ENTOMOLOGIE, 69: 5-18, 1999
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The spider fauna of the Belgian salt marshes

by Léon BAERT and Jean-Pierre MAELFAIT

Abstract

There are along our ca. 60km long coast, two situations in which salt marshes were able to evolve. One of these salt marshes is situated along the mouth of the river Yzer at Nieuwpoort, the other one in the ''Zwin'' plain near Knokke. For both salt marshes, the spider fauna was studied along a gradient running from the dry dune (Zwin, Yzer)/ dike (Yzer) situation towards the wet (flooded during spring tide) *Limonium* zone. The larger Zwin salt marsh (150 ha) is more stable and seems to be more typical than the Yzer salt marsh. Its older dunes have a higher species richness, while the *Limonium* zone is poorer in comparison with the Yzer salt marsh which is at the moment strongly endangered by a too high sand deposition. This results in a poorer dune spider fauna (young drift-dune) and a richer *Limonium* fauna with however species not typical for salt marshes (less flooding by sand deposition).

Both salt marsh complexes are separately analysed but also compared with each other revealing some interesting differences.

Mots-clefs: Araneae, près salins, Zwin, Yser, Belgique.

Résumé

Il existe deux sites le long de la côte belge où des près salins se sont développés. Le premier est situé à Nieuwpoort sur la rive droite de l'Yser, et le second à Knokke dans la plaine du Zwin. La faune aranéologique a été étudiée dans les deux sites le long d'un gradient écologique allant d'une zone sèche (à savoir, au Zwin, une dune, et une dune et une digue le long de l'Yser) à une zone humide et saline à *Limonium*. Les près salins du Zwin (superficie de 150 ha) sont plus stables et plus typiques que ceux de l'Yser. Les dunes y sont plus anciennes et leur richesse en espèces d'araignées est plus grande, alors que la zone à *Limonium* est plus pauvre en araignées. Aujourd'hui, l'existence même de près salins le long de l'Yser est compromise à cause d'un fort depôt de sable marin. Il en résulte que la faune aranéologique est plus pauvre dans la dune que dans la zone à *Limonium* où elle est toutefois composée d'espèces atypiques provenant des biotopes voisins.

La faune aranéologique des deux sites est analysée séparemment, puis comparée l'une à l'autre.

Key words: Araneae, Salt marshes, Zwin, Yser, Belgium.

Introduction

Salt marshes are found where the physical conditions of the coast afford areas of shallow and sheltered water. There are three main obvious characteristics of coastal salt marshes: (1) they consist of alluvial sediments, deposited on the shore by the sea; (2) they are subjected to tidal inundation by more or less diluted sea water; (3) their soil has a chloride content varying in space and time; they are consequently occupied by plant communities completely or mainly consisting of halophytes (BEEFTINK, 1977). Such habitats are partly populated by halophilic or halobiont animal species. These vulnerable habitats, due to their world wide restricted distribution, combine high productivity with extreme abiotic conditions related to the influence of saline water.

There are along the approximately 60 km long Belgian coast two situations in which salt marshes have evolved. One of these salt marshes is situated along the right border of the mouth of the river Yzer at Nieuwpoort, the other one in the eastern corner of the coast in the so ''Zwin''-plain (former Zwin river) near Knokke. Those salt marshes are continuously sampled since 1993. The only existing data about those salt marshes are unpublished student reports (e.g. NIJS , 1976)made during field courses of the ''Laboratorium voor Oecologie'' of the University of Ghent. These data contain pitfall trapping made during a few days and have only faunistic value. Many small tidal marshes are found along the tidal part of the river Scheldt, these were studied by HENDRICKX *et al.* (1998).

For neighbouring countries, extensive studies or reports about salt marsh spider populations exist for England (SUDD, 1972), France (FOUILLET, 1987), Germany (KNÜLLE, 1953; HEYDEMANN, 1973; HEYDEMANN, 1979; REINKE & IRMLER, 1994) and Holland (VAN HEERDT & BONGERS, 1967; MEIJER), 1973.

The aim of this paper is to consider the spider diversity and spider community structure of the Belgian salt marshes and their adjacent habitats (dikes, dunes).

Material and methods

Study sites

The spider fauna of both coastal salt marshes was studied along a gradient running from a dry dune (Zwin, Yzer)/dike (Yzer) situation towards the wet saline (flooded during spring-tide) *Limonium vulgare* zone.

