

Records of Odonata from Phong Nha-Ke Bang National Park and its Buffer Zone, Central Vietnam

Untersuchungen der Libellenfauna des Phong Nha-Ke Bang Nationalparks und seiner Pufferzone, Zentral-Vietnam

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Summary: From September 2010 until August 2011, the dragonfly fauna of several habitats in the Phong Nha-Ke Bang National Park and its buffer zone in Central Vietnam was investigated. It is the first time that research on dragonflies was undertaken in that area. The habitats surveyed in the buffer zone were rivers, water-filled bomb craters, paddy fields and forest streams, while the habitats where research on dragonflies was carried out inside the national park were forest rivers and forest streams. In total, 61 species were determined at 16 different sites, while the identification of 15 more species was possible just at genus level; an identification of the species requires further research. The species were identified either in the field, with the help of photographs or (when a specimen was collected) in the laboratory. The differences of the habitats surveyed and the species found at each location are discussed and compared with the knowledge of the dragonfly fauna of Vietnam. Furthermore, an outlook on further research in the future is given.

Keywords: Dragonflies, distribution, Vietnam, Phong Nha-Ke Bang National Park, buffer zone

Zusammenfassung: Von September 2010 bis August 2011 wurden qualitative Untersuchungen der Libellenfauna im Phong Nha-Ke Bang Nationalpark und der zugehörigen Pufferzone in Zentral-Vietnam durchgeführt. Das sind die ersten Erfassungen von Libellen im Phong Nha-Ke Bang Nationalpark. In der Pufferzone wurden Libellen an Flüssen, wassergefüllten Bombenkratern, nassen Reisfeldern und Waldbächen kartiert, im Nationalpark wurden Waldflüsse und Waldbäche untersucht. Insgesamt wurden an 16 verschiedenen Lokalitäten 61 Libellenarten festgestellt. 15 weitere Arten konnten bislang nur bis zur Gattung bestimmt werden. Die Libellenarten wurden entweder im Feld oder später anhand der Fotobelege bestimmt, in Ausnahmefällen wurden auch Tiere gesammelt, diese wurden dann mithilfe eines Mikroskops im Labor bestimmt. Die Unterschiede der untersuchten Libellenbiotope werden diskutiert und mit den bekannten Libellenvorkommen in Vietnam verglichen. Darüber hinaus wird ein Ausblick auf mögliche Ergebnisse von weitergehenden Untersuchungen in der Region gegeben.

Schlüsselwörter: Libellen, Verbreitung, Vietnam, Phong Nha-Ke Bang Nationalpark, Pufferzone

1. Introduction

The Phong Nha-Ke Bang National Park (PNKB NP) is located in Quang Binh, Central Vietnam, bordering Laos to the west and approximately 500 kilometers south of the capital city, Hanoi (Figs. 1, 2). Due to its length, Vietnam stretches across the subtropical and the tropical climate zone. The Province

Quang Binh belongs to northern Central Vietnam and thus is part of the subtropical climate zone (STERLING et al. 2007).

The Phong Nha-Ke Bang area was declared a national park in 2001. Two years later in 2003, the national park was declared a World Natural Heritage site by UNESCO (ZIEGLER 2004). The PNKB NP covers an area of 85,000 hectares and is known worldwide;

in Vietnam it is even famous for its special karst landscape and the caves typical of that landscape (CLOUGH 2008). The biggest cave in Vietnam is located in the PNKB NP (HERRMANN & PAGEL 2000).

The term "karst" refers to the weakly soluble carbonate rock mountains, which form the topography of the central Vietnamese highlands. Here, distinctive surface features like caves and underground rivers result from the weathering of the limestone (LESER 2009). Together with the Hin Namno biodiversity protection area in Laos, the PNKB NP is one of the biggest karst forest areas in all of Indochina that still boasts a high biodiversity



Fig. 1: The Province Quang Binh in Central Vietnam (from Wikimedia commons 2011, changed).
Abb. 1: Die Provinz Quang Binh in Zentralvietnam (aus Wikimedia commons 2011, verändert).

of animals and plants (ZIEGLER et al. 2004), including a high number of endemics, such as the Phong Nha-Ke Bang Gecko, *Cyrtodactylus phongnhakebangensis* Ziegler et al., 2003 (HERRMANN & PAGEL 2000).

