of autumn. The most diverse genus was *Argia* (17 species), followed by *Hetaerina, Progomphus, Brechmorhoga* and *Macrothemis* (5 species each). We conclude that β is an important contributor to diversity at a landscape scale.

Poster presentation

A preliminary study of impact of anthropogenic disturbance on dragonflies' habitats along Nairobi River

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Conversion of riverine ecosystem to both planned and unplanned human settlement drastically alters the fresh water habitats and makes them more susceptible to siltation and pollution. Such influence potentially results in major wetland biodiversity changes of major conservation concern. As the settlement activities continue to expand along the Nairobi River, there is an urgent need to find ways to conserve the wetland habitats and associated biodiversity such as dragonflies. Below is a short description of preliminary study of impact of anthropogenic disturbance on dragonflies' habitats along Nairobi River.

Oral presentation

Prediction of Odonata diversity: a tool for the assessment of freshwater biodiversity

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Odonata are valuable indicators of ecosystem health. As their species richness is often related to global biodiversity, this metric can be used as a surrogate in a global assessment, especially when funding is limited. We present here a methodology tested and used for the assessment of the biodiversity of Western Europe water bodies. This methodology has been developed in Switzerland, on the basis of adult Odonata inventories conducted in 80 small water bodies (6 m^2 to 9 ha). The assessment has been chosen in accordance with the European Water Framework Directive of 2000 which stipulates that the ecological status of water bodies has to be assessed by comparing the present conditions and the expected reference conditions. It has been achieved here by the ratio of the "*observed species richness*" over the "*predicted species richness for conditions that enable a high richness*"; it allows the classification of the water body into five biological quality classes (bad, poor, moderate, good, high).

The "*observed species richness*" is an index of diversity, which is obtained from a standardised field procedure conducted during 2 sampling days at the end of spring and in mid-summer (located during the flying period of Odonata). This index corresponds to the species richness issued from the field-checklist, further corrected by an abundance-based estimator (Chao1). The "*predicted richness for conditions that enable a high richness*" is obtained from a Generalized Additive Model, constructed on the basis of the relationships between species richness and environmental variables. Amongst about one hundred measured local and regional variables, three were found significant and are considered in the predictive model: altitude, water body area and water pH. Examples of the application of this assessment method are presented for ponds from Switzerland, including results obtained by end-users (local nature managers).

A further development of this assessment method is the prediction of the species composing the communities. We present here a first version of such a complementary tool.

Poster presentation

The influence of the change in the social environment of children on their recognition of dragonflies

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For most Japanese children, dragonflies have been one of the most familiar objects of their play. However, the change in the social and industrial structure and land-utilization must have been influencing the type of children's play. It is hypothesized that such changes have decreased the frequency of children's contact with dragonflies, resulting in the impoverishment of knowledge about dragonflies. We carried out a questionnaire survey of 149 university students about their knowledge of dragonfly morphology and ecology as well as their habits and environments when they were elementary school pupils.

The result shows that the score of dragonfly knowledge has significant (*$p<0.05$; **$p<0.01$) positive correlation with 'frequency of touching dragonflies'**, 'freq. of observing dragonflies'**, 'freq. of collecting dragonflies'**, 'freq. of seeing dragonflies'**, 'freq. of reading'*, 'freq. of playing in the field'*, and 'freq. of catching creatures at the water'*. On the other hand, the knowledge has no correlation with 'freq. of playing TV games', 'freq. of watching TV, 'freq. of outdoor play', 'population size', and 'building density'. Where a river or pond exists near the house, the 'freq. of catching at the water' is higher**, while as the building density increases the freq. decreases**. The building density has a negative correlation** with 'freq. of seeing dragonflies', but no correlation with 'freq. of catching dragonflies'. 'Freq. of seeing dragonflies' has a positive correlation with 'freq. of catching dragonflies'**. There is no correlation between freq. of 'TV games' and 'catching dragonflies'.

Thus, it is confirmed that those children that have abundant experience of playing in the filed, catching at the water, and therefore a higher chance to see, catch, contact and observe dragonflies, get and maintain better knowledge about dragonflies. A habit of reading enhances dragonfly knowledge but not so much as dragonfly experience in the field. The external environment such as population, building density, and nearness of rivers and ponds as well as the freq. of indoor plays don't have a significantly influence on dragonfly knowledge. However, building density, a kind of social change, reduces the chance of seeing dragonflies and playing at the water, which will eventually reduce the chance of dragonfly experience in children.

Oral presentation

Recent effects of climatic changes on the waters of the biosphere reserve "Palatinate Forest" and consequences for the web NATURA 2000

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Dragonflies are good indicators for the quality of aquatic environments and also for environmental changes. Consequently they are also used recently as monitoring organisms to demonstrate the effects of climatic changes, e.g. via the range expansion of southern species to the north or via the shifts within communities.

Here the results of a study, carried out during the last three years in the transboundary biosphere reserve "Pfälzerwald-Vosges du Nord" are presented. The dragonfly fauna and the environmental conditions of more then 20 water bodies – mainly dystrophic lakes (Natura 2000-code 3160) – were monitored and compared with previous investigations of these waters. All these water bodies are part of the national NATURA 2000 network.

As a consequence of the effects of climatic changes and also synergistic effects (e.g. ground water extraction), the water bodies changed dramatically in the last three years. In this period the water level decreased between one and two meters and the water had no more contact to the vegetation at the shoreline.

Consequently also the dragonfly fauna changed: most of the stenoecious and endangered mooreland species, which are characteristic for the dystrophic waters, are gone from nearly all waters (e.g. *Somatochlora arctica, Aeshna juncea, Leucorrhinia dubia, Coenagrion hastulatum*) and they are now also nearly extinct for the German part of the biosphere reserve. On the other hand these lakes were colonised in the same time by euryoecious and ubiquitous species, which are now dominating the waters and coenosis (e.g. *Anax imperator, Orthetrum cancellatum, Libellula depressa*) and indicating the strong disturbance. Some of the waters also dried out completely and lost totally their value for any aquatic fauna.