Fig. 1 — "Yzer" salt marsh (photo Th. HUBIN, IRScNB).

Fig. 2 — "Zwin" salt marsh, air view (photo Th. HUBIN, IRScNB).

Table 1 — Number of species caught in each sampled habitat.

Habitat	Zwin 92	Yzer 93	Yzer 97	Yzer 98
Dike (Dk)		62		
Dune (D)	70	66		
Upper flood border (B)	68	60		
Suaeda zone (S)			43	45
Elymus zone (E)			37	
Limonium zone (L)	22	38	35	
Halimione zone (H)	33			
Puccinellia zone (P)	36			

Three pitfall traps (with 4% formaline) were placed in each habitat and emptied fortnightly, except for the Yzer 1993 cycle where they were emptied weekly.

The "Yzer" salt marsh (Fig. 1)

The total surface of this salt marsh is approximately 10 ha. The salt marsh is enclosed in its upper part by an embryonic dune along the riverside and by a dike.

In 1993 four habitats were sampled between 5.III.1993 to 11.III.1994:
* the dike (YzDk) along its northern border with a typical ruderal vegetation;
* an embryonic drift dune (YzD) developing between the salt marsh and the river Yzer. The pitfalls were placed close to the top between *Ammophila arenaria* grass;
* the upper flood-border (YzB);
* the *Limonium* zone (YzL3).

In 1997 three habitats were sampled from 14.III.1997 to 20.III.1998:
* the higher marsh (YzS7) with *Suaeda maritima* vegetation;
* the *Elymus athericus* zone (YzE) situated on a ridge separating two *Limonium* parcels;
* the *Limonium* zone (YzL7).

In 1998 only the higher marsh YzS8 was sampled from 20.III.1998 to 19.III.1999:

The surface of this small salt marsh is rapidly shrinking by the rapid development of the drift dune along its western border. Sand deposition originating from the embryonic dune results in changes of the granulitic composition off the soil substrate (i.e. getting coarser) and due to soil level lifting to less inundation by saline water.

The "Zwin" salt marsh (Fig. 2)

This salt marsh complex has a total surface of approximately 150 ha. It seems to be a more stable salt marsh. The sampled area is called the "Konijnenveld (rabbit field)".

The following habitats were sampled in 1992 from 6.III.1992 to 12.III.1993:
* a low old inland dune with low vegetation (ZwD);
* upper flood border (ZwB);
* the *Limonium* zone (ZwL);
* the lower *Halimione* zone (ZwH);
* the lowest *Puccinellia* zone (ZwP).

The results were analyzed by mean of a Detrended Correspondence Analysis (DCA) and a Twinspan (TER BRAAK, 1988).

Results and discussion

The "Zwin" salt marsh

For the five sampled habitats, 95 species were caught of which 91 occurred in the dry dune and flood border habitats and 46 in the saline situations. The dry dune and upper flood border habitats are the habitats with the highest richness in species (resp. 70 and 68), with double or more species than the lower salt marsh habitats (see table 1). Within the salt marsh situation it is the lower *Puccinellia* zone which is richer than the higher *Limonium* zone.

A DCA-analysis shows a very clear variation along the first horizontal axis (eigenvalue of 0.70) from dry situations (dune, flood border) towards the moist saline situations (*Puccinellia-*, *Halimione-* and *Limonium*-zones), with a clear-cut segregation between the dry (left of the Fig 3) and the saline habitats (right of Fig. 3).

A small variation occurs between the individual pitfalls of both dry habitats, while a greater variation is visible for the more disturbed saline habitats.

A Twinspan-analysis shows a grouping of the species in 5 groups:
* species occurring only in the dry dune habitats: *Typhochrestus digitatus, Bolyphantes luteolus,Centromerus prudens, Centromerus sylvaticus, Hypsosinga albomaculata, Walckenaeria antica, Walckenaeria atrotibialis, Walckenaeria monoceros, Walckenaeria stylifrons, Arctosa perita, Tegenaria agrestis, Trichopterna cito, Centromerita concinna, Xerolycosa miniata, Xysticus kochi, Xysticus cristatus, Agroeca proxima, Dicymbium nigrum* and *Tapinocyba praecox*;
* species with a clear preference for the dry dune habitats, but which can also be encountered in the moist saline situations;
* species with no preference at all (ubiquists);
* species with a preference for the saline zones but which can also be encountered in the higher drier border situation (*Baryphyma duffeyi)* and in very small numbers in the dune habitat: *Oedothorax fuscus, Oedothorax apicatus, Erigone longipalpis, Pachygnatha clercki, Pardosa purbeckensis, Silometopus ambiguus;*
* species restricted to the saline habitats (*Enoplognatha mordax, Argenna patula, Oedothorax retusus*).

