Libellula 12 (3/4), 91-102 1993

Are Odonata useful as bioindicators?

Philip S. Corbet

eingegangen: 6. Mai 1993

Summary

Information and reasoning needed to answer this question are reviewed. It is concluded that Odonata can be useful as bioindicators subject to certain conditions, namely that: a base-line for comparison exists in cases of suspected habitat degradation; species assemblages rather than individual species constitute criteria; cognisance is taken of habitat and microhabitat attributes, such as certain aquatic macrophytes, that may be prerequisites for habitat occupancy by given species; and allowance is made for intraspecific variation.

The hypothesis

The hypothesis I pose is: "Odonata can be used reliably to indicate the type and quality of aquatic habitats."

Broadly speaking, the hypothesis implies that given species - or assemblages of species - occur predominantly, perhaps sometimes exclusively, in a habitat of a distinct and recognisable type. We assume that any such assortative distribution of Odonata among habitats is maintained by adults, especially ovipositing females, excercising a **habitat preference**. This is a large and active research field; so the references I cite can only be examples, and I am aware that many important contributions have been omitted from this article.

Philip S. Corbet, I.C.A.P.B., University of Edinburgh, West Mains Road, Edinburgh, EH9 3JT, U.K.

This subject has been studied by odonatologists for many years, as is evident from recent reviews (SCHORR, 1990; SCHMIDT, 1991). It has recently received informative and stimulating contributions, especially from Germany (BUCHWALD et al., 1989 on *Coenagrion mercuriale*; DONATH, 1989 on *Cordulegaster boltonii*) and from Switzerland (WILDERMUTH, 1986 et seq. on several species of Anisoptera).

Once the identification of the Odonata is soundly based (which of course depends on good taxonomy and diagnosis), the conventional steps for testing the hypothesis are two:

- characterising **habitats**, including those that do not contain Odonata; and
- characterising **habitat preferences**, a procedure that entails surveys to determine the correlation, if any, between odonate taxa and habitat types.

Despite the great amount of attention it has received, this subject remains complex and difficult and will clearly occupy researchers for the foreseeable future. In this brief review I focus on variables that need to be considered when testing the hypothesis, and then I examine the prospects, as they now exist, for using Odonata as bioindicators.

Habitat

First, one must distinguish between a habitat that certainly can, and one that probably cannot, support larval development. Strictly speaking, only emergence or the existence of final-stadium exuviae **in situ** (GERKEN, 1984) constitutes completely dependable evidence that larval development can be completed successfully. When alternative criteria have to be used, three considerations in particular must be kept clearly in mind; (1) as MARTENS (1992) has stressed, oviposition **movements** do not necessarily signify actual oviposition; (2) a significant proportion of species seen as adults at a habitat may be visitors and not regular occupants (SCHMIDT, 1986; OTT, 1991); and (3) following actual oviposition, some species may be unable to complete larval development in a habitat, perhaps because of competition during larval life (FINCKE, 1992), heavy predation by fish, or seasonal drought that larvae cannot endure.

Habitat preference

The essential resource for progress in this field is an inventory of habitats, including where available information on ecological niches (**sensu** SCHMIDT, 1991) together with the Odonata that occupy them. Such information is the product of careful, dedicated field work by expert observers. One cannot therefore overstate the importance of annotated species lists for work on bioindication and likewise on habitat conservation. When one tries to detect a correlation, especially a **useful** correlation, between odonate taxa and habitat types, several variables need to be allowed for.

Newly-formed habitats, and their odonate faunas, change with time through **ecological succession** (VOSHELL and SIMMONS, 1978; DONATH, 1980; MOORE, 1991; WILDERMUTH, 1992a). So species lists must be kept up to date if they are not to be misleading. Indeed, comparisons made possible by succession can themselves be used to inform us about the distinction between euryoecious Odonata, some of which are also early-colonisers (e.g. certain species of *Anax, Crocothemis, Ischnura, Orthetrum* and *Sympetrum*) and the stenoecious species that establish themselves later. Such comparisons are sometimes useful in documenting ecological impacts, such as pollution or physical degradation, that push habitats back to early stages of succession.

