Rainer Buchwald, Aurelio Manzi und Holger Hunger·

Habitat selection of Emerald Spreadwing *Lestes dryas* and Yellow-winged Darter *Sympetrum flaveolum* (Lestidae, Libellulidae; Odonata) in karst plateaus of Central Italy

R. Buchwald, Hchschule Vechta, INU, Driverstraße 22, D-49377 Vechta; rainer.buchwald@uni-vechta.de

A. Manzi, Largo dell' Torrione 9, I-Isola del Gran Sasso (AQ)

H. Hunger, August-Ganther-Straße 16. D-79117 Freiburg; holger.hunger@inula.de

Zusammenfassung

In zahlreichen permanenten und sommertrockenen Stillgewässern von Karst-Hochebenen Mittelitaliens wurden die Abundanz, Frequenz (= Stetigkeit) und Reproduktion der Libellenarten Glänzende Binsenjungfer (*Lestes dryas)* und Gefleckte Heidelibelle (*Sympetrum flaveolum)* in Abhängigkeit von diversen morphologischen, hydrologischen, vegetationskundlichen und sonstigen Faktoren untersucht.

Die beiden Arten besiedeln ein weites Spektrum von Gewässern und Habitattypen, allerdings mit unterschiedlich hohen Abundanzen und Frequenzen. Die Imagines bevorzugen Gewässer mit flachen Ufern, deren Helophyten-Vegetation von (braun- bis gelb-) grünen Beständen der Wuchstypen „Großsegge“ und „Binsen(artige)“ dominiert wird und in den Randbereichen eine Wuchshöhe von (30-)35 cm (*L. dryas*) bzw. 20 cm (*S. flaveolum*) und in den zentralen, tieferliegenden Bereichen von (30-) 35 cm (*L. dryas*) bzw (25-)30 cm (*S. flaveolum*) überschreitet. Im Vergleich zu Vegetationsaspekt, -farbe und Wuchshöhe der zentralen Bereiche spielen andere Parameter offensichtlich eine untergeordnete oder keine Rolle für die Libellenbesiedlung (z.B. Flächengröße, aktueller Wasserstand, Dichte und Deckungsgrad der Vegetation, Bodenfarbe).

Die erzielten Ergebnisse stimmen weitestgehend mit denjenigen aus anderen Regionen Europas überein. Aus den vorliegenden Resultaten wird eine Hypothese zur Habitatwahl der beiden Arten vorgestellt, die durch experimentelle, getrennte Bearbeitung der betreffenden Parameter zu überprüfen ist.

1. Introduction

From the evolutionary biologist's point of view, animal species and individuals are subject to strong evolutionary pressure to choose their habitat, and especially their reproductive sites, in a very efficient way This means that an animal has to either inherit or acquire the capability of distinguishing between suitable and unsuitable habitats, be it its natal place or a newly colonised area.

Up to now, the morphology of a water body (size, shape, shore length, depth, and so on), its hydrology (annual fluctuations of the water level, possible desiccation, water current, and so on), its thermal situation (thermal sum throughout the year or in the early summer, maximum summer temperature, minimum winter temperature, possible freezing of the complete water body) and its vegetation (structure, plant species composition, occurrence of “signal species”, and others) have been identified as important parameters of odonate habitats (BUCHWALD 1989, 1994a, 2003; WILDERMUTH 1993; CORBET 1999; RÖHN et al. 1999; SCHMIDT & STERNBERG 1999). Those factors that can be perceived by the sense organs of the imagoes at the time of habitat selection - such as size, shore morphology, vegetation structure - are considered signal factors sensu OSCHE (1986). Other factors which may be

crucial for habitat suitability may not be recognisable in general or at the point of time when habitat selection takes place (e.g., minimum winter temperature, possible freezing of the entire water body, probably maximum water depth) and have to be replaced by signal factors which are discernible and closely correlated with them (BUCHWALD 1989, 1994b).
The habitat selection of odonates can take place in three different ways:

1 The teneral and mature imagoes remain and reproduce at their birth place ("emergence site constancy").
2. The habitat is selected actively using signal factors which can be discerned by the imagoes. These can be basic signal factors, such as the presence of water or the water movement, or specific factors such as the surrounding landscape mosaic, the predominance of certain plant species or growth types of hydrophytes (water plants) or helophytes (marsh plants).
3. Unspecific signal factors (e.g., any kind of vegetation of a certain minimum density, water availability) are employed for habitat selection. This "trial and error strategy" means that the imagoes disperse to a multitude of waters and that matings and ovipositions take place more or less arbitrarily at potentially suitable reproductive habitats.