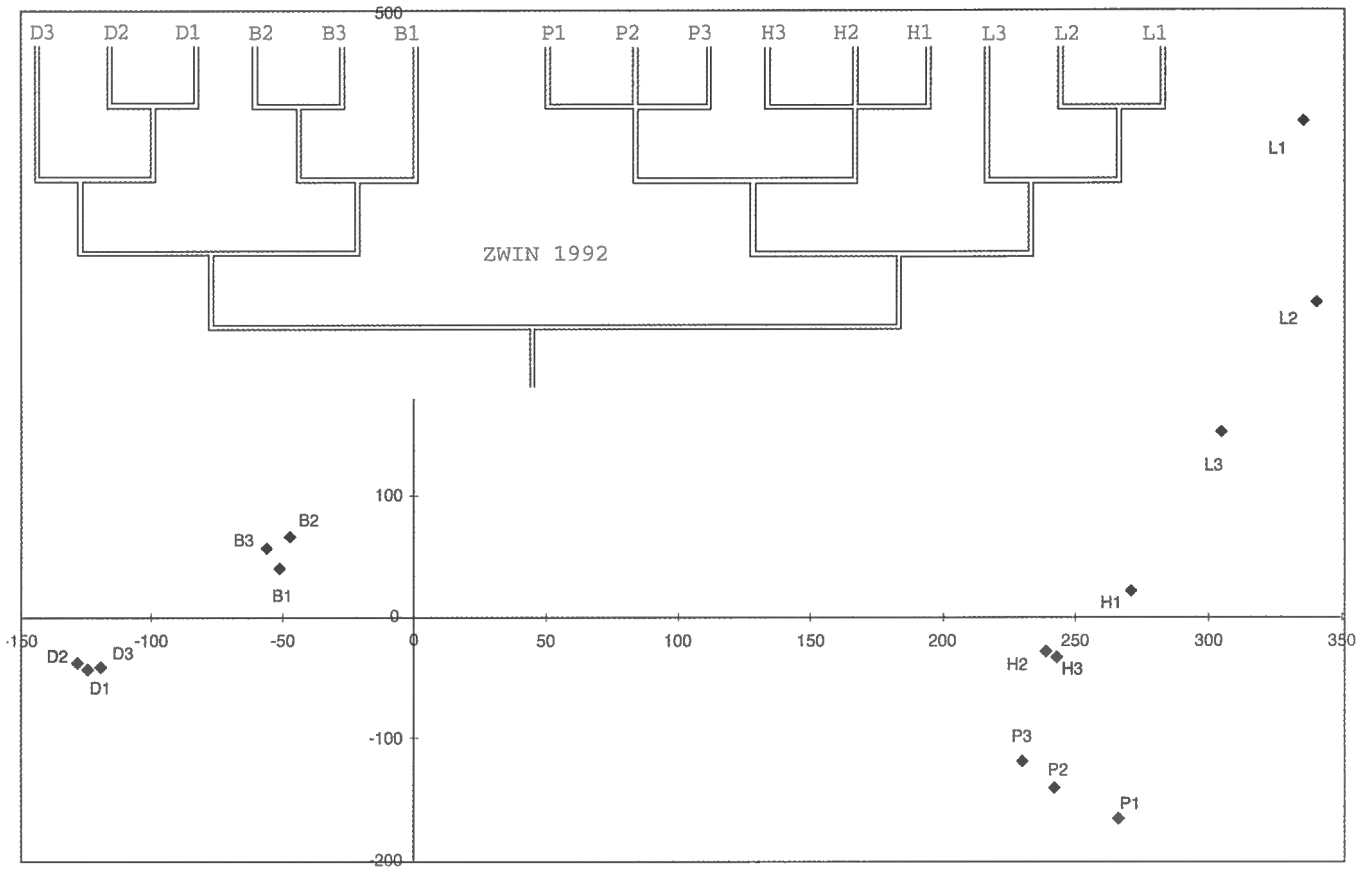

Fig. 3 — DCA ordination of the Zwin samples 1992/93.