Although a lot of research has been done in recent years, the Odonata fauna of Vietnam is still poorly known. The main focus of odonatologists is still on taxonomy (e.g. Do 2011), while just very few publications add to the knowledge of Vietnamese odonate diversity (D_O 2007).

Consequently, almost no published information about the distribution of dragonflies in Central Vietnam is available, and the Odonata fauna of the PNKB NP is basically unknown.

In April 2011 the discovery of *Rhinagrion hainanense* Wilson and Reels, 2001 in the PNKB NP during my investigation of the last year, was mentioned by KAWASHIMA et al. (2011).



Fig. 2: Position of the Phong Nha-Ke Bang National Park in Quang Binh, Central Vietnam (from: Wikimedia commons 2011, changed).
Abb. 2: Lage des Phong Nha-Ke Bang Nationalparks in Quang Binh, Zentralvietnam (aus: Wikimedia commons 2011, stark verändert).

Thus, the present investigation contributes to the knowledge of distribution of dragonflies in Vietnam. In addition, the importance of nature protection and the necessity of protected areas for Odonata and the conservation of unique nature areas such as the karst forests of the PNKB NP is pointed out. Furthermore, this investigation expands the knowledge of the dragonfly species in rural areas of Vietnam and in primary karst forest regions such as Phong Nha-Ke Bang. This investigation and its results should be seen as a starting point for more detailed research in the future.

2. Research area and methods

Odonata were investigated from September 2010 to August 2011.

Because of several unpredictable circumstances, such as floods and other unfortunate meteorological conditions, the investigation

sites could not be visited with the same frequency of visits in every location, thus qualitative research methods were used.

In total, Odonata were recorded during 74 field trips to 16 different locations (see Fig. 3). Every location was visited at least two times, except water body No. 13, where just one survey was possible. The surveys were carried out regularly when the weather was fine. In Central Vietnam, the year can be divided into two main seasons: a wet and cold winter, and a dry and hot summer. The rainy season is between September and December, and January and February are usually the coldest months (STERLING et al. 2007).

In 2011, the cold weather lasted till March and the summer months were unusually wet. Thus, from November to March only seven excursions were possible due to the rainy season and the long winter.

For each location the geo-coordinates were determined with a Garmin "GPS Map60SX".