Only the second case, where habitat selection is an active process, will be subject of the following text.
In the karst plateaus of Central Italy there exist many permanent or ephemeral standing waters which are characterised by strong fluctuations of the water level. Very shallow waters may dry up already between mid May and the end of June, while deeper ones can last through July or August. Some retain water throughout the year – at least in their centres. Characteristic odonate species of partially or completely summer-dry waters are the Emerald Spreadwing (*Lestes dryas*) and the Yellow-winged Darter (*Sympetrum flaveolum*). Both species reproduce prolifically in these waters (BUCHWALD 1994c) and colonise – just like in Central Europe – turf-like vegetation of intermediate growth height which is characterised by the predominance of sedges (*Carex* spp.) and/or rushes (rush-likes) (*Juncus* spp., *Eleocharis palustris* s.l.).
Studies carried out over the course of several years took aim at the following questions:

- Which standing waters are colonised by the two species, which ones not?
- Which morphological, hydrological, and vegetation factors are of great, which ones of less importance?
- Which hypotheses on habitat selection can be derived from the findings?

2. Study sites, methods
In the years 1990, 1991, 1994, 1995, and 2002, extensive biocenological studies – each one with a duration of approximately one week - were carried out in several karst plateaus (altipiani carsici) of Central Italy The study sites are located in the following regions: Marche (Pian Perduto di Gualdo), Umbria (Pian Grande and Pian Piccolo near Castelluccio di Norcia), Lazio (Piano di Rascino), and Abruzzo (Campo Imperatore, Piano di Campo Felice, Altipiano Rocca di Cambio, Opi, Rifugio Campitelli di Alfedena, Piano di Pescocostanzo/Rivisondoli, Piano di Cinquemiglia, Altipiano Stazione di Palena). The plateaus are situated between 1 130 and 1.550 m above sea level (a.s.l.). Summers are moderately warm with little precipitation, winters are harsh and snow-rich. Most study sites were visited two to three times

(1990, 1991, 2002). Specific surveys and experiments were carried out exclusively at the two plateaus near Castelluccio (Umbria).

The following biotic and abiotic factors were recorded at the study sites:
Odonate fauna: absolute number of imagoes per sampling site (= abundance); abundances in absolute numbers were aggregated in three classes (low, medium, and high abundance)
Frequency: percentage of visits when the respective species was encountered
Area: size of the water (length times width) in m²
Water depth: measured at the time of the odonate surveys, in cm
Shore characteristics: distance between water body and vegetated area at steep shores, in cm
Soil colour: from light brown to dark brown, scale of five classes
Vegetation colour: from green to brown/yellow, scale of five classes
Fertility: percentage (%) of flowering/fruiting stems of the characteristic plant species
Vegetation height: at the margins and in the centre, in cm
Vegetation density: number of stems of the characteristic plant species in a sampling square of 20 x 20 cm, at the margins and in the centre
Vegetation cover: degree of cover of the helophytes and hydrophytes, in %
Characteristic plant species (*Carex* spp., *Eleocharis palustris* s.l., *Glyceria fluitans* et *plicata*): presence yes/no
Vegetation aspect: percentage of the dominating growth types "sedges" and "rushes/rush-likes" with regard to the complete helophyte vegetation, in %.

We distinguished between four types of odonate habitats characterised by vegetational and hydrological parameters (tab. 1). These four habitat types occurred within the plant communities Caricetum gracilis, Caricetum vesicariae, Caricetum paniculatae (rare), community of *Carex otrubae*, community of *Eleocharis palustris* s.l. and *Glyceria fluitans* (et *Glyceria plicata*). As there were no notable differences in odonate colonisation between these five plant communities, they were aggregated.

Type	**1.1**	**1.2**	**2.1**	**2.2**
Characteristics				
desiccation in summer	very infrequent (August)	infrequent (July – August)	very often (June – August)	always (April – June)
fluctuations of water level	weak	strong	strong	very strong
occurrence of *Veronica scutellata* and *Ranunculus flammula*	-	+	+	+
occurrence of *Agrostis canina, Polygonum amphibium, Potentilla reptans*	-	-	+	+
occurence of *Deschampsia cespitosa, Carex panicea, Leontodon autumnalis* etc.	-	-	-	+

Table 1
Hydrological and vegetational characteristics of the four different types of odonate habitats in standing waters of the Central Italian karst plateaus.