If no changes will occur in the near future – and the scenaria show an even stronger impact on this region – and if no management and mitigation measurements will be undertaken immediately, the remaining waters will also loose their importance for the NATURA 2000 network within a short time. This will lead to a strong devaluation of the entire concept of the national and international biotope web in the region.

Oral presentation

Species protection programme for *Oxygastra curtisii* in Germany

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In 2005 and 2006 a species protection programme for *Oxygastra curtisii* was carried out at the river Our.

This population is up to today the only one existing in Germany and so the federal state of Rhineland-Palatinate has a special responsibility for the protection of this species, listed in the Annexes II and IV of the EC habitats directive.

It could be shown that at this river a vital population exists: In 2006 a total number of 1110 exuviae were found in the intensively investigated 12 km long river stretch. From a capture-recapture-study a population of more then 1200 individuals was calculated (method: DU FEU).

According to our study the larvae stay only in the dense roots of the alder trees (exceptionally also in willow roots) which grow along the shoreline of the river and protect them well against predators, like fish, crayfish etc. Here they complete their 3-year larval development. The main emergence period lasts from mid June until mid July, altered by the general climatic conditions in the years. The flight period lasts from June to early August. If the weather conditions are appropriate, the general activity phase of the species could be registered from the morning until the evening and lasts in total about ten hours (incl. oviposition).

Of particular interest and importance for the species are the pool-sections of the river. Typically these have alder trees at the shoreline. Oviposition takes places over and on the submersed, dense Alder roots along the shoreline.

A concept for the protection of *O. curtisii* was elaborated and special measurements for its realisation were developed.

Beside *O. curtisii* at the river Our, another 25 dragonfly species were found. Out of them ten are listed by the national red list of dragonflies, 16 by the Red List of the federal state of Rhineland-Palatinate.

In the site "Ourtal" (Our valley), which is part of the national network of NATURA 2000, in total 14 species of the Annexes II and IV were found or registered, which shows the national and European wide importance of the site.

Oral presentation

The colonization of temperate latitudes by Neotropical Zygoptera

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Of the Zygopteran genera that probably evolved in the Neotropics, few occur north of Mexico. Two that do get into mid-north temperate regions are *Argia* (Coenagrionidae) and *Hetaerina* (Calopterygidae). The distributions of these genera are similar, except that North America has no unique *Hetaerina*, but has at least 15 species of the more speciose genus *Argia*. The tactics that allow *A. vivida* and *H. americana* (the most northerly species in these genera) to occupy mid-temperate latitudes in western North America are very different. Occupancy of geothermally influenced streams that do not freeze in winter is probably important in both species. But larval diapause is an integral part of life history regulation in *A. vivida*, whereas there is no clear evidence of larval diapause in *H. americana*. The overall impression is that larval growth in *H. americana* is dictated by temperature; larvae simply grow as fast as temperatures allow assuming that food is not limiting. Observations in both the tropics and temperate region suggest that species of *Hetaerina* are capable of much faster growth than *Argia*. *A. vivida* is never more than uni-voltine whereas *H. americana* is bi-voltine even at its northerly limit. Rates of growth for *Hetaerina* are probably more comparable with those of lestids than coenagrionids. Currently there are more questions than answers to the colonization of temperate latitudes by Neotropical Zygoptera, but a useful approach would be to turn the question around and ask not how *Hetaerina* and *Argia* have been able to expand their ranges northward, but to examine other Neotropical Zygoptera and ask why they have *not* been able to expand their ranges into temperate latitudes. Answers will not be readily forthcoming until we know much more about the life histories of other species in the tropics.

Oral presentation

Hybridization in *Calopteryx* damselflies: the role of male alternative mating tactics

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Hybridization between two closely related species may occur because of problems in species recognition or because of adaptive mating decision. In the latter, an individual does better by reproducing with heterospecific than not breed at all. However, this happens only if at least some fertile hybrid progeny is produced. In species in which alternative male mating tactics (e.g. territorial and non-territorial tactics) exist, it could be that males with reproductively inferior tactics are not so choosy and thus may mate also with heterospecifics. In this study, we investigated whether male readiness to mate with heterospecific females is dependent on male tactic in the damselfly, *Calopteryx splendens*. In this species, it has been previously showed that males have poor premating reproductive isolation, and males frequently court females of related species, *C. virgo*. We tested male readiness to mate with heterospecifc females by presenting females to males with different reproductive tactics, and by recording the courting activity of males. In contrast to our prediction, males with alternative mating tactics were not as ready to mate with *C. virgo* as territorial *C. splendens* males. Actually, males which were most eager to mate with heterospecifics were territorial males with large wing spots indicating their high quality. The result can be explained if high quality, territorial males have most optimal cost: benefit-ratio for the behaviour. There are costs if a male mistakenly court and mate with heterospecific females. However, the high courting activity may benefit the male if it means that he does not miss conspecific females as often as less courting males.

Oral presentation

Forestry and dragonfly diversity: the uncertain long-time survival of specialist species in Central Sweden

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In a previous study of 32 forest lakes in central Sweden, GS showed that the highest diversity was found in lakes surrounded by undisturbed forest. When logging occurred near a lake a slow decrease in the species richness of partivoltine dragonflies was observed, while univoltine species were not affected. It was also shown that the species composition seemed to return to a more species rich state when 15 years or more had passed since the logging.

Re-sampling and re-analysing the lakes ten years later we uncovered some more clues to the long time development of the species composition in the region. We found that southern species like *Sympecma fusca* and *Aeshna mixta* had expanded into the area during the past ten years. This is due to changing distribution patterns caused by global warming, but the direct effect of these species on the original species composition is still unknown. Some of the rare and selective species in the 1996 survey have become more common and they have also shown a tendency towards changing localities - a classic metapopulation situation. Two examples are *Leucorrhinia pectoralis* and *L. albifrons*. This shows that either the conditions in the lakes have improved or that the gradual maturation process of the lakes has created conditions more favourable than ten years ago. On the other hand, the same maturation process seems to have caused other rare species like *Coenagrion lunulatum* and *Aeshna viridis* to disappear, giving room for more trivial newcomers. *Aeshna cyanea* was, for instance, found in a single lake in 1996 but now it occurs - often in large numbers - in no less than 14 lakes.