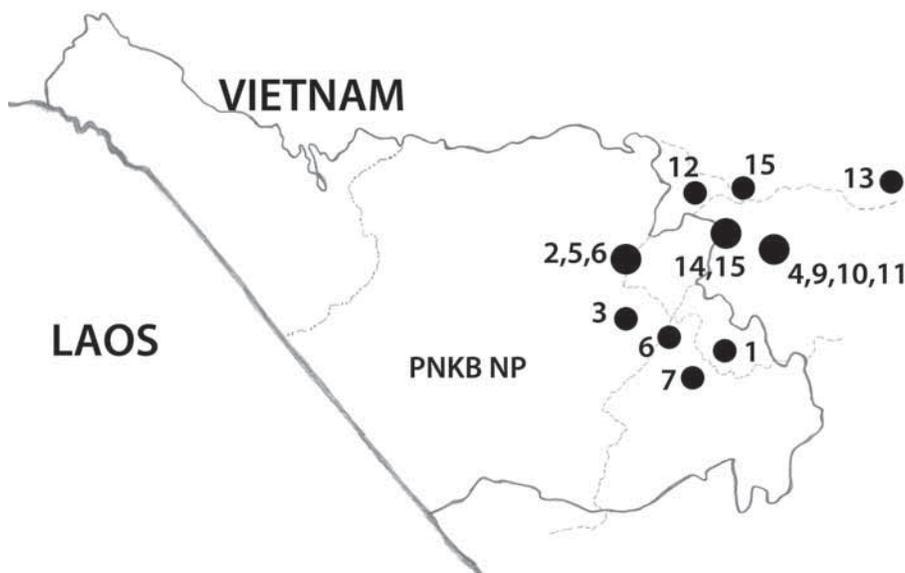


Fig. 3: The PNKB NP with extension area in the north-west and the research area in the east. The 16 localities where Odonata were surveyed are marked with black dots. Adapted from: FZS and CZ (unpubl., modified).

Abb. 3: Der Phong Nha-Ke Bang Nationalpark mit Erweiterungsgebiet im Nordwesten und dem Untersuchungsgebiet im Osten. Die 16 untersuchten Habitate sind durch schwarze Punkte markiert. Adaptiert von: FZS und CZ (unveröff., stark verändert).

Tab. 1: Overview about the different habitat types where dragonflies were investigated. The GPS coordinates are given in brackets, the characteristics of size, bottom structure and vegetation of each waterbody are summarized. Sizes are based on estimations and Google Earth measuring (see also Figs. 4a, b, e, f).

Tab. 1: Die unterschiedlichen Habitattypen, an denen Libellen kartiert wurden. Die GPS-Koordinaten sind in Klammern angegeben, charakteristische Merkmale der Größe, Vegetation und des Untergrundes der Gewässer sind zusammengefasst. Die Größenangaben beruhen auf Schätzungen und Messungen mit Google Earth (s. Abb. 4a, b, e, f).

I. Water bodies inside the national park

A) Forest streams	B) Forest rivers	C) Standing waters
<p>1) Khe Van forest-stream (N17 29.77 E106 17.46) width: 1-2 meters; channel: mostly rocky; vegetation: dense forest, interrupted by more loose sections</p>	<p>5) Nước Moq Ecotrail River (N17 33.34 E106 14.26) width: 20 (rapids)-50 (slow running water) meters; channel: rocky shores and rapids, sandy sections; vegetation: loose forest</p>	<p>8) Nước Moq Ecotrail temporary waters/bayou (N17 33.31 E106 14.20) surface area: < 1 - >50 square meters; bottom: rocky, sandy; vegetation: mostly open</p>
<p>2) Nước Moq Ecotrail streams (N17 33.36 E106 14.14) width: 50 cm - 3 meters; channel: rocky, clayey; vegetation: dense forest</p>	<p>6) Trang An River (N17 31.16 E106 16.43) width: 20-25 meters; channel: mostly sandy; vegetation: dense forest with loose parts at stream intersections</p>	
<p>3) Temporary forest stream between Paradise Cave and R20 (N17 31.82 E106 15.61) width: about 1 meter; channel: rocky, without flowing water in the time of investigation; vegetation: dense forest</p>	<p>7) Khe Van River, temporary (N17 29.21 E106 17.52) width: 10 - 35 meters; channel: rocky, without flowing water in the time of investigation; vegetation: dense forest</p>	
<p>4) Núi Đồi Stream lower reaches (N17 34.76 E106 18.76) width: 50 cm - 1 meter; channel: clayey, sandy; vegetation: dense vegetation (mainly shrubs and liana) open sections</p>		