The data were statistically processed employing the Spearman rank correlation, with rs = rank correlation (-1 < rs < +1), n = number of pairs, and α = probability of error

3. Results

a) The results of the surveys conducted in 1994 at 57 standing waters of the plateaus Pian Grande and Pian Piccolo near Castelluccio di Norcia (Umbria) are presented as an example for the odonate colonisation of the four habitat types. The surveys included all potentially suitable waters.

Type of habitat	1 1	1.2	2.1	2.2
Drying up of the water (months)	very rarely (8)	rarely (7/8)	frequently (6-8)	always (4-6)
Number of study waters (1994)	18	5	15	19
Cover of helophytes (%)	59 (1 - 100)	17 (5 - 35)	87 (60- 95)	88 (30-100)
Vegetation height in the centre (cm)	70 (60- 85)	73 (60 - 90)	56 (35- 90)	51 (30- 95)
Vegetation density centre (stems / 400 cm²)	99 (50-185)	67 (30-123)	74 (35-130)	79 (15-140)
Vegetation colour (1-5)	4,8 = (ye)gr	5,0 = gr	3,9 = ye-gr	3,4 = ye(gr)
Abundance *Lestes dryas* (classes 1-3)	1,3 (0-3)	2,8 (0-3)	1,0 (0-3)	0,4 (0-3)
Frequency *Lestes dryas* (%)	83	80	53	26
Abundance *Sympetrum flaveolum* (cl. 1-3)	0,6 (0-2)	1,0 (0-2)	0,9 (0-2)	0,2 (0-2)
Frequency Sympetrum flaveolum (%)	50	80	60	21
Waters not colonised (%)	17	0	27	63

Table 2: Abundance (in three classes; medium, minimum and maximum value) and frequency (in %) of *Lestes dryas* and *Sympetrum flaveolum*, and percentage of uncolonised waters of the four types of odonate habitats. Additional information is given on the cover of helophyte vegetation (in %), central vegetation height (in cm), central vegetation density (number of stems, per 400 cm²) (each with medium, minimum and maximum value) and medium vegetation colour (ye=yellow, gr=green).

All four habitat types are colonised by *L. dryas* und *S. flaveolum*. However, there are strong differences in abundance and frequency· types 1 1 and 1.2 are inhabited frequently, while type 2.1 is inhabited moderately, and 2.2 weakly Some of the 14 parameters we studied (e.g., percentage of cover of the helophytic vegetation) showed strong variance within one habitat type and low variance between the four habitat types. Therefore, these factors are probably of little or no importance for the observed differences in abundance and frequency!
In June/July 1994 and 1995, all potentially suitable standing waters of Pian Grande and Pian Piccolo were sampled several times in order to record the species'

abundance, as well as clues for reproduction or proofs of reproduction. In the following text, we will compare optimal odonate waters (with above average abundances and clues for risp. proofs of reproduction) with uncolonised waters.
Odonate abundance and frequency are very different between the four habitat types (fig. 1). Habitat type 2.2 is populated by both species only in single cases. The other three types are colonised regularly, *L. dryas* being the dominant species in habitat types 1 1 and 1.2, and *S. flaveolum* in habitat type 2.1

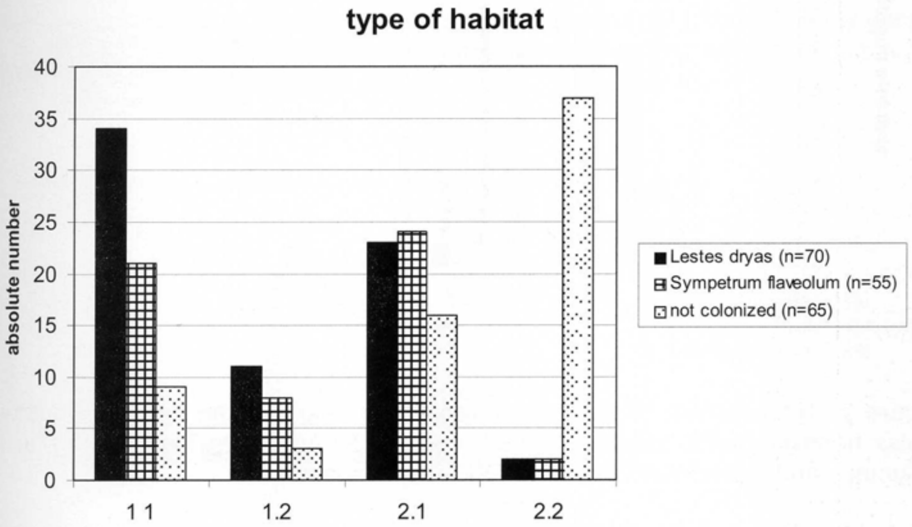

Figure 1 Distribution of optimal habitats of *L. dryas* (n=70, black columns), optimal habitats of *S. flaveolum* (n=55, grey columns), and uncolonised waters (n=65, white columns) on the four hydrological-vegetational habitat types (refer to table 1).