The average number of partivoltine species per lake has increased from 5.42 to 7.92 while the number of univoltine species has decreased from 2.38 to 1.26 per lake. Using discriminance analysis we see that instead of reverting to the old state, these lakes continue to diverge from the original species composition also 25 years after logging. Hence, in spite of very moderate and small-scale logging today, we will have a different odonate fauna in the future.

Oral presentation

Conspecific sperm precedence in Odonata

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Conspecific sperm precedence (CSP) is widespread in animals having complex behaviours or reproductive tract morphologies, which can allow many opportunities for female choice and sperm competition, and may play an important role in speciation. Here we present a laboratory study of the barriers that difficult hybridization between two species of damselflies of the genus *Ischnura* (*I. elegans* and *I. graellsii*) which are morphologically and genetically very similar and occur sympatric along the whole Galician (NW Spain) coast. Mechanical barriers impede 90% of matings between male *graellsii* and female *elegans*, and 10% in the opposite direction. However, only 40% of *graellsii* females mated by *elegans* males lay eggs and only 56% of them are fertile. We tested the potential of conspecific sperm precedence as an isolation barrier in 6 heterospecific matings in both directions. Three clutches of 15 larvae each were screened using the ITS-1 sequence that identifies hybrids unambiguously. In 5 out of 6 crossing 98-100% of the progeny was fathered by *I. graellsii*, regardless of the order of mating, while in homospecific crossings last male sperm precedence is usually 100%. CPS might result from a prefertilization obstacle to heterospecific sperm. These results suggest that females mediate sperm competition, and the last male sperm precedence is not an automatic consequence of the mechanics of sperm removal and storage.

Oral presentation

Odonata of the Arabian Peninsula

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With approximately three million square kilometres, the Arabian Peninsula almost reaches the size of India and may be regarded as a subcontinent. Although Arabia predominately consists of semiarid to hyperarid lands, its odonate fauna is comparatively rich, with 64 species recorded so far, of which two genera, five species, and one subspecies are endemic. Novelties are still to be expected in remote and inaccessible wadi systems in the Southwest. High species densities are found in pluvial refugia and tropical pockets (high mountains in the South West, the Oman Mountains, and Dhofar). Recent changes in the taxonomy of (mainly) East African species with direct implications on the status of several populations of Arabian Odonata made it clear that accurate interpretation of their distribution patterns in space and time is linked to progress in African Odonatology.

Poster presentation

Biogeography of Odonata in SE Madagascar

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Little is known about the dragonfly fauna of Madagascar. About 180 species are described from the island, and the taxonomy is well resolved in comparison to many other insect orders. However, neither work on biogeography nor ecology of the Odonata has been published yet. The study area in SE Madagascar consists of a mosaic of different ecosystems along a general gradient of rainfall and vegetation formations, ranging from evergreen humid to spiny forest within a few kilometres. The focus was to survey the Odonata of different forests, but dragonflies were also sampled outside the forests in order to get a complete species composition and also to identify species that are obligatorily connected to forest sites. Anisoptera and Zygoptera species were collected and observed at the beginning of the rainy season. Within this region we investigated two littoral forests, two humid forests, one transitional forest and deforested cultural landscapes. Especially the small littoral forest fragments are under heavy threat due to anthropogenic use and were sampled with greater effort. The species were collected and observed at different reproduction habitats like streams, ponds, swamps and rice paddies. We took samples at each locality at least including one day with sunshine. Further collecting for several days at the same locality did, at most sites, not result in more Odonata species. In total we found 71 Odonata species in the region of which 35 were connected to the sampled forests. Similarities of species composition between the different forest sites are shown. In the degraded landscape around the littoral forest fragments no forest-dwelling species were found, and especially for the Zygoptera with poor dispersal potential, forest fragmentation leads to isolated small populations.

Oral presentation

Female-biased sex-ratios and putative sex-role reversal in an island community of damselflies

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Oceanic islands have long provided important case examples in evolutionary ecology, yet they are relatively understudied from an odonatological perspective. Earlier reports suggested that some damselfly species of the genus *Nesobasis* on the Fiji Islands exhibit both an extreme rarity of males at oviposition sites and an associated form of 'sex-role reversal', in which females display territorial behaviour. Given that parthenogenesis has now been demonstrated in a damselfly species on the Azores, it is possible that the extreme selection pressures on islands have led to these unusual reproductive systems.

Here we report on the sex ratio (based on adults and larvae) and territorial behaviour of a number of *Nesobasis* species from the two main Fijian islands (Viti Levu and Vanua Levu). We also present a mtDNA-based phylogetic hypothesis for 28 species distributed across a number of islands in the archipelago.

Our estimation of the adult sex ratios of *Nesobasis* species at oviposition sites during 2005 and 2006 confirmed that populations of some *Nesobasis* species were consistently female-biased, while populations of other *Nesobasis* species were consistently male biased. In species where males were relatively common, males showed clear evidence of territoriality in that they physically challenged intruders while remaining within a confined area. However, in species where males were consistently rare or absent, females were not territorial, indicating that they did not exhibit genuine role reversal. While populations of some *Nesobasis* species were clearly female-biased at oviposition sites, their sex ratios on emergence were more balanced. Intriguingly, males suffered much higher mortality than females shortly after emergence, possibly as a consequence of fungal infection.

Our phylogenetic analysis provides strong support for allopatric speciation, in that sister species tend to occur on separate main islands. Furthermore, those species that exhibit extreme adult sex ratio bias at oviposition sites are distributed throughout the phylogeny, suggesting that this trait is an independently derived condition.