Mention of euryoecious and stenoecious species reminds one of what to human eyes appears to be the wide **interspecific variation** in habitat acceptance that some species show. At one extreme are euryoecious species; at the other extreme are species like the neotropical protoneurine *Roppaneura beckeri* that, as far as is known (MACHADO, 1981), oviposits only in the leaf axils of the terrestrial plant, *Eryngium floribundum*. Among some species at intermediate points along this gradient there appears to be a close association between biotope occupancy (and usually oviposition) and a particular macrophyte. Such associations offer exciting opportunities for the researcher studying habitat preferences and the notion of "Biotopbindung" (see SCHMIDT, 1983), and in general they fortify the widely-held view that aquatic macrophytes (with respect to structure, species composition and extent of surface coverage) constitute one of the most important factors determining habitat preference for many species (REHFELDT, 1986; BUCHWALD, 1989; LENZ, 1991; WILDERMUTH, 1992a). Consideration of what seems to be interspecific variation focuses attention on the distinction drawn by SCHMIDT (1991) between the essentially anthropogenic concept of "habitat" and the so-called "keystone" factors (physical and biotic) that make up the ecological niche of a species - a property that to a considerable extent overlaps the term " microhabitat" as used in this paper.

Seductive though some odonate-plant associations may be, probably few if any are invariable. **Intraspecific variation** is evident even in the celebrated example of *Aeshna viridis* (MÜNCHBERG, 1956; SCHMIDT, 1975) which, according to POOSCH (1973), is sometimes common where *Stratiotes aloides* is absent. Always one must remember that **apparent** habitat preferences within a species may vary, perhaps even between individuals of the same population. I say "apparent" preferences in order to stress, as others have done (SCHMIDT, 1991), that it is **we** who choose the criteria for characterising habitats. Thus we traditionally place importance on whether a water body is lentic or lotic; and we are encouraged to do so because Odonata segregate fairly well according to this dichotomy (DONATH, 1984; ANSELM, 1985). However the occasional existence of "lotic" species in "lentic" biotopes (e.g., SCHMIDT, 1988; BEUTLER, 1989) makes it likely that, for some species at least, dissolved oxygen, turbulence (as distinct from directional flow **per se**) (see ZAHNER, 1965; SCHMIDT, 1984) and sediment particle-size (for species with burrowing larvae) (see CLAUSNITZER, 1992) are prerequisites for habitat occupancy and that intraspecific variation need not be responsible for such apparent anomalies. In this connection allowance must be made for the existence of a kind of imprinting at emergence such that adults return to their natal habitat when reproductively mature (UTZERI et al., 1976).

Proximate cues

Analysis of examples of Biotopbindung leads to a consideration of **proximate cues** - the stimuli, or signals, that enable an ovipositing female to recognise a habitat as being acceptable, and that presumably indicate the complement of physical and biotic factors (the so-called "ultimate factors") that are conducive to survival of her progeny. BUCHWALD (1988) has improved our understanding of this supposed link in his study of habitat requirements of *Cordulegaster bidentatus*. He relates each putative cue to certain abiotic and biotic conditions and the developmental stage thought to be dependent on them, an approach adopted profitably by SOEFFING (1986) in his demonstration that *Sphagnum*, used for oviposition by *Leucorrhinia rubicunda*, provides favourable conditions for the nutrition and thermal environment of the larva. SOEFFING`s work reminds us that the successive stages in the dragonfly life-cycle depend on different microhabitats within a habitat to meet their needs (KÖNIG, 1990; OTT, 1991). The exciting research field of proximate cues has been illuminated by WILDERMUTH`s elegant, reductionist field experiments that have identified signals that elicit oviposition in *Aeshna juncea, Leucorrhinia pectoralis, Perithemis mooma* and *Somatochlora arctica* (WILDERMUTH, 1992a, b, 1993; WILDERMUTH and SPINNER, 1991).

Odonata as bioindicators

A correlation clearly exists between certain habitat types and species of Odonata. However, the **usefulness** of Odonata as bioindicators will depend not only on which species or species assemblages are chosen (CARCHINI and ROTA, 1985; SCHMIDT, 1985), but also on the habitat-attributes that they are asked to indicate, and on how reliably the Odonata are expected to perform. For example, in his study of lowland brooks in the southeastern Netherlands, WASSCHER (1988) found that seven species of Odonata fitted well into three (high-ranking) categories of the water-quality classification of MILLER-PILLOT (1971) and that one species - *Ischnura elegans* - which seemed able to tolerate water of low quality, could not be assigned to any one category. WASSCHER found that the spatial heterogeneity of a brook was linked closely with occupancy by *Calopteryx virgo* and *Gomphus vulgatissimus* in particular, whereas *I. elegans* actually preferred canalised stretches where heterogeneity was low.

I now briefly consider, as examples, three environmental variables for which Odonata have been regarded as possible indicators: (1) pH; (2) salinity; and (3) pollution.

