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Highway stormwater detention ponds as biodiversity islands?

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Abstract

The European Directive on urban wastewater treatment voted in 1991, compelled industries to deal with their wastewater. As a result, highways companies had to dig stormwater detention ponds alongside roads mainly in order to catch and treat road runoff. These stormwater ponds were quickly and largely colonised by aquatic organisms while they were only designed for a technical purpose. But if many of them have been dug all over Europe, their use by wildlife remains poorly studied.

This article aims at taking stock of the role of highway stormwater detention ponds for biodiversity by (i) reviewing the knowledge on the chemical contamination found into it and (ii) addressing the problem of the use of these stormwater ponds by wildlife. The discussion is based on a survey conducted during one year (2002 – 2003) on six highway stormwater detention ponds situated in south-eastern France.

Keywords: *Highway, Stormwater detention pond, Biodiversity, Freshwater organisms*

Abbreviations: *PEHD: high density poly-ethylene*

Résumé

Les bassins de rétention autoroutiers: des îlots de biodiversité?

La directive européenne relative au traitement des eaux urbaines résiduaires, votée en 1991, impose aux industries de traiter leurs eaux résiduaires. Par conséquent, les sociétés autoroutières ont été obligées de creuser des bassins de rétention le long des routes afin de recueillir et de traiter les eaux de ruissellement. Ces bassins, conçus uniquement à des fins techniques, ont été rapidement et amplement colonisés par les organismes aquatiques. Même si de nombreux bassins ont été creusés dans toute l'Europe, peu d'études ont été consacrées à leur utilisation par la faune sauvage.

Cet article vise à évaluer le rôle des bassins de rétention autoroutiers pour la biodiversité (i) en faisant le bilan des connaissances relatives aux contaminations chimiques dans ces milieux et (ii) en abordant la problématique de l'utilisation de ces réservoirs par la faune sauvage. L'étude est basée sur le suivi durant une année (2002 – 2003) de six bassins de rétention autoroutiers du sud-est de la France.

Mots-clés: *Autoroute, bassin de rétention, biodiversité, organismes d'eau douce*

Abréviations: *PEHD: polyéthylène de haute densité*

Introduction

The last centuries have seen a major artificialisation of natural ecosystems. For example, in France, between 1992 and 2002, the surface covered by buildings increased by 12%, by roads and car parks by 10% and by gardens by 17% (IFEN 2003). This landscape modification, since the XXth century, also affected wetlands, which disappeared in a proportion of 90% in the Mediterranean region (Papayannis and Salathé 1999) and from 40% to 90% in northern European countries (Hull 1997). This drop was similarly observed with small wetlands such as ponds which are defined by Collinson et al. (1995) as water-bodies between 1 m^2 and 2 ha which usually retain water throughout the year. On the opposite, many man-made ponds have been built in order to treat waste waters or solely for leisure activities (e.g. golf, ornamental garden). Moreover, the urban development (leading to the soil waterproofing) and an