Oral presentation

What are they to us? Valuing dragonflies as service providers

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Global freshwater systems are severely imperiled. The situation of South Africa's rivers and wetlands is not much better, with an estimated rate of degradation up to five times higher than that of terrestrial systems. Odonata (dragonflies and damselflies) are well known taxonomically and ecologically. Indeed, a recent national conservation assessment - based on the categories of threat used for species in the IUCN Red Data Books - on the state of main river ecosystems in South Africa, warns that 84% of the ecosystems are threatened, with 54% critically endangered, 18% endangered, and 12% vulnerable. Among the greatest threats to the functioning of aquatic ecosystems are destruction or degradation of habitat; invasion by exotic species; overexploitation; water pollution; and, flow modification. Recently, ecosystem valuation has emerged as a tool set to conserve biodiversity. From this, a new category of population, the service providing unit (SPU), has emerged as a key feature of valuation. The SPU can operate at any given temporal or spatial scale, and provide a direct or indirect service to humanity. Dragonflies are direct SPUs, in all four core categories of ecosystem service provision. They thus continue to lead the way as flagships for freshwater ecosystem conservation.

Oral presentation

Predicting life cycle alterations due to climate change along thermal gradients: a case study on *Gomphus vulgatissimus*

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All climate change scenarios of the IPCC show a warming in the future across Europe. We assumed that potential effects of such warming should be reflected in life history patterns of dragonflies observed in warmer climates, i.e. in southern Europe, or in habitats that are different in ambient temperature. *Gomphus vulgatissimus* (L.) is widespread in Europe occurring in different climates. The species is semi- to partivoltine with a two- to four-year life cycle documented. Begin of emergence ranges from early April (southern Europe) to mid June (northern Europe).

The aim of our study was to model effects of future climate changes (as predicted by IPCC) in the entire range of the species. We presumed that the voltinism, i.e. the numbers of generations per year, decrease from south to north and from warmer to colder habitats. We therefore first analysed data on voltinism from 13 sample sites along a latitudinal gradient from about 44°N to 53°N, comprising different habitat types from small streams to large rivers. Furthermore, to simulate different conditions and to allow projections for future climate change scenarios, we developed a population dynamic model based on a projection matrix approach. The parameters of the model are dependent on temperature and day-length.

Our field results indicate a slight decrease in voltinism along the latitudinal gradient from southern to northern Europe and a strong increase in voltinism with width of the running water. Taking only smaller rivers into account, the model replicates the field results in showing a decrease in voltinism with latitude. Under the impact of global warming scenarios of IPCC the model predicts an increased development speed and alterations in phenology of *G. vulgatissimus*. Additionally, the model predicts an extension of the northern range limit.

Oral presentation

Selective predation on wing colouration and sexual isolation in calopterygid damselflies

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Although predation is thought to affect species divergence, the effects of predator-mediated natural selection on species divergence and in non-adaptive radiations have seldom been studied in natural populations. Wing melanization in *Calopteryx*-damselflies have important functions in sexual selection, interspecific interactions as well as in species recognition. I show that avian predation strongly affects natural selection on wing morphology and male wing melanization in two congeneric and sympatric species of this genus (*C. splendens* and *C. virgo*). Predation risk was almost three times higher for *C. virgo*, which has an exaggerated degree of wing melanization, compared to the less exaggerated, sympatric congener *C. splendens*. Selective predation on the exaggerated species *C. virgo* favored a reduction and redistribution of the wing melanin patch. Moreover, I also present data from experimental wing color enlargements of the extent and size of the dark wing patches in *C. splendens* males and females and confirm that the darkness and size of these wing patches function as species recognition characters and mediate sexual isolation between *C. splendens* and *C. virgo*. Selective predation could interfere with sexual isolation, species divergence and species coexistence in this genus.

Oral presentation

Changes in the number of spermatozoa in sperm storage organs of *Ischnura asiatica* female during copulation

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The copulation process in the non-territorial damselfly, *Ischnura asiatica*, was divided into three stages (I, II and III), according to the movements of the male abdomen. The mean duration of each stage was 75.8 ± 8.8 min, 6.4 ± 0.3 min and 15.8 ± 0.9 min for stage I, II and III, respectively (S.E.). Duration of stage I was negatively correlated with the time of day for the onset of copulation. The number of spermatozoa ejaculated in females in each stage was examined with interrupted copulation experiments in both laboratory and the field. Virgin females did not receive any sperm during stage I. Sperm transfer in the bursa copulatrix had been started after the beginning of stage II. Although stage III was a phase without apparent abdominal movement of the male, the sperm transfer was continued. Immediately after copulation termination, 64,500 ± 4,425 and 43,143 ± 6,397 spermatozoa (S.E.) were found in the bursa copulatrix and the spermatheca, respectively. At the end of the male's secondary genitalia, there was a pair of horns, which might be used to remove sperm from sperm storage organs of female during copulation. In the female, the spermatheca was joined to base of the bursa copulatrix by a narrow and long spermathecal duct. The mean length of the spermathecal duct was 757.6 ± 88.1μm (S.E.), with a range from 480.0μm to 813.3μm. The mean length of each horn of the male was 334.0 ± 5.9μm (S.E.) with a range from 266.6μm to 386.6μm. Therefore, the spermatheca might be inaccessible for males. However, mated females in the field contained lower number of spermatozoa either in bursa copulatrix or in spermatheca during stage I than pre-copula mated females. Thus, an additional mechanism on the sperm removal in the spermatheca was suggested.

Oral presentation

Frequency-dependent mating attempt to female colour dimorphism in *Ischnura senegalensis* during diurnal oviposition activity

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Females of coenagrionid damselflies exhibit colour dimorphism, andromorph and gynomorph, which are maintained under frequency-dependent process by sexual harassment derived from mate-searching males. The males seemed to change their mating preference according to prior copulation experience. In order to clarify the mating preference of wild males in *Ischnura senegalensis*, binary choice experiments between the two female morphs were carried out in five local populations in early morning (07:00-09:00) and afternoon (12:00-14:00), the time which is the onset and the end of daily copulation activity, respectively. According to the line census for each population along the water edge, the estimated frequencies of andromorph in the female population varied from 14% to 63%. In each population, males showed fair selectivity to female morphs in the early morning, while males chose the dominant morph in the afternoon, indicating that males changed their mating preference with frequency of female morphs via the daily copulation activity. Since females oviposit alone during the afternoon, male mating attack to the dominant female morph in the afternoon resulted in the inhibition of oviposition behaviour of the morph. In the local population where the gynomorph was dominant, the number of mature eggs loaded in each female morph was counted by dissecting just before and just after daily oviposition activity. A clear decline in the number of mature eggs loaded throughout daily oviposition activity was found not in the gynomorph but in the andromorph, suggesting the increase in daily number of eggs laid in the andromorph. Thus, non-dominant morphs might oviposit freely without male sexual harassment. Such frequency-dependent male mating harassment might be consequently a selective force to maintain the female colour dimorphism in *I. senegalensis*.