(1) It seems that few if any Odonata segregate among habitats according to pH. Several species (e.g. of *Leucorrhinia*) are regarded as acidophile (KNAPP et al., 1983) and could perhaps be seen as candidate indicators for acid waters. However, although the general absence of some species from *Sphagnum* bogs may indicate an inability to tolerate a pH below about 4.5 (SCHMIDT, 1989), Odonata typically tolerate a wide range of pH values (POLLARD, 1987; but see GORHAM and VODOPICH, 1992) and certain species may well be conspicuous in acid habitats primarily because insectivorous fishes, to which they are exceptionally vulnerable, are absent from acid waters (EVANS, 1987).

(2) Definitive studies on the tolerance of Odonata to salinity (DUNSON, 1980; CANNINGS and CANNINGS, 1987) reveal that the few species tolerant of high salinity (i.e. more than 10 % and sometimes more than 50 % seawater) occur also at low salinity. So they could serve as indicators of high salinity only if other, less-tolerant species **(that would otherwise have been present)** were absent.

(3) Odonata might reasonably be expected to help investigators to distinguish between water bodies of different pollution burden due to chemicals or heat. With few exceptions, research in this field is still at the early stage of assembling and interpreting empirical data, derived from unforeseen pollution incidents (RAVEN, 1987) and from planned habitat manipulation (PATTERSON and WINDEGUTH, 1964). Because habitat requirements of Odonata consist of very much more than pollution-free water, it remains essential to have a baseline for comparison, either from the same habitat **before** an actual or suspected change, or from other similar habitats nearby, a consideration that emphasises the great value of long-term studies (DE RICQLES, 1988), and constitutes a compelling reason why collecting specimens of Odonata should not be generally prohibited by legislation. Even so, it is possible that the Odonata will be used tentatively, to support a conclusion already reached, or that they will be used in conjunction with other criteria, such as aquatic macrophytes or prey, on which their presence may depend. Thus, if a biocide eliminates the prey of Odonata, the latter will in due course be eliminated also, regardless of whether they are themselves susceptible to the biocide. Awareness of such **indirect** effects can be important when interpreting the outcome of field treatments involving biocides to which Odonata are significantly less susceptible than their prey (e.g. DDT used in rivers: MUIRHEAD-THOMPSON, 1973; diflubenzuron in bog pools: HOUSE, 1988; lead in former mining pools: SCHMIDT, 1990). It is known that certain species assemblages of Odonata are significantly reduced, in numbers and diversity, by habitat degradation due to pollution (HECKMAN, 1981; WATSON et al., 1982; TAKAMURA and YASUNO, 1986; LENZ, 1991). Sometimes the effect is known or suspected to be indirect, as described above. Sometimes it **could** be direct, although prey reduction would in any case have played a role **eventually**. The best example known to me where a species assemblage of Odonata can be used to indicate pollution relates to thermally-enhanced streams near a power plant in South Carolina, U.S.A. (GENTRY et al., 1975). In this case it could be demonstrated by laboratory experiment that the effect of temperature was direct, rather than indirect: only seven species (all pond-dwelling Libellulidae) out of the 21 at risk could survive a sustained rise of 15 - 20°C during winter.

Conclusion

I conclude from this brief survey that the hypothesis stated at the beginning of the article is indeed supported, but only subject to several important qualifications.

Odonata **can be** useful as bioindicators, but mainly as one among a mosaic of correlated habitat (and especially microhabitat) attributes that together correlate with "water quality" and stages of ecological succession, including degradation caused by human impact.

The use of **species assemblages** - or **representitive spectra of Odonata species** (the "RSO" of SCHMIDT, 1985) - rather than individual species, strengthens this usefulness by rendering less fragile the correlation between habitat and Odonata, and by buffering that correlation against the effects of some small deficiency in the array of physical and biotic conditions needed by each species, and against intraspecific variation.

By the same token, it will always be necessary to allow for, and therefore to include in an assessment, other factors known or suspected to be prerequisites for habitat and microhabitat occupancy (e.g. aquatic macrophytes - for oviposition or larval refuges).

Finally, and to adopt a different perspective: the use of Odonata as bioindicators, where scientifically justified, has an important **tactical and political** dimension. Like birds, dragonflies are large and beautiful animals enjoyed by many naturalists who feel impoverished when they disappear. Everyone interested in protecting the integrity of aquatic habitats (for whatever reason) would be well advised to include Odonata among the recognised criteria of a healthy environment, because by doing so they will increase the likelihood that any conservation message is received sympathetically.