II. Water bodies in the buffer zone of the national park

A) Forest streams	B) Rivers	C) Standing waters
<p>9) Núi Đồi Stream upper course (N17 34.58 E106 19.16) width: 50 cm - 1 meter; channel: clayey, rocky; vegetation: dense forest</p>	<p>12) Song San River (N17 35.44 E106 16.86) width: 100 - 150 meters; channel: muddy, sandy vegetation: no vegetation at the shores, grassland and paddy fields</p>	<p>15) Bomb craters/buffalo ponds/rice fields Phong Nha (N17 35.39 E106 17.69) surface area: bomb craters and buffalo ponds 5-15 square meters; bottom: muddy; vegetation: largely open, rushes, reed</p>
<p>10) Núi Đồi Stream 2 (N17 35.00 E106 18.93) width: 50 cm - 1 meter; channel: clayey, sandy; vegetation: dense forest</p>	<p>13) Ho Chi Minh Highway River (N17 30.18 E106 30.36) width: 25 - 30 meters; channel: rocky, muddy; vegetation: largely open, shrubs</p>	<p>16) Bomb craters RS4/RS6 (N17 34.90 E106 18.47) surface area: 10-15 square meters; bottom: muddy; vegetation: largely open, rushes, reed</p>
<p>11) Núi Đồi Stream 3 (N17 35.06 E106 18.89) width: 50 cm - 1 meter; channel: clayey, sandy; vegetation: dense forest</p>	<p>14) RS4/RS6 River (N17 35.01 E106 18.39) width: 5 - 10 meters; channel: sandy, clayey; vegetation: loose forest</p>	

At each location adult dragonflies were sought along the shore, over the water surface and in the surroundings. Each survey lasted between one and six hours and most surveys were carried out between 11 a.m. and 2 p.m. Most species were identified in the field or later by photographs with the use of various books and papers (e.g. LAIDLAW 1950; HÄMALÄINEN 1991; ORR et al. 2004; BEDJANIC et al. 2007). In some cases specimens were collected for a detailed examination later in the laboratory, but it was not possible to get a permit for collecting dragonflies.

2.1. Localities

16 reference sites were investigated for Odonata, eight in the buffer zone and eight inside the national park boundary (Fig. 3, Tab. 1; see also Figs 4a, b, e, f).

The sampling sites were chosen by two criteria: First, the area had to be within reach, so that a field-survey including the travel to the site and back was possible on a single day; and second, the localities were chosen to cover a typical spectrum of Odonata habitats present in the PNKB NP.

Location No. 4 lies outside the border of the national park but belongs to the area of the park because it was bought by the park for carrying out the reintroduction of endangered animals.

2.2. Habitat types

For the Odonata water bodies are the most important habitats, because dragonflies spend the longest part of their life as larvae in these waters. Regional exceptions may be traced within the genus *Gynacantha* which shortly was found to develop in temporal water bodies in very short times (see DE MARMELS & NEISS 2011 for a Brazilian representative of this genus). In addition, the waterbodies serve as reproductive sites for the adults.

I follow the classification of water types by DO (2007) who divided the Odonata

habitats into lentic and lotic ecosystems and distinguished between the river systems of the north, the south and the central part of Vietnam. For the PNKB area, I differentiate between the habitats of the national park and those of its buffer zone, due to the differences in structure and degree of pollution in the two types of habitats. Furthermore, the lentic waters are divided into rice fields, bomb craters and temporary standing waters or bayous. Bayou is used here as a term to describe the mostly sluggish, sometimes even lentic tributaries of the forest rivers that can be found particularly in the dry season. The lotic waters are divided into rivers and streams by means of their different channel morphology. Inside the national park, such a classification is only a helpful construct as water systems in a primary landscape, especially a karst area such as PNKB NP, change their conditions very often according to the high dynamics in the landscape (e.g., floods).

2.2.1. Water bodies inside the national park

The forest streams inside the Phong Nha-Ke Bang National Park are characterized by a high density of shore vegetation and sudden changes of the watercourse, which might include sections of subterranean flow, especially in the dry summer months. Rapids and waterfalls are frequent, as is typical of running waters in a karst landscape (LESER 2009). The stream beds are mostly rocky, regularly interrupted by clay or sand sediments. Depending on the season and weather, forest streams inside the national park vary in width approximately between 50 cm and 5 m.

Forest rivers inside the PNKB NP are much broader, but their water levels also change significantly during the course of the year. The rivers receive all the water from the catchment area completely situated within the borders of the national park, and transport it out of it. When the water level drops, the rivers become ephemeral and numerous bayous

and temporary standing waters come into existence in the river bed. These temporary standing waters are among the only lentic waters inside the national park, and they attract a high number of dragonfly species.