Oral presentation

Population increase of the threatened damselfly, *Mortonagrion hirosei*, inhabiting an artificially established reed community

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A new reed community was artificially established by transplanting reed rhizomes densely adjacent to the small reed community, which is a habitat of the threatened damselfly, *Mortonagrion hirosei*. The goal for the mitigation project was that the damselfly would immigrate and colonize the newly established habitat. The adult population number was considered to be one of the indicators for assessing the mitigation project. In order to estimate the daily number of adults in the established habitat comparing with that in the original one, applying the line census method was a useful method rather than the mark-and-recapture method, due to the dense reed shoots. Intensive sweeping often fell reed shoots, making gaps in the community, and a gap was an unsuitable space for the habitat of damselfly in viewpoint of light intensity, supplying to the habitat for the other odonate species that prefer open habitat. Some of them are the predators of *M. hirosei*. From late May to early August, there was a good relationship between the daily number of adults detected per 10m along the line and the estimated daily number of adults calculated by the Manly & Parr method based on mark-and-recapture sampling. In the original habitat, the estimated population size was stable at 15,000-18,000 for 4 years, that is, about 20 adults per square meter. In the established habitat, a few adults was found daily in 2003 of the 1st year and most of them were restricted near the original habitat due to the low flight activity of adults. In 2004, the 2nd year, the population size was around 10,000. In 2005 or the 3rd year, population size increased to 23,000. In 2006, the estimated population size was 46,000, that is, 22 adults per square meter. Therefore, the mitigation project is now successful.

Oral presentation

How to protect endangered Red List species in the Netherlands: from ecological research to conservation

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Adequately protecting dragonflies is a complicated challenge, which asks for a step-wise strategy and the co-operation of many people. In the Netherlands, six Red List species have been subject of species protection plans on national, regional or local scale in the last few years. Two national species protection plans have been published, of which that of *Aeshna viridis* is the longest in action. The experiences during the process of these conservation initiatives will be presented, with a special focus on the role of applied ecological research and the translation of ecological knowledge into concrete conservation projects.

First of all, it is vitally important to put endangered dragonfly species on the agenda of policy makers, by making them aware of the endangered status of the species. Research to the causes of the species' decline is often a necessary first step in the protection project. Research examples of different Red List species include a survey on the ecological needs of *Coenagrion hastulatum*, which will be summarised. The second step is to translate knowledge of dragonflies into concrete recommendations for habitat management. This is best done in close consultation with the managers of the nature areas in which the species occurs, or might occur in the future. Ultimately, the protection plan should be presented to a broad public, in order to get the needed commitment for the execution of the desired conservation measures. For example, the local water board, a group of enthusiastic volunteers, local policy makers and the owner of the nature reserve all worked together in the protection of a small brook in the southern part of the Netherlands, to protect the rare *Cordulegaster boltonii*.

Poster presentation

Trends in ranges of dragonflies in the Netherlands: does climate change play a role?

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The trends of 60 Dutch dragonfly species were calculated for three different periods (1980-1993, 1994-1998 and 1999-2003). Comparing period 1 and period 3 shows that 39 of these species have increased, 16 have remained stable and 5 have decreased. These results show a revival of the Dutch dragonfly fauna, after decades of ongoing decline. The species were categorized in different species groups: species with a southern distribution range, species with a northern distribution range, species of running waters, species of fenlands and species of mesotrophic lakes and bogs. The trends of these different species groups were compared with the all-species control group. As expected, a significantly higher proportion of the southern species shows a positive trend than the all-species group. In the northern species group on the contrary, a significantly higher proportion of the species show a negative trend than the all-species group. Different explanations for these results are discussed, such as climate change and degradation of certain habitats. It is likely that the observed increase of southern species is at least partly caused by the increasing temperatures. Whether or not climate change also plays a role in the negative trend of some northern species is difficult to prove, because the habitats of northern species are more prone to negative influences of other environmental factors.

Poster presentation

Dragonfly protection in the Netherlands: a stepwise approach

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In contrast of what may be expected from the name, Dutch Butterfly Conservation is not only involved in the protection of butterflies but also in the protection of dragonflies for already many years. Part of our conviction is that dragonflies are an essential part of our nature and that they should thrive wherever they belong. Dutch Butterfly Conservation informs, advises and encourages people and organisations by devising projects, and, by carrying them out in collaboration with other organisations. The Dutch Dragonfly Monitoring Scheme and a diversity of species protection projects, both nationally and regionally, are amongst the many dragonfly projects carried out at Dutch Butterfly Conservation lately. On our poster we summarise how, in general, our dragonfly projects are carried out. Firstly, we work on public awareness. We are trying to increase support for nature management both by getting more people involved, and by deepening their involvement. Secondly, we invest in ecologically screening. We collect data on occurrence and thus can see changes both in time and space. Furthermore, we look for the causes of such changes in occurrence and also for ways in which a possible decline can be halted. Thirdly, we invest in volunteers. Many of our achievements are due to the work carried out by highly motivated voluntary workers. Our fourth step is that we act upon management and advice and inform policy makers, which puts us into a position to influence nature policy. The fifth step is that we try to influence environmental conservation in giving advice on the best way green spaces and water bodies can be managed. Finally, we aim to play an active role during the execution of the advisories. On our poster we offer examples from our dragonfly projects of all these six steps and in our oral presentations we will outline which of the six steps is involved in the main projects of our talks.