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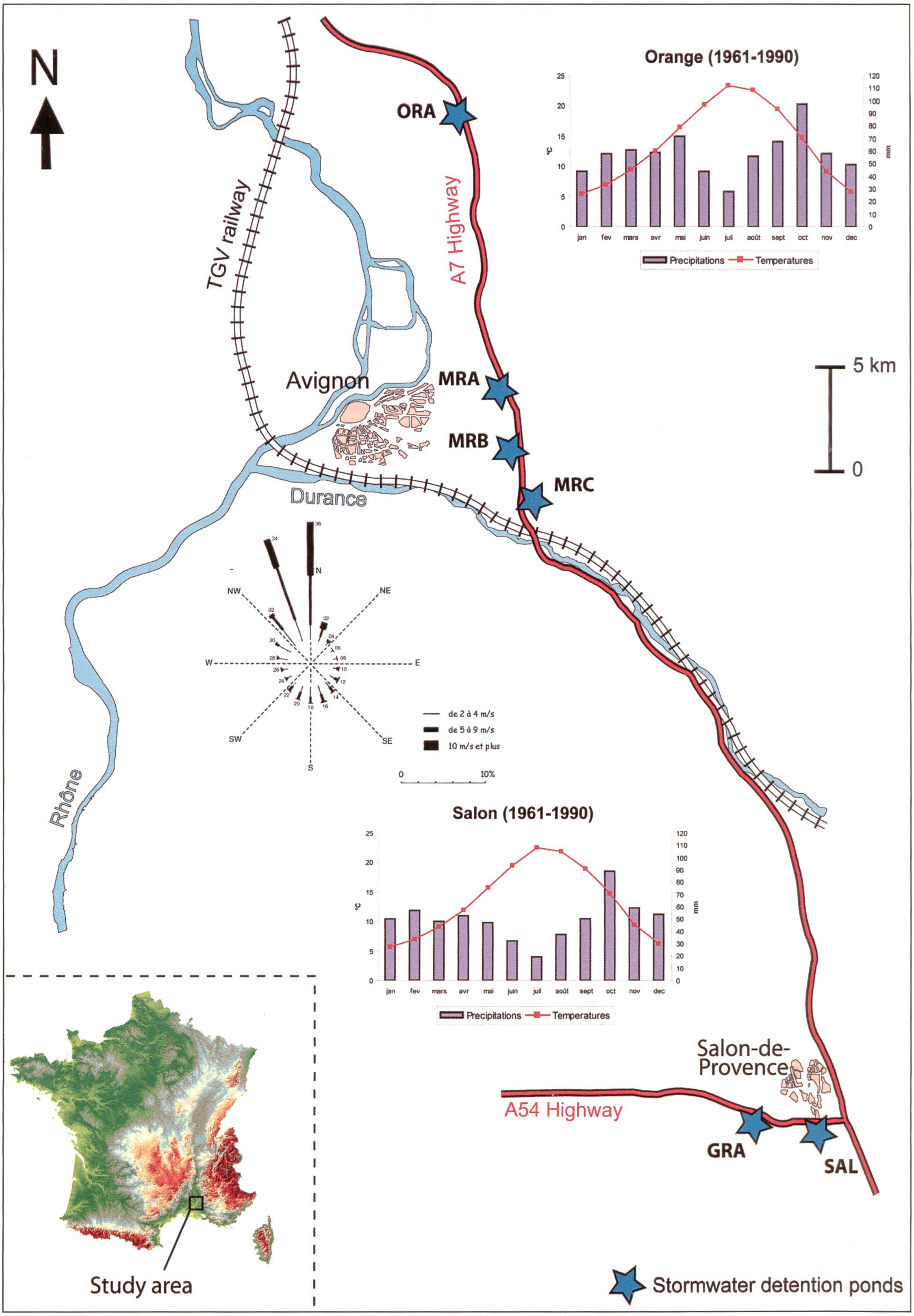

Fig. 1: Map of the study area showing sampling sites and climatic data (Mediterranean region)

increasing vehicle traffic have conducted to an increase of pollutant deposition on roads leading to a contamination of water and soil by contaminated runoff. In 1991, the European Directive on urban wastewater treatment (Directive 91/271/CEE 1991), transcribed by the French Water Act (n° 92-3, 1992) was voted. This act compelled industries to deal with their wastewater. Then highways companies had to dig stormwater detention ponds alongside roads in order to catch and treat road runoff.

A stormwater detention pond can be defined as a part of a drainage system, which objectives aiming at (1) reducing the peak flow associated with large storm events, (2) preventing water from chronic road pollution (i.e. trace metals, hydrocarbons) and (3) preventing water from exceptional contamination (e.g. industrial chemicals spread on road surface after an accident). Most of the constructed ponds are designed to maintain a permanent pool of water and to retain a certain amount of storm runoff (Maestri and Lord 1987). In order to waterproof the pond, an artificial plastic membrane (PEHD) is laid on the ground and then covered by a sediment layer. Size of the pond is designed to retain runoff for a sufficient period of time in order to allow sedimentation of pollutants or infiltration and sorption to sediments (Barbosa and Hvitved-Jacobsen 1999). Therefore, these habitats have been shown to be contaminated by trace metals (copper, lead and zinc mainly), hydrocarbons and herbicides (Pagotto 1999; Hares and Ward 1999; Legret 2001; Scher and Thiéry 2004) because of their role as road pollutants sink.