2.2.2 Water bodies in the buffer zone of the national park

Beside rare signs of human presence (also sometimes even inside the national park) such as broken branches or small paths along the water, forest streams in the buffer zone resemble those inside the national park.

Rivers in the buffer zone are no longer typical forest rivers, because they flow through a rural landscape, especially rice fields and small villages. They are characterized by the nearly complete absence of riverine vegetation and increasing pollution, with nutrients from agriculture and waste waters from households and livestock farming.

The standing waters of the buffer zone are bomb craters, paddy fields or buffalo ponds. The term buffalo pond is used to describe water bodies that are used frequently by buffalos and do not serve any other purpose. The vegetation varies, depending on the use of the waterbody. Some, like the rice fields, dry out in summer; others are used for irrigation agriculture. If the number and frequency of buffalos visiting the waters is high, these waterbodies become turbid and polluted, and consequently the number of dragonflies present is reduced.

3. Results

During the one year of investigation 76 species were found in total, 61 of them were identified to the species level. The species belong to 50 genera in 13 families.

As shown in table 2 (see also Fig. 4), certain species, e.g. *Orthetrum pruinosum* and *Pantala flavescens*, are eurytopic and can be found at nearly every waterbody, regardless of habitat type. Others, such as *Mnais mneme*

and *Heliocypha biforata*, are typical of a single habitat type.

Because of this and the difficulties of defining the habitat types in an always changing landscape, I propose a classification of the different habitat types with the use of Odonata coenoses, as they are found in the PNKB NP and its buffer zone.

This classification is preliminary and should be seen as a first step to a more precise definition in the future.

The forest streams inside the national park as well as the forest streams in the buffer zone can be characterized by a high diversity of species belonging to the superfamily Calopterygoidea. Especially the species *Neurobasis chinensis* (Fig. 4d), *Heliocypha biforata* and *Euphaea masoni*, can be seen as typical species of these water types.

At the forest rivers in the national park, fewer species occur than at the forest streams. Also, more eurytopic species can be found, probably because of the capacity of the river to create standing waters in the dry months. Core species could be *Zygonyx iris* and *Heliocypha perforata*.

The temporary standing waters inside the PNKB NP are inhabited mostly by libellulids such as *Orthetrum glaucum* and *Orthetrum chrysis*, but also species of the family Coenagrionidae are present, for example *Ischnura senegalensis*.

The rivers in the buffer zone can be clearly defined by the absence of the stenotopic Calopterygoidea species that occur at every clear river and stream inside the national park. Instead, species such as *Trithemis pallidinervis* and *Pseudagrion microcephalum* are common.

The standing waters of the buffer zone can be characterized by species that are eurytopic. Here most of the libellulids occur, such as *Brachydiplax farinosa*, *Diplacodes nebulosa* and *Brachythemis contaminata*.

About 90 % of the species recorded from inside the Phong Nha-Ke Bang National Park are found along forest streams. The forest

Tab. 2: List of species recorded; indication of the site where they were recorded; study sites and number of species found.
Tab. 2: Liste der nachgewiesenen Arten mit Fundorten; Anzahl der Arten je Fundort.