Acknowledgements

It gives me pleasure to thank Dr. Jürgen OTT for suggesting that I prepare this article and Prof. Dr. Eberhard SCHMIDT for his valued comments on the manuscript.

Literature

ANSELIN, A. (1985): Odonata and their habitats above 1,000 m in Central Spain. *Libellula* 4: 138-147a

BEUTLER, H. (1989): Notiz zur Lebensweise von Zangenlibellenlarven, Onychogomphus forcipatus (L.), in ostbrandenburgischen Seen (Insecta, Odonata, Gomphidae). *Beeskow. naturw. Abh.* 3: 93-94

BUCHWALD, R. (1988): Die Gestreifte Quelljungfer Cordulegaster bidentatus (Odonata) in Südwestdeutschland. *Carolinea* 46: 49-64

BUCHWALD, R. (1989): Die Bedeutung der Vegetation für die Habitatbindung einiger Libellenarten der Quellmoore und Fließgewässer. *Phytocoenologia* 17: 307-448

BUCHWALD, R., B. HOPPNER and W. ROSKE (1989): Gefährdung und Schutzmöglichkeiten grundwasserbeeinflußter Wiesenbäche und -graben in der Oberrheinebene-Naturschutzorientierte Untersuchungen an Habitaten der Helm-Azurjungfer (Coenagrion mercuriale, Odonata). *Natur u. Landschaft* 64: 398-403

CANNINGS, R.A. and S.G. CANNINGS (1987): The Odonata of some saline lakes in British Columbia, Canada: ecological ditribution and zoogeography. *Adv. Odonatol.* 3: 7-21

CARCHINI, G. and E. ROTA (1985): Chemico-physical data on the habitats of rheophile Odonata from central Italy. *Odonatologica* 14: 239-245

DE RICQLES, A. 1988: Les odonates de Dordogne et leur intérêt comme indicateurs de l`évolution à moyen terme. *Revue Ecol. (Terre Vie)* 43: 177-194

DONATH, H. (1980): Eine bemerkenswerte Libellenfauna an einem Kiesgrubenweiher in der Niederlausitz (Odon.). *Ent.Ber., Berl.* 1980 (2): 65-67

DONATH, H. (1984): Libellen als Bioindikatoren für Fließgewässer. *Libellula* 3 (3/4): 1-5

DONATH, H. (1989): Verbreitung und Ökologie der zweigestreiften Quelljungfer, Cordulegaster boltoni (Donovan, 1807) in der DDR (Insecta, Odonata, Cordulegasteridae). *Faun. Abh. Dresden* 16 (6): 97-106

DUNSON, W.A. (1980): Adaptions of nymphs of a marine dragonfly, Erythrodiplax berenice, to wide variations of salinity. *Physiol. Zool.* 53: 445-452

EVANS, R. (1987): Singing in the acid rain: Leucorrhinia dominates benthos of acidified, fishless lakes. *Bull.N. Amer.benthol. Soc.* 4(1): 96

FINCKE, O.M. (1992): Interspecific competition for tree holes: consequences for mating systems and coexistence in Neotropical damselflies. *Amer.Nat.* 139: 80-101

GENTRY, J.B., C.T. GARTEN, F.G. HOWELL and M.H. SMITH (1975): Thermal ecology of dragonflies in habitats receiving reactor effluent. *In:* Environmental effects of cooling systems at nuclear power plants. IAEA-SM-187/12: 563-574. International Atomic Energy Agency, Vienna

GERKEN, B. (1984): Die Sammlung von Libellen-Exuvien-Hinweise zur Methodik der Sammlung und zum Schlüpfort von Libellen. *Libellula* 3 (3/4): 59-72

GORHAM, C.T. and D.S. VODOPICH (1992): Effects of acidic pH on predation rates and survivorship of damselfly nymphs. *Hydrobiologicy* 242: 52-62

HECKMANN, C.W. (1981): Long-term effects of intensive pesticide applications on the aquatic community in orchard drainage ditches near Hamburg, Germany. *Arch. environm. Contam. Toxicol.* 10: 393-426

HOUSE, N.L. (1988): *The ecology of Leucorrhinia hudsonica (Selys) (Odonata: Libellulidae) in Newfoundland bog pools.* B. Sc. thesis, Memorial University, Newfoundland, Canada

KNAPP, E., A. KREBS and H. WILDERMUTH (1983): Libellen. *Neujahrsbl. naturf. Ges. Schaffhausen* 35: 1-90