Despite their relative small size, ponds appear to be of high interest regarding the biodiversity they support (Biggs et al. 1994; Oertli et al. 2002) but have been poorly studied compared to rivers, streams or lakes (Williams et al. 2004; Wood et al 2003). Moreover, even though their number increased in all landscapes, stormwater detention ponds have not gained much interest in the study of their use by wildlife (Wren et al. 1997; Bishop et al. 2000a, b) and particularly with regard to highway stormwater detention ponds that were designed for a technical purpose and not as substitution ponds (Scher and Thiéry 2004, in press). Nevertheless, some studies have shown the use of man-made ponds by amphibians (Hecnar and M'Closkey 1996; Hazell et al. 2004), adult dragonflies (Raab et al. 1996; Kadoya et al. 2004) or macroinvertebrates (Winfield Fairchild et al. 2000; Wood and Barker 2000; Solimini et al. 2003), which demonstrates the potential of these artificial habitats to hold ecological functions.

The purpose of this paper is to highlight the role of highway stormwater detention ponds for aquatic biodiversity. The paper is based on a study conducted in the Mediterranean region in 2002 and 2003. First, a review of the chemical contamination found in highway stormwater detention ponds is presented. Then, the role and the threat of these habitats for wildlife are discussed.

Experimental procedures

The current study was conducted in south-eastern France, in the Provence region (Fig. 1). This area is under the influence of a Mediterranean climate, which can be defined as an unique combination of hot and dry summers with humid and cold winters combined with a strong and cold northerly wind called *Mistral* (Blondel and Aronson 1999). Six stormwater detention ponds dug in 1993 (ORA, MRA, MRB, MRC) and 1996 (SAL, GRA) were surveyed every four weeks during one year (March 2002 to March 2003) for their physicochemical and biological characteristics (Fig. 2). These ponds were also chosen according to their bottom type (i) ponds with a PEHD membrane (MRA, GRA and SAL), (ii) ponds with a natural bottom (ORA, MRB and MRC). Physical and chemical parameters consisted of the measurement of temperature (°C), conductivity (µS/cm), dissolved oxygen (% saturation), water level (cm), main dissolved ions (mg/l), trace metals, i.e. cadmium, copper, lead and zinc (µg/l in water column and mg/kg in dry sediment), total hydrocarbons (mg/l; mg/kg) and herbicides, i.e. glyphosate and atrazine (µg/l). Regarding biological data, amphibians, dragonflies, aquatic invertebrates and plants were surveyed. Detailed procedures for chemistry, amphibian and dragonfly sampling can be found in Scher and Thiéry (2005).

Aquatic invertebrates were sampled every four weeks in each stormwater detention pond. Two to three replicates (depending of the pond size) were collected using a hand-net (mesh size = 125 µm) with an opening of 21 cm. These replicates were randomly taken at each sampling date. Total distance swept by the net, from bottom to surface, was 4 m. First of all, invertebrate samples were preserved in the field in 5 % formaldehyde and then sorted in the laboratory and identified to the lowest practical taxonomic level according to Tachet et al. (2000). If most invertebrates were identified to species or genus level, some were only to family, so all identified macroinvertebrates will be called "taxa" in this study. Sorted samples were finally preserved in a 70% ethanol solution.

Results and discussion

Chemical background

Main physical and chemical characteristics of the six studied highway stormwater detention ponds are presented in Table 1. We particularly found significant concentrations of amino-methyl phospho-

Fig. 2: Surveyed highway stormwater detention ponds with (1) ORA, (2) MRA, (3) MRB, (4) MRC, (5) SAL and (6) GRA

nic acid (AMPA, the by-product of glyphosate molecule) all year-round in the water column. AMPA has been shown to be the second most common herbicide found in superficial water in France (IFEN 2004). If sediment contamination complies with what has been found in other studies (high levels of Zn and Cu *versus* low levels of Cd and Pb), water contamination by trace metals appears to be insignificant (dissolved trace metals were only detected twice in 15 samples per pond). This could be explained by the lack of rainstorm events and by a dispersal of contaminated particles by wind (Scher and Thiéry 2005).