Our results show a clear influence of the following three parameters on odonate abundance and frequency·

- vegetation height in the centre (fig. 2)
- vegetation aspect: percentage of growth types "sedges" and "rushes/rush-likes", in relation to the entire helophytic vegetation (fig. 3)
- vegetation colour (fig. 4)

The growth height in the central depressions of the habitats inhabited by both species ranges from 25 cm to 190 cm (fig. 2). The helophytic vegetation of waters which remain uncolonised is usually lower (15-60 cm). *S. flaveolum* has an amplitude of 25 – 120 cm, and reaches its optimum in vegetation of 40 – 60 cm. Compared to this, *L. dryas* has a far wider amplitude of 35 – 190 cm, and its optimum is in higher vegetation (40 – 90 cm) (fig. 2).

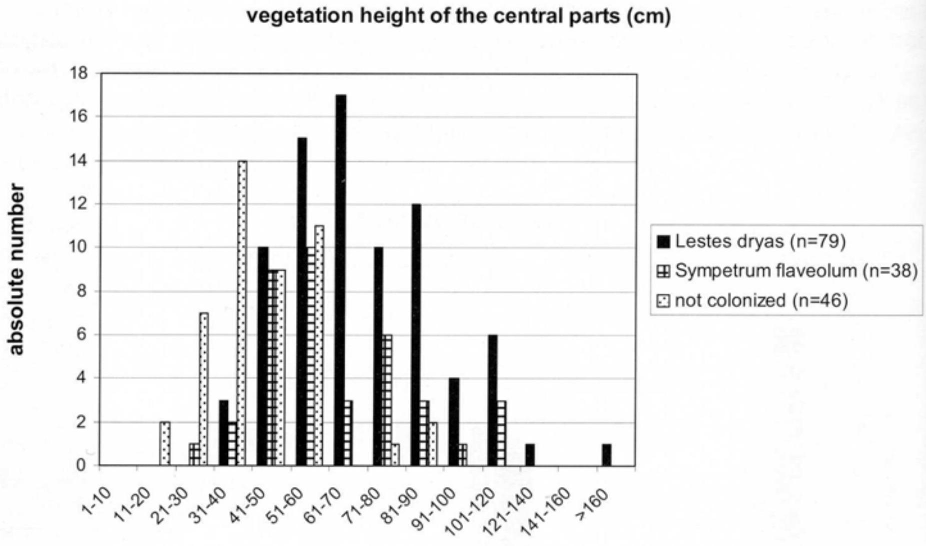

Figure 2: Total number of classes of vegetation height in the centre of optimal *L. dryas* habitats (n=79, black columns), optimal *S. flaveolum* habitats (n=79, grey columns), and uncolonised waters (n=46, white columns).

The vegetation aspect of the waters has to be dominated by sedges and/or rushes/rush-likes if the imagoes are to accept the habitat. The threshold is a percentage of 30-40% (fig. 3). Again, a difference in the ecological demands is notable: *L. dryas* has an amplitude of 45-100% of characteristic growth types and reaches its optimum above 80%. These values are more extreme than those for *S. flaveolum* with an amplitude of 30-100% and its optimum above 60% (fig. 3).

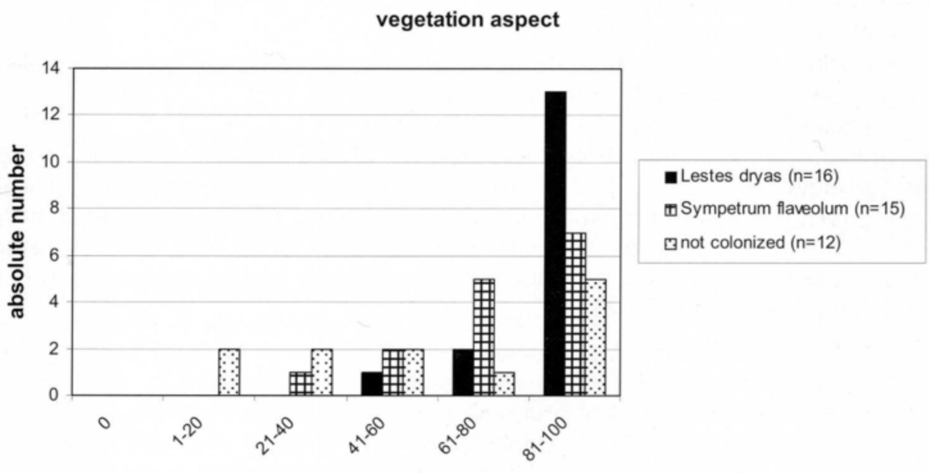

Figure 3: Vegetation aspect of optimal *L. dryas* habitats (n=16, black columns), optimal *S. flaveolum* habitats (n=15, grey columns), and uncolonised waters (n=12, white columns). The diagram shows the distribution on six classes of the percentage (%) of sedges and/or rushes/rush-likes with regard to the complete helophytic vegetation.