Oral presentation

The Gondwanan aeshnids of Australia

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This is a report on a study by Günther Peters & Günther Theischinger (in press) to appear in October 2007 in *Denisia*. The paper entitled "Die gondwanischen Aeshniden Australiens (Odonata: Telephlebiidae und Brachytronidae)" explores the phylogenetic relationships of some "southern Australian aeshnids". In the study a brief introduction to morphology and biology of this group of dragonflies is presented. Monophyletic groups and sister-group relationships are hypothesized on the basis of morphological synapomorphies of adults and larvae. This starts at specific, and ends at supra-superfamily level. In particular it is hypothesized that, except for *Dendroaeschna*, the "non-aeshnine (= brachytronine) Australian aeshnids" constitute the monophyletic Telephlebiidae, and the monotypic genus *Dendroaeschna* is the sole "southern" member of the Brachytronidae. Gondwana origin is suggested for all "non-aeshnine Australian aeshnids". Colour photos are presented of all species, and an attempt is made to date some speciation events in *Austroaeschna*.In the report a brief history of aeshnid systematics and some hitherto existing information on the classification of the title group are given. The problems faced and the methods and characters used for the phylogenetic approach are illustrated. A slide parade of the species with some information on morphology and ecology is presented. The resulting phylogenetic hypotheses are displayed followed by discussions on geographic distributions and speculations on some aspects of speciation.

Oral presentation – Plenary talk

Movement in dragonflies

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Corbet (1999) recognized four types of nontrivial flight performed by dragonflies within a single generation. These were Maiden Flight (one-way), Commuting (two-way), Seasonal Refuge (two-way) and Migration (one-way). I will describe some exciting work published in the last year that relate to the last of these categories and involved, arguably, our two most familiar long distance migrants. One study compared the migration strategy adopted by *Anax junius* with that adopted by birds in crossing an area of open water. A second threw new light onto the triggers that sent *Pantala flavescens* over the sea at night in northern China.

Most of the talk will be concerned with Commuting and will describe in depth two studies in which 8000 and 10000 marked individuals of the damselfly *Coenagrion mercuriale* were studied in two different habitats. The first was a more or less linear habitat that stretched for 10km; the second was a more or less circular area of heathland of around 22km^2. For each study both the ecological and genetic issues arising from the results will be discussed.

Finally some synthesis of Commuting studies will be attempted including their relationship to larger scale movements.

Oral presentation

Effectiveness of the evaluation of freshwater bodies using odonate assemblage in a management project of a wetland under the stress of regional development

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Kushiro marsh (20,000 ha) is the largest wetland in Japan, providing habitats for several red data species, such as the Japanese crane (*Grus japonensis)*, the Siberian salamander (*Salamandrella keyserlingii*), and the Yezo white-faced dragonfly (*Leucorrhinia intermedia ijimai*). The ecosystems of this wetland have been legally protected from vandalism and uncontrolled exploitation. However, the wetland has been suffering (1) inflow of sand and silt due to large-scale felling of the forest and river improvement and (2) water pollution due to excrement of cattle in the catchment area of the rivers flowing into the wetland.

In 2003 the 'Kushiro Nature Restoration Committee' was established, based on the 'Law for the promotion of nature restoration', which was enacted for the purpose of recovery of ecosystems that had been injured by socioeconomic activities in the past. The committee that is constituted of the Ministry of Environment; Ministry of Land, Infrastructure and Transport; Ministry of Agriculture, Forestry and Fisheries; local governments and non-governmental organizations, have been discussing and decided on several measures to conserve, restore, or regenerate the wetland.

In such a context, I have been engaged together with my students in comprehensive research projects of the wetland since 1999, focusing on the capacity of odonate assemblages as an indicator of environmental conditions of habitats in the wetland. In this occasion I report the results of census on adult odonates at 30 quadrats in three areas (Onnenai area, Takkobu area and Kirakotan area) of the wetland and discuss their capacity as indicators.

Poster presentation

Dragonfly guardians of the southern wing of the Yungas mountain rain forest

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The Yungas are cloud forests extending from Venezuela south into NW Argentina along the Eastern slope of the Andean cordillera. In Argentina they are distributed discontinuously along the Subandean chains within the provinces of Salta, Jujuy, Tucumán and Catamarca. Biogeographically they belong to the Yungas province included in the Neotropical region, and in Argentina they represent one of the most species-rich biogeographic provinces.

During the last few decades, the Yungas have become intensively fragmented due mainly to expansion of agricultural areas; 90 percent of what once was foothill jungle in Argentina has been replaced by monocultures. An urgent need to conserve their biota has been acknowledged, but prerequisite biological and taxonomic data, especially of insects, are still almost nil.

The study area includes the Bermejo watershed in Salta and Jujuy provinces between national parks Baritú, Calilegua and El Rey, and includes part of the recently created (2002) Argentine Protected area of the Yungas in the World Net of Biosphere Protected Areas from UNESCO. Our goal is to determine the dragonfly species composition of this area, compare species assemblages among similar environments in protected and unprotected areas, and analyze species diversity along latitudinal and altitudinal gradients. According to our study the Argentine Yungas houses 102 species of odonates in 45 genera and 9 families, representing over a third of the total species richness of the order in Argentina. From these, four are new to science, eight are new records for the Argentine fauna, and nine are endemic to the Yungas biome throughout South America. We are currently producing identification keys and a regional field guide to allow limnologists, ecologists, and wildlife biologists to identify odonates, and use them thus as indicators of the conservation status of this biome.

Poster presentation

An updated checklist of the Odonata from Argentina

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This study includes an updated checklist of the Odonata species known to occur in Argentina with distributional information by province. Twenty-three species are removed from the previous list, and 31 new records are added, bringing the total number of species up to 255 by December 2006. Although the rate of description of new species occurring in Argentina has been slow during the last century, with over half of its odonates already described at the beginning of the 1900's, there are still new species being discovered, of which we currently know of 15, bringing the total of known species for the country to 270.

Best and less known areas of Argentina as regards to its odonate composition are mentioned. Its richest areas are found in the northern subtropical provinces, which house over two thirds of the total number of species, most of them widely distributed in the Neotropical region and reaching their southern limit of distribution in Argentina. Although the odonates found in the southern half of the country comprise just a few species (35 recorded for Patagonia), they are of particular interest because they include many endemics to S Chile and SW Argentina, and several of them show affinities to taxa from Australia and New Zealand. There are 17 species so far known to occur only in Argentina, and for which five areas of endemism can be identified.