Roadside pollutants have been shown to have three main origins: vehicles, road materials (crash barrier, etc.) and dry or wet (dust or rain) atmospheric pollution (Forman et al. 2003). Highway companies also add chemicals by applying herbicides (glyphosate) for roadsides maintenance and by de-icing road surface in winter (NaCl increase in

Table 1. Mean and range values for chemical and physical characteristics in motorway stormwater retention ponds (ORA to GRA).

		ORA	MRA	MRB	MRC	SAL	GRA
Water column	Temperature (°C)	13.7 (5.8-20.7)	17.9 (2.7-36.7)	18.7 (6.2-30.6)	16.8 (6.9-29.3)	15.3 (8.1-20.4)	17.6 (6.2-30.5)
	Conductivity (µS/cm)	686 (273-1102)	319 (203-1330)	1074 (830-1499)	828 (272-1631)	3482 (888-25 900)	303 (114-934)
	Dissolved oxygen (% saturation)	72.39 (5.23-150.99)	131.23 (82.51-231.03)	129.80 (9.60-235.97)	80.06 (22.53-178.66)	92.87 (12.65-219.18)	104.45 (40.32-178.86)
	Total carbonates (meq/l)	3.69 (1.74-6.48)	2.21 (0.89-3.58)	5.19 (3.21-6.88)	3.85 (1.60-5.70)	4.56 (2.58-5.65)	0.88 (0.08-1.74)
	Total chloride (meq/l)	1.40 (0.21-2.69)	1.62 (0.01-7.06)	1.62 (0.47-1.82)	1.49 (0.22-3.00)	8.16 (2.52-20.55)	1.38 (0.07-5.47)
	Nitrate nitrogen (meq/l)	0.06 (0-0.32)	0.005 (0-0.04)	0.05 (0-0.17)	0.01 (0-0.09)	0.10 (0-0.17)	0.01 (0-0.04)
	Hydrocarbons (mg/l)	0.14 (0-0.82)	0.04 (0-0.31)	0.23 (0-0.36)	0.08 (0-0.44)	0.08 (0-0.44)	0.07 (0-0.42)
	Glyphosate (µg/l)	1.18 (0-9.78)	0.40 (0-3.9)	0.36 (0-2.02)	0.27 (0-2.28)	0.37 (0-0.97)	0.21 (0-0.98)
	AMPA (µg/l)	0.70 (0-4.35)	0.29 (0-3.58)	0.28 (0-2.02)	0.26 (0-1.16)	0.39 (0-1)	0.17 (0-0.28)
Sediment	Hydrocarbons (mg/kg)	74.3 (23-130)	12.65 (3.6-21)	87.4 (14-120)	12.2 (0-19)	333 (200-570)	176.7 (100-220)
	Cadmium (mg/kg)	3.93 (0-4.5)	2.63 (0-3.3)	2.16 (0-3.5)	2.33 (0-2.6)	2.7 (0-4)	1.77 (0-2.1)
	Copper (mg/kg)	69.75 (40-130)	157.5 (150-180)	230 (210-270)	"143;3 (120-160)"	185 (170-190)	137.5 (120-150)
	Lead (mg/kg)	89 (1-160)	53.5 (6-84)	44.46 (2-96)	27.6 (1-59)	76.8 (3-120)	89.8 (1-140)
	Zinc (mg/kg)	118.3 (49-210)	270 (200-410)	174 (120-210)	107.2 (86-160)	390 (350-430)	640 (540-730)
	Surface area (ha)	0.25	0.11	0.3	0.34	0.03	0.19
	Maximum depth (cm)	120	40	80	150	60	140
	Hydrology	near-permanent*	seasonal*	permanent	near-permanent*	permanent	near-permanent*

* according to the classification of temporary wetlands by Yavercovski et al. (2004)

water). Many studies focused on the identification and quantification of pollutants caught by these stormwater detention ponds and particularly the efficiency of these systems for pollution removal (Lee et al. 1997; Barbosa and Hvitved-Jacobsen 1999; Legret and Pagotto 1999; Lundberg et al. 1999; Legret 2001; Mallin et al. 2002). They concluded that trace metal elements, total hydrocarbons and total suspended solids were the main contaminants found in highway ponds.