At the time of the surveys (mid June until early August), the characteristic plants of the study waters displayed the complete spectrum of vegetation colours (fig. 4). Except for two *L. dryas* waters, the stands of *Carex* spp., *Eleocharis palustris* s.l., and *Juncus* spp. belonged to the colour classes 1 (only green), 2 (predominantly green), and 3 (yellow and green equally dominant). There was no significant difference between the two odonate species.

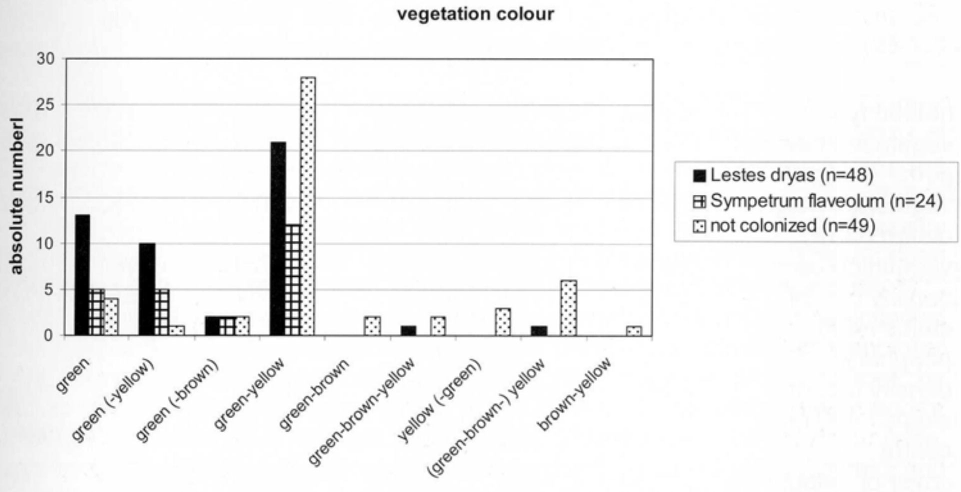

Figure 4 Total number of vegetation colours (scale of 1 to 5) in the stands of the characteristic growth types of optimal *L. dryas* waters (n=48, black columns), optimal *S. flaveolum* waters (n=24, grey columns), and uncolonised waters (n=49, white columns).

The following parameters had little influence on the colonisation by odonates:

- shore morphology· only steep shores remained (mostly) uncolonised
- cover of the helophytic vegetation: only sites with extremely dense (>90%) or sparse (<10-15%) vegetation remained (mostly) uncolonised
- vegetation height of the marginal zones

The following parameters had very little or no influence on the colonisation by odonates:

- size of the water
- water depth (at the time of the survey)
- degree of cover of the hydrophytic vegetation
- vegetation density of the marginal parts
- vegetation density of the central parts
- presence of characteristic plant species
- fertility of characteristic plant species
- soil colour

Our results clearly show that the two odonate species tolerated wide amplitudes for some factors, but only narrow ones for others. It is likely that the latter ones might function as signal factors.

The statistical analysis (Spearman rank correlation) shows that in several cases there are strong correlations between odonatological parameters and vegetational parameters, especially between the abundances of the odonate species on one side and habitat type, vegetation height of the central parts, and vegetation colour on the other side (tab. 3). The correlation of the same vegetation parameters with frequencies and reproduction of the two species are much weaker; other parameters of the vegetation exhibit medium (fertility) or (very) low rank correlations.