Species	Location (habitat type and number of site)																
	I A)			I B)			I C)			II A)			II B)			III C)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
<i>Minus mame</i> Ris, 1916	x	x		x													
<i>Nerobasis chinensis</i> (Linnaeus, 1758)	x	x			x		x		x	x							
<i>Vestalis gracilis</i> (Rambur, 1842)				x	x				x	x							
<i>Aristocypha fenestrella</i> (Rambur, 1842)	x	x			x		x										
<i>Heloclypha biflorata</i> (Selys, 1859)				x					x	x							
<i>Heloclypha perforata</i> (Percheron, 1835)	x	x		x	x	x			x	x							
<i>Euphonia guerini</i> Rambur, 1842	x	x		x	x		x		x	x							
<i>Euphonia masoni</i> Selys, 1879	x	x		x	x		x		x	x							
<i>Euphonia ochracea</i> Selys, 1859									x	x							
<i>Lestes praenervus</i> Hagen in Selys, 1892																x	
<i>Rhinagrion haitianense</i> Wilson and Reels, 2001		x							x								
<i>Acisagrion pallidum</i> Selys, 1891										x	x						
<i>Acisagrion occidentale</i> Laidlaw, 1919																	
<i>Agrionemis fenitia</i> (Brauer, 1868)				x												x	
<i>Ceragrion aurantiacum</i> Fraser, 1922			x	x												x	
<i>Ischnura songalensis</i> (Rambur, 1842)												x				x	
<i>Pseudagrion microsphaerum</i> (Rambur, 1842)												x	x			x	
<i>Pseudagrion pruinosum</i> (Burmeister, 1839)												x					
<i>Pseudagrion rubriceps</i> Selys, 1876				x													
<i>Prodasineura autumnalis</i> (Fraser, 1922)		x		x					x	x				x			
<i>Prodasineura croconata</i> (Ris, 1916)	x	x		x					x	x							
<i>Prodasineura doisuthensis</i> Hoess, 2007				x												x	