When looking at the elements carried by road runoff, zinc (originated from galvanised crash barrier, tyre wear and vehicle brake), lead (originated mainly from fuel combustion), copper (originated from vehicle brake) and cadmium (originated from tyre wear) appear to be the most common metallic pollutants. This metallic pollution is mainly transported under a particulate form with a proportion of 95% for Pb, 65% for Cu, 60% for Cd and 50% for Zn (Legret, 2001). Particulates rapidly settle in pond sediment that is functioning as a sink for trace metals (Stead-Dexter and Ward 2004). The measure of total trace metal concentration in sediment does not give much information on their environmental impact. Peltier et al. (2003) who studied the zinc and lead sequestration in an polluted wetland showed that these two elements rapidly formed strong sulfides complex that were mostly bio-unavailable because of low equilibrium dissociation constants. However, resuspension phenomenon may allow the mobility and then bioavailability of these contaminants, particularly through aquatic macrophyte sorption (Peltier et al. 2003) or through soil pH modification (Barbosa and Hvitved-Jacobsen 1999).

If road runoffs have been shown to carry many pollutants, wind also plays a key role in particles dispersion. Most of trace metals and polycyclic aromatic hydrocarbons (PAH), indeed, dispersed by wind and traffic turbulences end up alongside roads (Koeleman et al. 1999), which is confirmed by high level of contamination found in roadside soil (Lee et al. 1997). However, Legret (2001) highlighted the fact that barely 10% of lead and copper released by transport activity were carried by runoff, retained by road porous surface or deposited alongside roads when looking at the produced quantities on roads. This proportion was about 60% for zinc and was not estimated for cadmium. This may be explained by a wide dispersion of trace metals in atmosphere or by an overestimation of source loads linked to road uses. A wind dispersion was pointed out by Hamers et al. (2002) when they studied small mammals contamination by road pollutants. They observed that the strongest contamination by PAH was recorded at the most distant studied site (5 km) from the highway. This resulted from an input of airbone pollutants deposited on plant surfaces.

If a contamination of stormwater ponds water and sediment by transport by-products has been well documented, mechanisms that drive pollutants transfer to the natural ecosystem remain poorly understood and need to be more investigated.

Can we consider highway stormwater detention ponds as Biodiversity islands ?

The digging of many stormwater detention ponds, about one every two or three kilometres along highways, leaded to the creation of numerous new small

Table 2. List of macrophyte species found in surveyed stormwater detention ponds

	ORA	MRA	MRC	SAL	GRA	Total
Alisma plantago-aquatica L.	+	+	+			3
Chara globularis Thuill.			+		+	2
Chara intermedia Braun.	+					1
Chara vulgaris L.	+	+	+		+	4
Iris pseudacorus L.	+					1
Juncus glaucus Sibth.	+					1
Lemna minor L.	+					1
Myriophyllum spicatum L.			+			1
Phragmites communis Trin. ex Steud.	+					1
Potamogeton crispus L.	+					1
Potamogeton natans Thunb.			+			1
Potamogeton pectinatus L.			+		+	2
Ranunculus aquaticus Neck.		+				1
Scirpus holoschoenus L.	+		+			2
Scirpus lacustris L.	+		+			2
Typha angustifolia L.	+	+	+	+		4
Typha latifolia L.	+		+	+		3
Total	12	4	10	2	3	

wetlands with perennial water, where no one existed before. For example, a comparison between a 1:20 000 scale map of the studied zone drawn in 1944 and the current one (2001) showed a 480% increase in number of ponds in the studied area, consisting of urban retention ponds, stormwater detention ponds and golf ponds. The accumulation of organic sediments carried by runoff in these ponds has probably allowed the development of aquatic macrophyte and invertebrate species leading to the attraction of vertebrates to the site. Our study area is characterised by its unpredictable rainstorm frequency, which can lead to a quick filling of the pond or to long periods of drought. That could explain the lack of natural permanent ponds, all being temporary ponds in *Provence* (Blondel and Aronson 1999; Grillas et al. 2004).