	abundance	abun-dance	frequency (%)	frequency (%)	reproduction	reproduction
	L. dryas	S. flaveolum	L. dryas	S. flaveolum	L. dryas	S. flaveolum
habitat type	-0,4721	-0,4438	-0,4825	-0,3947	-0,2176	-0,2103
vegetation height, periphery (cm)	0,4124	0,165	0,3175	-0,0959	0,2296	0,0612
vegetation height, centre (cm)	0,5479	0,446	0,474	0,3979	0,2783	0,2871
vegetation colour	-0,5091	-0,2222	-0,4129	-0,1529	-0,2191	-0,0783
density (no. of stems / 400 cm²), periphery	0,3723	0,1191	0,3541	0,0652	0,1593	-0,0196
density (no. of stems / 400 cm²), centre	0,1854	0,291	0,2381	0,2881	0,0782	0,239
cover of helophytes (%)	-0,1154	0,1494	0,0099	0,1388	-0,2058	0,0296
cover of hydrophytes (%)	0,1977	-0,1371	0,1089	-0,1585	0,1668	-0,0542
fertiliy of characteristic plant species (%)	0,3948	0,354	0,3386	0,3154	0,1659	0,1378

Table 3: Spearman rank correlations between various odonate and vegetation parameters, studied in 1994 and 1995; n = 30 waters, $r_s > 0,42$ for $\alpha < 1\%$. For the units of the parameters see chapter "methods"

In order to find out which vegetation parameter(s) are crucial for the strong affinity towards specific habitat types, experiments by which each parameter is tested separately are necessary and have already been initiated (BUCHWALD et al. in prep.). The Spearman correlation test shows high coefficients especially for vegetation colour (positively correlated with habitat type, negatively correlated with marginal vegetation height, fertility of characteristic species, cover of hydrophytes, and marginal vegetation density) and of marginal vegetation height (positively correlated with marginal vegetation density and cover of the hydrophytes, negatively correlated with habitat type). A multivariate analysis of the extensive data is in progress in order to illuminate the mathematical interdependencies.

4. Discussion

a) The results of the biocenological studies in the karst plateaus of Central Italy demonstrate that morphological parameters (size, shore characteristics), hydrological (current water depth) and other parameters (soil colour) are of little or no significance for the colonisation of standing waters by the odonate species *L. dryas* and *S. flaveolum*. Instead, vegetation parameters determine whether waters are colonised at all, if reproduction occurs, and how high the abundances are. Vegetation colour, the presence and predominance of characteristic growth types, and central vegetation height are the most important parameters. The imagoes of *L. dryas* and *S. flaveolum* choose permanent or summer-dry waters with shallow (to moderately steep) shores, the vegetation of which is dominated by (brownish- or yellowish-) green stands of the growth types "sedge" and rush/rush-like which belong to the phytosociological units Magnocaricetalia and/or Agrostietalia (BUCHWALD 2003). The growth height of the marginal vegetation stands is at least (30-)35 cm (*L. dryas*) resp. 20 cm (*S. flaveolum*). In the centres, the vegetation height is (30-)35 cm (*L. dryas*) resp. (25-)30 cm (*S. flaveolum*).

Actually it is still unclear whether each of these three vegetation parameters (central growth height, aspect, colour) has an separate effect on quality and quantity of habitat use by the two odonate species. We can only state that the three factors are interconnected to a large extent, but not completely For example, central vegetation stands are usually distinctively higher than 30-35 cm; they are made up of mostly green vegetation dominated by sedges and/or rushes/rush-likes. These close relations are widely confirmed by the Spearman correlation coefficient (see table 3).

All in all, our results stress the importance of vegetation for the habitat selection of odonates. Specific conditions of the vegetation are particularly relevant for stenotopic odonate species, and when ecological factors are decisive which cannot be evaluated directly but only indirectly via cues given by the composition and/or structure of vegetation (BUCHWALD 1989, 1994a, STERNBERG 1999). In our case, the course of weather conditions (predominantly the amount of precipitations) and with this the hydrograph curve in the months following oviposition decide about the egg and larval development and thus reproductive success.

Whilst the role of specific aspect-forming growth types has been demonstrated in several earlier publications (e.g., *Coenagrion mercuriale*: BUCHWALD 1989, 1994b; *Nehalennia speciosa*: DEMARMELS & SCHIESS 1977, SCHMIDT & STERNBERG 1999; *Leucorrhinia pectoralis*: WILDERMUTH 1992, STERNBERG et al. 2000), this is the first study on odonate habitat selection which associates the two specific vegetation parameters "minimum vegetation height" and "vegetation colour" with the intensity of odonate colonisation,

b) Habitat selection is triggered by specific signal factors, the sum of which represents the eco scheme ("Ökoschema"; OSCHE 1986). These signal factors are characteristic for the habitat (STERNBERG 1999).