A major development over the last few decades has been an increase in the knowledge of the larval stages, which is crucial for the development of regional programs for conservation and management of wetlands. Approximately two thirds of the known larvae have been described during the last 25 years, and about half of them during the last 8 years. In spite of these considerable advances, the larval stages of almost half of the species (53%) remains to be described.

Oral presentation

The most speciose group of dragonflies, Libelluloidea: phylogeny, dating and phylogeography

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Dragonflies (Odonata: Anisoptera) are among the most recognizable of insects and have been used in a wide array of studies. Their recognizable progenitors date to the Carboniferous (360-290 million years ago) and are probably the most widely known extinct insects. Anisoptera (in their present form) arose later, with earliest known fossils from the Triassic (250-200 million years ago). Within dragonflies, Libelluloidea is the most diverse superfamily, yet its phylogenetic relationships are poorly understood. Extant Libelluloidea include, among others, Macromiinae and Corduliinae and the most abundant and familiar dragonflies, Libellulidae. A well-supported phylogenetic hypothesis is needed to reach an understanding of the evolution of this speciose and heterogeneous superfamily. I have structurally aligned, and analyzed molecular data from two independent gene fragments, (16S and 28S) for 123 species. Although several families have been proposed within Libelluloidea, my work supports the validity of only four. The family Corduliidae is paraphyletic. The subfamily Corduliinae may be elevated to family status while it appears that the Australian members of Corduliidae are, in fact, a new, distinct family. Macromiidae and Libellulidae remain valid but few of the recognized libellulid subfamilies are supported. It appears that several dragonfly subfamilies were created using non-homologous wing venational characters that converged due to flight behaviour. Perchers and fliers may have evolved different wing venation patterns to meet their flight requirements. I collected 92 wing vein measurements for 86 species from nine families to explore differences in wing vein lengths, wing loading, wing area and body mass between the two flight behaviors. Perchers possess vein patterns that would increase rigidity in regions affecting flight stability and allow for elasticity and flexibility in regions that are important for maneuverability. I have reconstructed ancestral vein lengths to determine whether the ancestors to extant taxa were likely to be perchers or fliers. The biogeographical, ecological, and temporal distribution of these ancestors may have favored the evolution of percher or flier behaviour. I explore the biogeographical history of the Libelluloidea and present Bayesian molecular divergence estimates.

Oral presentation

Changes in spatial distribution and species composition of larval dragonflies in the artificial reed community established as a habitat for *Mortonagrion hirosei*, an endangered brackish water damselfly

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Yearly changes in the odonate larval community were surveyed for 4 years after setting up an artificial reed community adjacent to the original habitat of *Mortonagrion hirosei*, an endangered brackish water damselfly. *M. hirosei* larvae were only found in the original habitat throughout the survey period, indicating that no other species had entered the original habitat, partly because of their low saline tolerance. In the first year of the artificially established habitat, which was open due to sparse reed shoots, larvae of many odonate species that prefer open water were collected using the quadrate method. *Ischnura senegalensis* was the dominant species in the larval community of the first year, and the larvae and adults seemed to be a predator of the larvae and adults of *M. hirosei*, respectively. Although the number of *M. hirosei* larvae increased with year by year, becoming the dominant species after the second year, the species composition of the larval community was different between the west and east of the established habitat because of environmental factors, such as saline concentration and reed shoot densities. *M. hirosei* larvae had expanded their distribution to the entire area of the established habitat in 2005, while the distribution of *I. senegalensis* had been restricted to several patchy areas with a decrease in their population. The established reed community became dense and provided the closed habitat that is suitable for *M. hirosei* adults. There was a negative relationship in the number of larvae between *M. hirosei* and *I. senegalensis*. The prey-predator relationship between the two species might affect the population dynamics and distribution of *M. hirosei*. The larval density in established community of the 4th year, 2006, reached the high density as in the original habitat. The odonate larval community and habitat environment which is optimal for *M. hirosei* conservation are discussed from the viewpoint of both biotic and abiotic factors.

Poster presentation

Tracking migratory Green Darner dragonflies with radiotelemetry

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We attached miniaturized radio-transmitters (~300 milligrams) to the thoraxes of 14 individual dragonflies (Common Green Darners, *Anax junius*) and followed them during their fall migration for up to 12 days, using receiver-equipped Cessna airplanes and ground teams. Green Darners exhibited distinct stopover and migration days. On average, they migrated every 2.9±0.3 days, and their average net advance was 58±11km in a generally southward direction (186±52º). They migrated exclusively during the daytime, when wind speeds were <25km h^{-1}, regardless of wind direction, but only after two nights of successively lower temperatures (decrease of 2.1±0.6°C). Logistic limitations prevented following the dragonflies more than 150-200 km beyond their release point, but the technology offers the promise of tracking them to the completion of their migration.

Oral presentation

Ecological traps for dragonflies in man-modified landscapes – old and new facts to polarization vision

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Males of various libellulids have repeatedly been reported to establish their territories erroneously over automobiles while females tried to oviposit on the paintwork of roofs and bonnets. Both sexes seemed to prefer dark colours. The same phenomenon has been observed on shiny floors and glass panels. Obviously, certain horizontal and highly reflective surfaces are being mistaken for water bodies. These reactions towards man-made substrates may heavily impair the dragonflies' individual fitness, thus constituting ecological traps. According to recent observations, many individuals may be involved simultaneously at the same locality. In the Swiss Plateau, a typical man-modified landscape, about 50 individuals of *Libellula quadrimaculata* were reproductively active on a large strawberry field that was covered with shiny black plastic sheets between the long plant rows. The males patrolled the plastic sheets from their perches, chased rivals and copulated with arriving females. The latter tried to oviposit at many sites on the plastic that was sometimes heated up to 60° C. Similar behaviour was recorded in a Hungarian cemetery where individuals of four *Sympetrum* spp. exhibited typical elements of reproductive and foraging behaviour from perches over black, horizontal gravestones with polished surfaces. In a field study on the habitat requirements of *Orthetrum coerulescens* breeding in small ditches in a Prealpine region both sexes were exclusively attracted by small water surfaces also visible to the human observer. Ditch sections that dried out or became densely overgrown with vegetation over the season were strictly avoided. However, lining the sites with pieces of black plastic could easily lure males and females. Videopolarimetry performed by G. Horváth has revealed that horizontal surfaces of various shiny, non-metallic dark materials reflect highly horizontally polarized light. As shown in numerous field experiments, such surfaces attract dragonflies like the similarly polarized light reflected from water surfaces. The ability to find water bodies that serve as rendezvous and oviposition sites is adaptive. However, in man-modified landscapes with decreasing numbers of breeding sites and increasing areas of polarizing surfaces, dragonflies may be deceived into making maladaptive habitat choices that may perhaps accelerate the decline of many species.