Bishop et al. (2000a, b) in their study of 15 stormwater detention ponds in Ontario region concluded that vertebrate species they found were typical of urban environments. But they observed that some stormwater ponds could attract similar numbers of bird species as other small wetlands. As for birds, amphibians were attracted by these created habitats but ponds were rated as "low" or "medium" in terms of species richness when compared to natural habitats found in the study region. They particularly highlighted the lack of suitable habitats (in terms of breeding, foraging or resting sites) surrounding stormwater ponds. They also noticed an impact of urban pollution on macroinvertebrate biodiversity, revealed by the dominance of one or two taxa in the most polluted sites and a moderate community richness of benthic invertebrates.

We did not observe such contrasted results in our study of Mediterranean stormwater ponds (Scher and Thiéry 2005). We firstly found significant differences in macrophyte species richness (Table 2) linked to the bottom type of the pond (one-way ANOVA, $F=57.6$; $p<0.01$). As regards to amphibians (Table 3), these stormwater ponds were largely colonised by opportunistic and anthropophilous species such as *Rana perezi-ridibunda-graffi* (as defined by Crochet et al. 2004) or *Hyla meridionalis*, agreeing with observations of Bishop et al. (2000a). But about 50 % of species potentially found at the regional scale were sometimes found with large populations (*Triturus helveticus and Pelodytes punctatus*). This clearly highlights the use of these habitats by amphibians. But the pond's surrounding habitat appeared to be a key factor to explain amphibian richness as demonstrated by several authors (Joly et al. 2001; Beja and Alcazar 2003; Joly 2004). When looking at dragonfly communities (Table 3), differences were noticed. Actually, species richness can be considered as "high" because a total of 29 species were observed accounting for 60% of the potential species found at the regional scale. Moreover, if two regionally common species appeared to be rare in stormwater ponds (*Orthetrum coerulescens and Coenagrion mercuriale*), four regionally rare species seemed to be favoured by these habitats (*Ischnura pumilio, Erythromma viridulum, Sympetrum sanguineum* and *Aeshna affinis*). Dragonfly species richness seemed to be mainly explained by (i) the pond area (higher in larger ones), (ii) the bottom type (higher when natural bottom occurs) and (iii)

Table 3. List of Amphibian and Dragonfly species found in surveyed stormwater detention ponds

Species	ORA	MRA	MRB	MRC	SAL	GRA	Total
			AMPHIBIAN				
Rana ridibunda (Pallas, 1771)	+	+	+	+	+	+	6
Hyla meridionalis (Boettger, 1874)		+	+	+	+	+	5
Pelodytes punctatus (Daudin, 1802)				+			1
Bufo calamita (Laurenti, 1768)				+			1
Triturus helveticus (Razoumowsky, 1789)		+				+	2
Total	1	3	2	4	2	3	
Species			**DRAGONFLY**				**Total**
Lestes viridis (Vander Linden, 1825)		+	+	+	+		4
Lestes virens (Charpentier, 1835)		+	+				2
Sympecma fusca (Vander Linden, 1820)	+	+		+		+	4
Cercion lindenii (Sélys, 1840)	+	+	+			+	4
Ceriagrion tenellum (Villers, 1789)	+		+				2
Coenagrion mercuriale (Charpentier, 1840)	+		+				2
Coenagrion puella (Linné, 1758)	+		+	+			3
Coenagrion scitulum (Rambur, 1842)				+			1
Enallagma cyathigerum (Charpentier, 1840)				+		+	2
Erythromma viridulum (Charpentier, 1840)	+		+	+	+	+	5
Ishnura elegans (Vander Linden, 1820)	+	+	+	+	+	+	6
Ishnura pumilio (Charpentier, 1825)	+	+		+	+	+	5
Pyrrhosoma nymphula (Sulzer, 1776)				+			1
Aeshna affinis (Vander Linden, 1820)	+	+	+	+			4
Aeshna isoceles (Müller, 1767)			+	+			2
Anax imperator (Leach, 1815)	+		+	+	+	+	5
Anax parthenope (Sélys, 1839)	+	+	+	+		+	5
Crocothemis erythraea (Brullé, 1832)	+	+	+	+	+	+	6
Libellula fulva (Müller, 1764)					+		1
Libellula quadrimaculata (Linné, 1758)			+	+			2
Orthetrum albistylum (Sélys, 1848)	+						1
Orthetrum brunneum (Fonscolombe, 1837)	+	+	+		+		4
Orthetrum cancellatum (Linné, 1758)	+	+	+	+		+	4
Orthetrum coerulescens (Fabricius, 1798)			+				1
Sympetrum depressiusculum (Sélys, 1841)			+				1
Sympetrum fonscolombei (Sélys, 1840)		+	+	+	+	+	5
Sympetrum meridionale (Sélys, 1841)	+						1
Sympetrum sanguineum (Müller, 1764)	+	+	+	+		+	5
Sympetrum striolatum (Charpentier, 1840)	+	+	+	+	+	+	6
Total	18	14	21	19	10	13	