The obvious results of the study allow for the set-up of a well-founded hypothesis of habitat selection of *L. dryas* and *S. flaveolum* in the study waters of the Central Italian karst plateaus. Odonates orient visually so that conspicuous optical signal factors are likely to trigger habitat selection. It is not very likely, that one of the factors mentioned above acts as single signal factor, because the combination of two or three factors reduces the likelihood of erroneous habitat selection. Moreover, the extreme values of the factors "central vegetation density" and "shore characteristics" suppress habitat selection so that waters with exceptionally dense or sparse helophyte stands and/or vertical shores with a height of more than 40-50 cm are not accepted and not colonised. The role of the factor "current water level" – i.e., the area of water that is

visible for the imagoes – can only be investigated experimentally. Both species select water-bearing and desiccated waters as habitats as well. Possibly the three vegetational parameters mentioned above are less important when water is present during the time of oviposition. In this case, the potential suitability of the habitat for successful larval development and thus reproduction would be indicated by the factors "water level" (visible water), "shore characteristics" (shallow shore), and, where applicable, the presence of the growth types "sedges" and "rushes/rush-likes" It is still unknown whether the signal factors contribute additively or multiplicatively to the habitat selection process, and if they are effective simultaneously or successively.
c) Of course, the descriptive results and the hypothesis on habitat selection brought forward refer strictly to our study areas in the karst plateaus of Central Italy (BUCHWALD 1994c). However, they are congruent with results from varoius regions of Central Europe (e.g., GEREND 1988, KUHN 1995, 199; RÖHN et al. 1999, 2000), and it is therefore possible that they can be transferred to big parts of or even to the complete range of the two species. Future biocenological studies should aim at answering this question.
d) In several sections of the results chapter, we pointed out differences in the ecological requirements of the two odonate species. As a matter of fact, they usually cohabit, but are probably niche specified both temporally (*L. dryas* 2-3 weeks earlier than *S. flaveolum*, wide overlap) and spatially (*L. dryas* leaning towards permanent waters with high, green sedge vegetation, *S. flaveolum* towards summer-dry waters with partially yellowish or brownish, lower sedge and/or rush/rush like vegetation, wide overlap as well) (BUCHWALD 1994c). In addition, niche specification is enhanced effectively by differences in the mode of oviposition (*L. dryas*: endophytic; *S. flaveolum*: exophytic) and in the larval habitats (*L. dryas*: hydrophytes and submerged parts of helophytes; *S. flaveolum*: water bottom) (RÖHN et al. 2000).

5. Summary

In numerous, both permanent and ephemeral (summer-dry) standing waters of karst plateaus of Central Italy, we studied the effect of various factors regarding their structure, hydrology, and vegetation on abundance, frequency, and reproduction of the odonate species *Lestes dryas* and *Sympetrum flaveolum*. Both species occur in a wide variety of waters and habitat types – however, with significant differences in frequency and abundance. The imagoes prefer waters with shallow shores which are covered by (brownish- or yellowish-) green vegetation dominated by the growth forms "rushes" (or similar) and "sedges" The vegetation height exceeds (30-) 35 cm *(L. dryas)* respectively 20 cm *(S. flaveolum)* along the edges and (30-) 35 cm *(L. dryas)* respectively (25-) 30 cm *(S. flaveolum)* in the central depressions. Compared to vegetation aspect and –colour and vegetation height in the central depressions, other parameters (e.g., area size, water level at the time of oviposition, density and cover of the vegetation, soil colour) play a subdominant or no role at all for the colonisation by the studied species.
These results are congruent with those from other regions of Europe to the greatest possible extent. From our findings, we derive a habitat selection hypothesis for the two species. This hypothesis should be tested by carrying out experiments designed to study the importance of each parameter individually

6. Riassunto

In numerosi ambienti umidi permanenti e temporanei, localizzati negli altipiani carsici dell'Italia centrale, è stato condotto uno studio sugli effetti di alcuni fattori riguardanti la loro struttura, l'idrologia e la vegetazione e di altri fattori sull'abbondanza, frequenza e riproduzione di due specie di libellule *Lestes dryas* e *Sympetrum flaveolum*. Entrambe le specie si rinvengono in una notevole varietà di ambienti acquatici, però, con significative differenze nella frequenza e abbondanza. Gli adulti preferiscono gli habitat acquatici con sponde poco profonde ricoperte da comunità vegetali di colore verde (a brunastro a giallastro), caratterizzate sotto l'aspetto strutturale e morfologico da specie erbacee del tipo "magnocarice" e "giunco(-simile a giunco)" Nelle zone periferiche l'altezza della vegetazione è maggiore di (30-)35 cm negli habitat di *L. dryas* e di 20 cm in quelli di *S. flaveolum*; nelle depressioni centrali l'altezza della vegetazione supera i (30-)35 cm negli habitat di *L. dryas* e i (25-)30 cm in quelli di *S. flaveolum*.