Poster presentation

Seasonal emergence observations of odonates in tropical forest streams at Endau-Rompin, Malaysia

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Endau-Rompin is a pristine, lowland rainforest covering more than 49,000 ha, located in Johor, southeast peninsular Malaysia. It is the second largest National Park in peninsular Malaysia and lies between 2º and 3ºN latitude. Compared to temperate and subtropical regions, seasonal temperature variation is relatively small. Nevertheless, in east peninsular Malaysia, the April to May period experiences a period of relatively high average temperature and the December to January period experiences the lowest average temperature. Unlike the majority of neighbouring, continental SE Asia countries, which are subjected to dry weather conditions during the winter months, with wet springs and summers, peninsular Malaysia has its heaviest rainfall during the November to January period. The seasonal rainfall pattern in east Peninsular Malaysia can be characterised as having two distinct phases, namely; November to January, which is very wet, with maximum rainfall and June to July, which is the driest period. It is evident, in contrast to much of continental SE Asia, the wettest period at Endau-Rompin, December to January, does not coincide with rising (spring) temperatures, which are experience in April-May. The wettest season at Endau-Rompin is significantly cooler then the long summer season. Three surveys were conducted at Endau-Rompin during August 2004 (wet summer), January 2005 (very wet winter) and May 2006 (relatively dry early summer). The majority of odonate families did not demonstrate any discernible seasonal emergence patterns with the exception of Gomphidae. Lotic gomphids were not observed, on the wing, during August or January but several species were observed on the wing during May, indicating a seasonal emergence pattern, probably linked to rising water temperatures. Gomphids exhibiting seasonal flight periods included *Gomphidia abbotti*, *Megalogomphus sumatranus*, *Microgomphus chelifer*, *Onychogomphus thienemanni* and *Sieboldius japponicus*. The hypothesis that insect emergence for large larvae with regulated emergence patterns, including odonates, is timed to precede monsoon rains is not supported by observations at Endau-Rompin. The modified view that 'emergence may be timed to avoid spate-induced mortality of mature larvae, a degree of synchrony arising from physiological responses to temperature and/or increasing day length' is also not supported, since during the most turbulent flow conditions at Endau-Rompin lotic gomphids remain in larval stage.

Oral presentation

Overview of the "giant dragonflies" of the Paleozoic

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An overview of the "giant dragonflies" (Meganisoptera) of the paleozoic will be given. So far, more than 24 genera of Meganisoptera with wingspans from 5 to 70 cm are known world-wide. I will show pictures and drawings of the oldest Carboniferous dragonflies from the Hagen-Vorhalle locality in the uppermost Namurian B. The brickyard quarry at this famous German carboniferous site yielded *Namurotypus sippeli* Brauckmann & Zessin, 1989*; Erasipteroides valentini* (Brauckmann, 1985) and the smallest species *Zessinella siope* Brauckmann, 1988 (wingspan only 5 cm).

Photographs and drawings of Piesberg near Osnabrück (Westfalium C) will include *Erasipterella piesbergensis* Brauckmann, 1985 and *Piesbergtupus hielscheri* Zessin, 2006. The meganeurid *Kohlwaldia kuhni* Guthörl, 1961 were found in deposits from Saarland, Germany, while the coal dump at Ploetz, near Halle, yielded *Stephanotypus schneideri* Zessin, 1983. A photograph and drawings of the wing of the latter species shows two impressions on the costal margin of the wing and a subnodal structure.

Poster presentation

Some German Paleozoic Meganisoptera (Odonatoptera) and their finding places

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The poster has 8 sequences of pictures from the Carboniferous sites at Hagen-Vorhalle, Ruhr area (Namurium), Piesberg near Osnabrück (Westfalium) and Ploetz near Halle (Stefanium), with paintings and drawings of some fossil insects.

Sequence 1: A map of Northwest Germany with the Carboniferous locality Hagen-Vorhalle and photographs from the early 1980s of the uppermost Namurian B in the brickyard quarry at this famous fossiliferous locality (Photographs by Wolfgang Sippel, Ennepetal and Wolfgang Zessin, Jasnitz)

Sequence 2 : Reconstructions of Carboniferous life with dragonflies (painted by W. Sippel, Ennepetal)

Sequence 3: Fossil Dragonflies: Photographs and drawings by Carsten Brauckmann, Elke Groening & W. Zessin of *Namurotypus sippeli* Brauckmann & Zessin, 1989*; Erasipteroides valentini* (Brauckmann, 1985); and *Zessinella siope* Brauckmann, 1988

Sequence 4: Photographs and drawings of Piesberg near Osnabrück (Westfalium C) with the dragonflies *Erasipterella piesbergensis* Brauckmann, 1985 and *Piesbergtupus hielscheri* Zessin, 2006. From Saarland, the Meganeurid *Kohlwaldia kuhni* Guthörl, 1961

Sequence 5: A map of East Germany with the locality Ploetz near Halle and some photographs of the Stefanium C coal dump

Sequence 6: Photographs and a drawing of the forewing of the giant dragonfly *Stephanotypus schneideri* Zessin, 1983

Sequence 7: Other fossils (insects, spider, plants)

Sequence 8: The coal dump at Ploetz in art: a patchwork of Christa Gabriel, Halle and an oil painting by Lothar Gruenewald (1935-2001, Halle)

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