by the macrophyte species richness (higher in dragonfly richest ones). As opposed to amphibians, dragonflies can easily colonise new habitats because of their flight ability and they do not seem to be disturbed by obstacles such as roads. Moreover, most of studied highway stormwater detention ponds contain perennial water, even during dry summers, which allow the survival and larval development of many organisms. We can then consider these man-made habitats as real refuges for dragonfly species.

Macroinvertebrate and plankton assemblages were characterised by a low number of taxa (50 ± 7 taxa) and by about 50% of taxa common to the five stormwater ponds (MRB pond was excluded from analysis because it was not sorted). Firstly we used a Jaccard coefficient of similarity to assess relationships between stormwater ponds. Ponds that were geographically nearby seemed to be more similar (Fig. 3). But if we look at pond age, we observe a significant relationship between age and taxon richness (one-way ANOVA, F=14.935; p<0.05) and a non significant one for bottom type and macrophyte richness. This highlights the importance of time to observe an increase of communities richness as previously shown for water beetles by Winfield Fairchild et al. (2000) or for dragonflies by Kadoya et al.

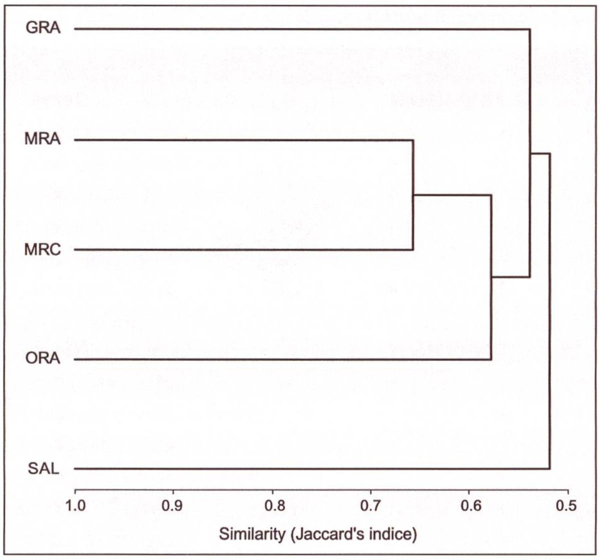

Fig. 3: Hierarchical classification of ponds in relation to their invertebrate communities similarity (Jaccard coefficient of similarity)