Rispetto all'altezza della vegetazione nelle parti centrali e a colore ed aspetto della vegetazione, gli altri parametri presi in considerazione (superficie dell'area, livello dell'acqua nel periodo della ovideposizione, densità e copertura della vegetazione, colore del suolo) rivestono un ruolo secondario o di nessuna rilevanza per la colonizzazione delle specie di libellule studiate.

Questi risultati concordano con quelli ottenuti in altre regioni d'Europa. I nostri risultati ci inducono a formulare l'ipotesi della selezione dell'habitat per le due specie. Questa ipotesi dovrebbe essere provata con specifici esperimenti finalizzati a testare l'importanza dei singoli parametri.

7. Literature cited

BUCHWALD, R. (1989): Die Bedeutung der Vegetation für die Habitatbindung einiger Libellenarten der Quellmoore und Fließgewässer - Phytocoenologia 17(3): 307-448.

BUCHWALD, R. (1994a): Die Bedeutung der Vegetation für die Habitatwahl von *Ceriagrion tenellum* (Villers) in Südwest-Deutschland.- Adv Odonatol. 6: 121-147

BUCHWALD, R. (1994b): Die Bedeutung der Artenzusammensetzung und Struktur von Fließgewässer-Vegetation für die Libellenart *Coenagrion mercuriale* mit Bemerkungen zur Untersuchungsmethodik.- Ber Reinh.-Tüxen-Ges. 6: 61-81

BUCHWALD, R. (1994c): Vegetazione e odonatofauna negli ambienti acquatici dell'Italia centrale.- Braun-Blanquetia 11 1-77

BUCHWALD, R. (2003): Vegetationskundliche und ethologische Aspekte bei der Habitatwahl von Libellen, dargestellt am Beispiel der Glänzenden Binsenjungfer und der Gefleckten Heidelibelle in den Karst-Hochebenen Mittelitaliens.- Ber Reinh.-Tüxen-Ges. 15: 89-104

CORBET, P.S. (1999): Dragonflies: behaviour and ecology of Odonata.- 829 pp., Chichester

DEMARMELS, J. & SCHIESS, H. (1977): Zum Vorkommen der Zwerglibelle *Nehalennia speciosa* (Charp. 1840) in der Schweiz (Odonata: Coenagrionidae).- V.j.schr Naturf. Ges. Zürich 122: 339-348.

GEREND, R. (1988): Faunistik und Ökologie von *Lestes dryas* Kirby, 1890 in Luxemburg.- Paiperlek, Letzeb. Entom. Zaitschr 11 99-120.

KUHN, J. (1995): Die Libellen des Schmiechener Sees 1980-1994 eine Übersicht.- Beih. Veröff. Naturschutz. Landsch.pfl. Bad.-Württ. 78: 411-416.

KUHN, J. (1998): Gefleckte Heidelibelle – *Sympetrum flaveolum* (Linnaeus 1758).- In: Bayer Landesamt für Umweltschutz und Bund Naturschutz Bayern (Hrsg.): Libellen in Bayern; 178-179. Stuttgart.

OSCHE, G. (1986): Ökoschema.- In: Lexikon der Biologie, Band 6: 225. Freiburg/Basel/Wien.

RÖHN, C., STERNBERG, K. & KUHN, J. (1999): *Lestes dryas*.- In: Sternberg, K. & Buchwald, R. (Hrsg.): Die Libellen-Baden-Württembergs, Band 1 398-408. Stuttgart.

RÖHN, C., KUHN, J. & STERNBERG, K. (2000): *Sympetrum flaveolum*.- In: STERNBERG, K. & BUCHWALD, R. (Hrsg.): Die Libellen Baden-Württembergs, Band 2: 548-559. Stuttgart.

SCHMIDT, B. & STERNBERG, K. (1999): *Nehalennia speciosa*.- In: STERNBERG, K. & BUCHWALD, R. (Hrsg.): Die Libellen Baden-Württembergs, Band 1 358-368. Stuttgart.

STERNBERG, K. (1999): Habitatselektion.- In: STERNBERG, K. & BUCHWALD, R. (Hrsg.): Die Libellen Baden-Württembergs, Band 1 112-117 Stuttgart.

STERNBERG, K., SCHIEL, F -J. & BUCHWALD, R. (2000): *Leucorrhinia pectoralis*.- In: STERNBERG, K. & BUCHWALD, R. (Hrsg.): Die Libellen Baden-Württembergs, Band 2: 415-427 Stuttgart.

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