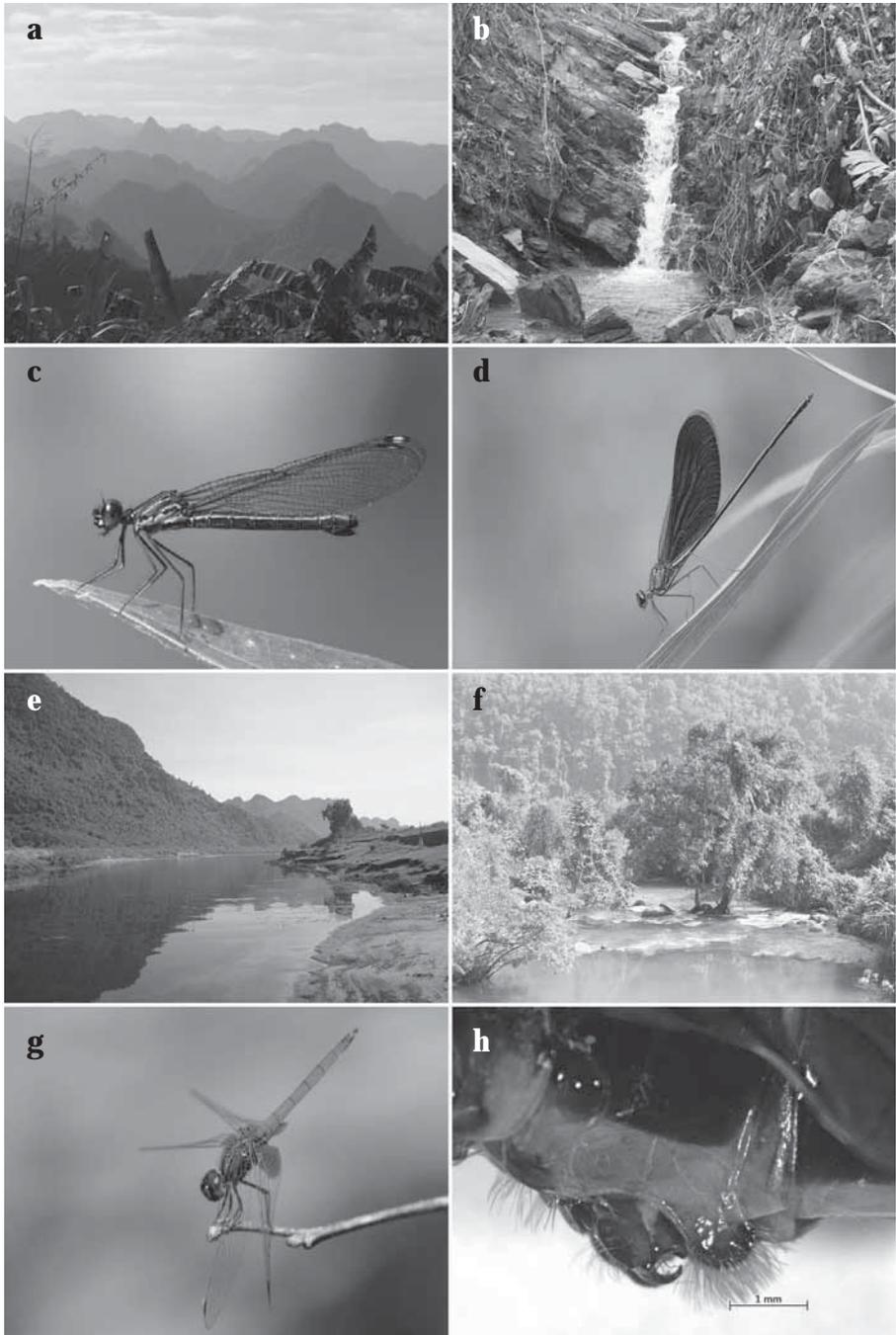


Fig. 4: Karstforest in the Phong Nha-Ke Bang Nationalpark (a); forest-stream and waterfall inside the nationalpark (b); *Aristocypha fenestrella*, female (c); *Neurobasis chinensis*, male (d); Song San River in the buffer zone of the national park (e); Ecotrail River inside the national park (f); *Trithemis aurora*, male and the secondary genitalia of *Idionyx victor* (g); male (collected specimen, light microscopic picture) (h).

stream No 3 (see Tab. 2) is an exception, because it was completely dry during the time of investigation. Forest rivers and standing waters show a significant smaller quantity of species, with 36 % and 25 % respectively. In the buffer zone, the proportions of species occurrence at the different sampling sites are more equally distributed. The forest streams show the greatest diversity, with about 69 % of the species occurring in the buffer zone. But the differences from lentic waters (50 %) and rivers (approximately 35 %) are less than in the national park.

Species found inside the national park are about 73 % of the total number. This amount is essentially the same in the buffer zone, where 77 % of the total species occur. Thus, all of the species that occurred only

inside the PNKB NP flew at forest streams, whereas 66.6% of the species that occurred only in the buffer zone, were found only at standing waters and rivers and 33.3 % only at forest streams. This shows, that in general the species that occur only inside the national park are stenoecious, whereas most of the species that were found only in the buffer zone are euryoecious.

For 15 other species, a reliable identification at the species level could not be made (Tab. 3).

4. Discussion

To identify the species listed in table 3, further research, including the collecting of specimens, is required. For example, *Macrogomphus lankanensis* is known only as

Tab. 3: Species that could not be surely identified and the site at which they were found.

Tab. 3: Arten die nicht absolut sicher bestimmt werden konnten mit Fundorten.

Species/genus	Location
<i>Dysphaea</i> sp.	2, 5
<i>Coelicia</i> sp.	3
<i>Coelicia scutellum</i> Laidlaw, 1932/ <i>Coelicia tomokunii</i> Asahina, 1997	3
<i>Agriocnemis</i> cf. <i>pygmaea</i> (Rambur, 1842)	15
<i>Pseudagrion</i> sp.	15
<i>Gynacantha</i> sp.	3
<i>Asiagomphus</i> cf. <i>xanthenatus</i> (Williamson, 1907)	4
<i>Asiagomphus</i> sp.	4
<i>Ictinogomphus</i> cf. <i>rapax</i> (Rambur, 1842)	12, 15
<i>Lamellogomphus</i> cf. <i>camelus</i> (Martin, 1904)	4
<i>Macrogomphus</i> cf. <i>lankanensis</i> (Fraser, 1933)	4
<i>Chlorogomphus</i> sp.	4, 9
<i>Epoptalmia</i> sp.	10
<i>Orchithemis</i> cf. <i>pulcherrima</i> Brauer, 1878	1
<i>Orthetrum</i> cf. <i>triangulare</i> (Selys, 1878)	4, 9