KÖNIG, A. (1990): Ökologische Einnischungsstrategien von vier Arten der Gattung Sympetrum (Anisoptera: Libellulidae). *Libellula* 9 (1/2): 1-11

MACHADO, A.B.M. (1981): Biologia de Roppaneura beckeri Santos, 1966, libéllula cuja larva vive na água acumulada em folhas da umbelifera Eryngium floribundum. *Resum. Com. cient. 8 Congr. brasil. Zool. Brasilia*: 41-42

MARTENS, A. (1992): Egg deposition rates and duration of oviposition in Platycnemis pennipes (Pallas) (Insecta: Odonata). *Hydrobiologia* 230: 63-70

MOLLER-PILLOT, H.K.M. (1971): *The assessment of pollution in lowland streams by means of macrofauna*. Pillot-Standaardboekhandel, Tilburg

MOORE, N.W. (1991): The development of dragonfly communities and the consequences of territorial behaviour: a 27 year study on small ponds at Woodwalton Fen, Cambridgeshire, United Kingdom. *Odonatologica* 20: 203-231

MUIRHEAD-THOMPSON, (1973): Laboratory evaluation of pesticide impact on stream invertebrates. *Freshwater Biol.* 3: 479-498

MÜNCHBERG, P. (1956): Zur Bindung der Libelle Aeschna viridis Eversm. an die Pflanze Stratiotes aloides L. (Odon.). *Nachrbl. bayer Ent., Munich* 12: 113-118

OTT, J. (1991): *Populationsökologische Untersuchungen an Großlibellen (Anisopera) unter besonderer Berücksichtigung der Edellibellen (Aeshnidae)*. Diss. Univ. Kaiserslautern, Germany

PATTERSON, R.S. and D.I. von WINDEGUTH (1964): The use of Baytex as a midge larvicide. *Mosquito News* 24: 393-396

POLLARD, J.B. (1987): Anisopteran odonate communities in a series of south-central Ontario lakes exhibiting a pH gradient. *Bull. N. Amer. benthol. Soc.* 4: 72

POOSCH, H. (1973): Zum Vorkommen und zur Populationsdynamik von Libellen an zwei Kleingewässern in Mittelmecklenburg. *Natur und Naturschutz Mecklenburg* 11: 5-14

RAVEN, P.J. (1987): Odonate recovery following a major insecticide pollution of the River Roding, Essex. *J. Brit. Dragonfly Soc.* 3: 37-44

REHFELDT, G. (1986): Libellen als Indikatoren des Zustandes von Fließgewässern des nordwestdeutschen Tieflandes. *Arch. Hydrobiol.* 108: 77-95

SCHMIDT, E. (1975): Zur Klassifikation des Eiablageverhaltens der Odonata. *Odonatologica* 4: 177-183

SCHMIDT, E. (1983): Odonaten als Bioindikatoren für mitteleuropäische Feuchtgebiete. *Verh. Dtsch. Zool. Ges.* 1983: 131-136

SCHMIDT, E. (1984): Gomphus vulgatissimus L. an einem belasteten Havelsee, dem Tegeler See (Insel Scharfenberg) in Berlin (West). *Libellula* 3 (3/4): 35-51

SCHMIDT, E. (1985): Habitat inventarization, charakterization and bioindication by a "representative spectrum of Odonata species (RSO)". *Odonatologica* 14: 127-133

SCHMIDT, E. (1986): Die Odonatenfauna als Indikator für Angel-Schaden in einem einmaligen Naturschutzgebiet, dem Kratersee "Windsborn" des Mosenbergs (Vulkaneifel, BRD). *Libellula* 5 (3/4): 113-125

SCHMIDT, E. (1988): Ist die Westliche Keiljungfer Gomphus pulchellus Selys, 1840, eine Stillwasserart? (Odonata-Gomphidae). *Tier und Mus.* 1:17-20

SCHMIDT, E. (1989): Zur Odonatenfauna des Hechtmoores in Angeln/Schleswig. *Drosera* 1/2: 31-42

SCHMIDT, E. (1990): Die Odonatenfauna eines ehemaligem Bleisandabsetzbeckens (Buchholzweiher bei Mechernich, Nordeifel). *Mitt. Pollichia* 77: 383-393

SCHMIDT, E. (1991): Das Nischenkonzept für die Bioindikation am Beispiel Libellen. *Beitr. Landespflege Rheinland-Pfalz* 14: 95-117