(2004). We then compared taxa assemblages found in stormwater detention ponds with the ones found in three protected temporary ponds localised in the Provence region, away from any road (Thiéry 2002). Moreover, these three temporary ponds are isolated and separated from each other by one to three kilometres. We particularly looked after Coleoptera (active dispersers) and Cladocera (passive dispersers) taxa (Fig. 4). We did not find any difference with Coleoptera taxa richness in stormwater ponds *versus* temporary ponds (Mann-Whitney U-test) whereas differences appeared concerning Cladocera taxa richness (Mann-Whitney U-test, $p<0.05$). Temporary ponds had the highest Cladocera taxa richness (12.3 ± 0.58) versus stormwater ponds (7.4 ± 2.61). As for dragonflies, Coleoptera can easily colonise new waterbodies, but their taxa richness has been shown to be correlated to pond size and habitat permanence (Rundle et al. 2002). Their colonisation of stormwater detention ponds does not seem to be disturbed by road or urban obstacles. But two stormwater detention ponds, GRA and SAL, exhibited a really poor coleopteran richness. This could be explained by a lack of other waterbodies in the surrounding area. As for Cladocera, Bilton et al. (2001) showed that passive dispersal could occur through wind and animal vectors. The studied stormwater ponds are protected from most intrusion (animal or human) by a steel fence and most of them are also surrounded by cypress hedge (used in Provence to "cut" the wind strength). Moreover a few vertebrates were observed in them and consisted mainly of birds (*Anas platyrhynchos*, *Tachybaptus ruficollis*, *Larus ridibundus*, *Ardea cinerea* and *Gallinula chloropus*) whereas only one mammal was observed (*Myocastor coypus*). Finally, the isolation of stormwater detention ponds and their little use by birds could explain the low cladoceran taxa richness observed in each of them, while dispersal in temporary ponds appears to be easier (high connectivity between sites and no anthropogenic obstacles). But, if the cladoceran richness can be described as "low", it is interesting to note that about 43% of cladoceran taxa were only found once per pond, which should be underlined in term of biodiversity.

Conclusion

Our study focused on the biodiversity and functions of highway stormwater detention ponds. These freshwater habitats, despite their large number in our urban landscape, remain poorly studied. In the Mediterranean region, these ponds offer favourable conditions for aquatic organisms in terms of perennial water, macrophyte cover and food. Moreover, the chemical assessment of water and sediment conducted between March 2002 and March 2003 in six stormwater detention ponds showed a very limited contamination of the water column (mainly impacted by glyphosate) whereas high concentration of copper and zinc were found in sediment. But this pollution appeared to be highly reduced when compared to studies conducted out of the Mediterranean region. This study clearly showed the use of such constructed habitats by aquatic wildlife and particularly the quality of dragonfly assemblages that colonised them. Nevertheless, the small number of surveyed stormwater detention ponds does not allow us to conclude on the importance of these habitats in term of

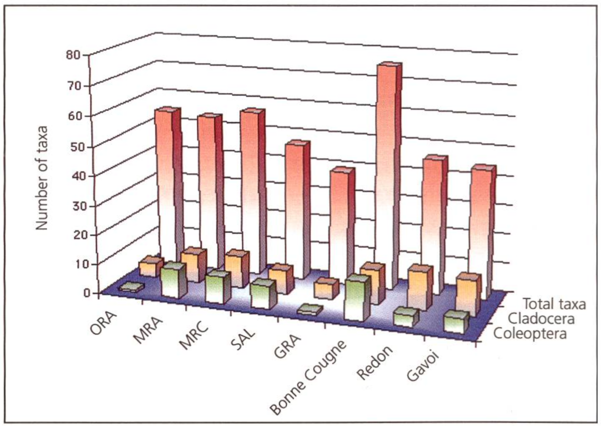

Fig. 4: Histogram of colepteran, cladoceran and total taxa richness of surveyed stormwater detention ponds (ORA, MRA, MRC, SAL and GRA) versus natural temporary ponds (Bonne Cougne, Redon and Gavoti)

biodiversity conservation. So it would be of high interest to engage biodiversity inventories in these stormwater ponds at a larger scale in order to (i) clarify the importance of these habitats for wildlife at the regional scale and (ii) suggest management practices "biodiversity-friendly" to highway companies. But, at the same time, we can also wonder whether favouring biodiversity in such habitats would be perspicacious. Whatever we do, wildlife already uses highway stormwater detention ponds and a knowledge of these habitats is still lacking.

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