Abb. 4: Karstwald im Phong Nha-Ke Bang-Nationalpark (a); Bergbach mit Wasserfall im Nationalpark (b); *Aristocypha fenestrella*, Weibchen (c); *Neurobasis chinensis*, Männchen (d); Song San-Fluss in der Pufferzone des Nationalparks (e); Ecotrail-Fluss im Nationalpark (f); *Trithemis aurora*, Männchen (g); die zur Bestimmung notwendige Aufnahme der sekundären Geschlechtsorgane von *Idionyx victor*, Männchen (Präparat, lichtmikroskopische Aufnahme) (h).

endemic to Sri Lanka (BEDJANIC et al. 2007). To confirm that it also occurs in Vietnam, a photographic proof is not enough, but a detailed comparison of genital structures must be done with a specimen collected. Additionally, the two *Coeliccia* species that were found during this investigation cannot be identified, even though they were collected: *Coeliccia* sp. is a new species, and the species *Coeliccia scutellum* and *Coeliccia tomokunii* cannot be distinguished (D_o 2008).

According to the present study, it is possible to state that the species which were recorded for the Phong Nha-Ke Bang National Park and its buffer zone during this investigation represent the typical species diversity of Odonata in central Vietnam (D_o pers. comm.). Without doubt, especially in the primary forest regions of the Phong Nha-Ke Bang National Park, more species could be found if more intensive research was carried out. This has already become clear through this year of research, during which the limitations became obvious. There have always been some species that could not be identified or caught. The weather was often bad, so during entire months no investigations were possible. As a result, conditions for field trips were frequently unsuitable, especially after floods. Additionally, it will be possible to check more different sites and water bodies if more researchers could be integrated in the study of dragonflies in this area. It is dangerous to walk through the karst forest around Phong Nha, especially alone, taking into account the karst topography with steep and sharp ridges, holes in the ground and unstable limestone formations (LESER 2009). It is also necessary to collect more specimens so that correct determinations of additional species can be done. Many species have to be identified by the use of the original description, because there is no other information (and certainly not field keys) available. Identification of many tropical species is nearly impossible without a specimen on hand.

Among the 61 species found in and around the Phong Nha-Ke Bang National Park,

27 belong to the family Libellulidae. This remarkable fact was also shown in earlier studies in other countries (TANG et al. 2010), because the family Libellulidae consists of many eurytopic species which are quite flexible and can tolerate pollution and changes of their habitat (ORR et al. 2004). Especially in the buffer zone, the number of libellulid species increased, whereas the more stenoeccious species, living only in clear forest streams (ORR et al. 2004), could not be found in the buffer zone. This was to be expected, because the anthropogenic impact on the buffer zone is much higher than in the national park itself. The rivers and ponds are used by humans and livestock (e.g. cattle) and are therefore much polluted. Whereas rivers and ponds can thus be easily distinguished by means of their dragonfly species, forest streams inside the national park and in the buffer zone show little difference in species diversity: 11 of these species were found only in national park streams, and 6 only at buffer zone streams. In general, the same typical species were found at forest streams both inside the national park and at the border of the national park in the buffer zone. This interesting fact mainly results from the further fact that most of the species found are generally common at clear forest streams. But it is also due to the presence of forest in the buffer zone, although it is restricted in extent. Many people pass through the forest and some even bring their cattle for grazing, but the streams are mostly unaffected. The forest is not used for agriculture, and people are not allowed to cut wood, thus especially close to the border of the national park, the forest of the buffer zone is of similar value to dragonflies as the secondary forest inside the PNKB NP.

Although this might be the case in Phong Nha-Ke Bang, it should not be forgotten that in other regions the buffer zone forest is victim to logging, which makes protected areas such as the Phong Nha-Ke Bang National Park even more important for conservation (D_o 2001).

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