SCHORR, M. (1990): *Grundlagen zu einem Artenhilfsprogramm Libellen der Bundesrepublik Deutschland*. Ursus, Bilthoven (ISBN 90-73527-01-5)

SOEFFING, K. (1990): *Verhaltensökologie der Libelle Leucorrhinia rubicunda (L.) (Odonata: Libellulidae) unter besonderer Berücksichtigung nährungsökologischer Aspekte*. Doct. Diss., University of Hamburg, Germany

TAKAMURA, K. and M. YASUNO (1986): Effects of pesticide application on chironomid larvae and ostracods in rice fields. *Appl. Ent. Zool.* 21: 370-376

UTZERI, C., E. FALCHETTI and G. CARCHINI (1976): Alcuni aspetti etologici della ovideposizione di Lestes barbarus (Fabricius) presso pozze temporanee. *Odonatologica* 5: 175-179

VOSHELL, J.R. and G.M. SIMMONS (1978): The Odonata of a new reservoir in the southeastern United States. *Odonatologica* 7: 67-76

WASSCHER, M.T. (1988): *Libellen als mogelijke indicatoren voor waterkwaliteit en ruimtelijke variatie op laaglandbeken in Zuid Oost Brabant*. M.Sc. thesis, University of Utrecht, The Netherlands

WATSON, J.A.L., A.H. ARTHINGTON and D.L. CONRICK (1982): Effect of sewage effluent on dragonflies (Odonata) of Bulimba Creek, Brisbane. *Aust. J. Mar. Freshwater Res.* 33: 517-528

WILDERMUTH, H. (1986): Zur Habitatwahl und zur Verbreitung von Somatochlora arctica (Zetterstedt) in der Schweiz (Anisoptera: Corduliidae). *Odonatologica* 15: 185-202

WILDERMUTH, H. (1992a): Habitate und Habitatwahl der Großen Moosjungfer (Leucorrhinia pectoralis) Charp. 1825 (Odonata, Libellulidae). *Z. für Ökologie und Naturschutz* 1 (1): 3-21

WILDERMUTH, H. (1992b): Visual and tactile stimuli in choice of oviposition substrates by the dragonfly Perithemis mooma Kirby (Anisoptera: Libellulidae). *Odonatologica* 21: 309-321

WILDERMUTH, H. (1993): Habitat selection and oviposition site recognition by the dragonfly Aeshna juncea (L.): an experimental approach in natural habitats (Anisoptera: Aeshnidae). *Odonatologica* 22: 27-44

WILDERMUTH, H. and W. SPINNER (1991): Visual cues in oviposition site selection by Somatochlora arctica Zetterstedt (Anisoptera: Corduliidae). *Odonatologica* 20: 357-367

ZAHNER, R. (1965): Organismen als Indikatoren für den Gewässerzustand. *Arch. Hygiene und Bakteriol.* 149: 243-256

Libellula 12 (3/4): 103-118 1993

Die Ergebnisse der Libellenerfassung in einem UTM-Rasterquadrat in Ungarn (ET 56, NO-Ungarn, 1989)[1]

György Dévai und Margit Miskolczi

eingegangen: 27. August 1993

Summary

In this paper the authors present the results of a study on dragonflies (Odonata) which was carried out within the ET 56 UTM grid quadrat, a 10 by 10 km square located east of Debrecen, NE-Hungary, in 1989. The basic sampling area was partitioned into 2.5 by 2.5 km subquadrats. The investigations involved 71 sites of 44 water bodies. Throughout the collections, 5635 specimens of 46 species were captured, representing 2686 data. In addition to collections, regular observations were also made. The evaluation and comparison of faunistical data involved three different ways: a/ site by site according to the subquadrats of the UTM grid; b/ according to different sized UTM grid subquadrats (2.5x2.5, 5x5 and 10x10 km); and c/ according to the water bodies within the basic grid. The authors concluded that the area maintains a very rich dragonfly fauna and is of outstanding concern in nature conservation, which results from the overall variety of water bodies as well as the structural complexity of the individual water bodies themselves.

Dr. György Dévai und Margit Miskolczi, Lehrstuhl für Ökologie der Universität L. Kossuth, Postfach 14, H-4010 Debrecen, Ungarn

1) Die zugrundeliegende Arbeit wurde aus Mitteln des Forschungskontraktes Nr. 1758 im Rahmen des ungarischen Forschungsunterstützungsprogramms "OTKA" über die Universität L. Kossuth (Debrecen, Ungarn) gefördert.