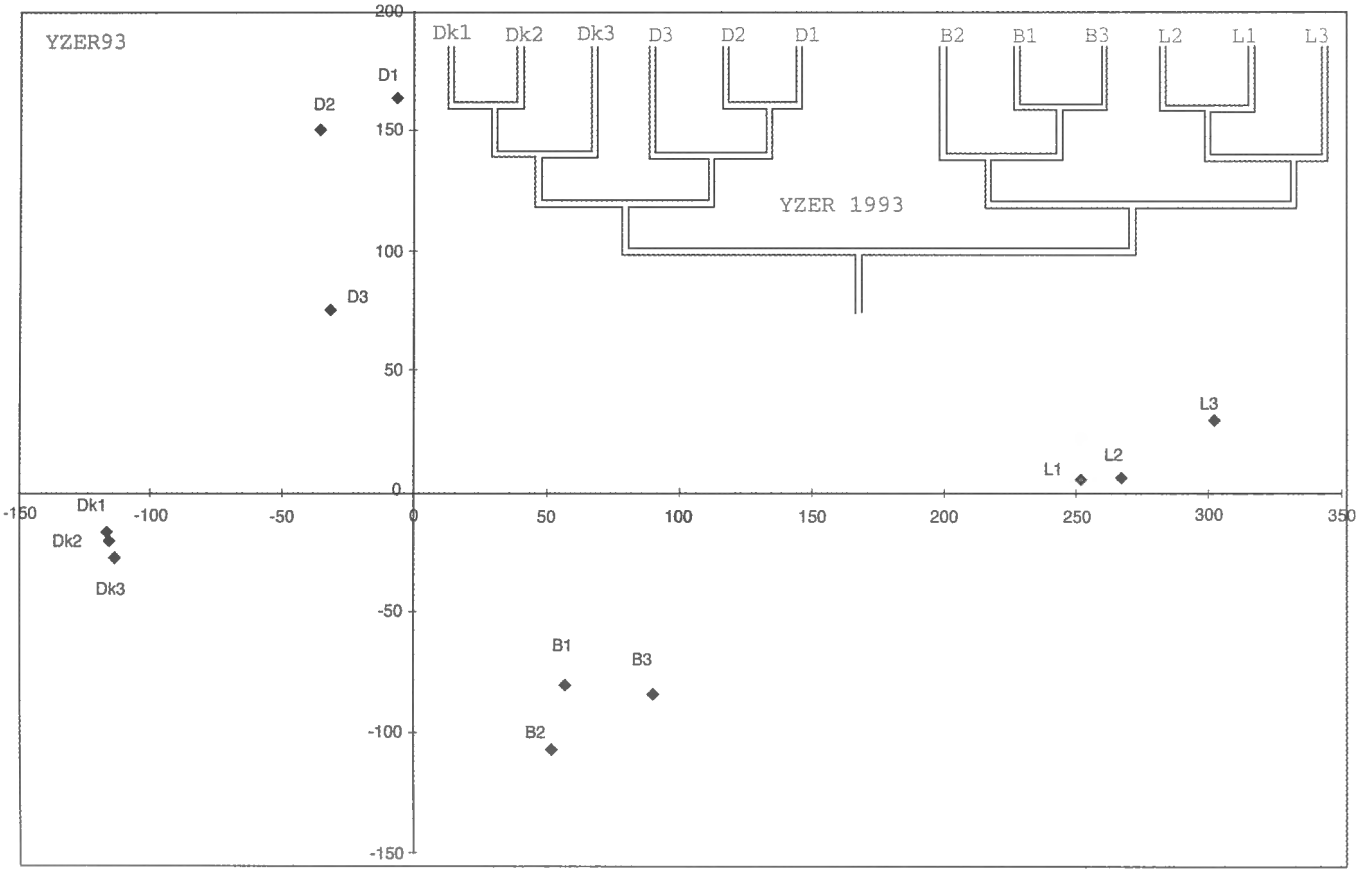

Fig. 4 — DCA ordination of the Yzer samples 1993/94.

Table 2 — Sequence of the dominant species of the *Limonium* and *Suaeda* habitats at the Yzer salt marsh in two different years.

***Limonium* zone**				
1993	%	pos.	1997	%
Pardosa purbeckensis	35.8	12	Baryphyma duffeyi	53.5
Oedothorax fuscus	14.0	1	Pardosa purbeckensis	20.8
Erigone longipalpis	12.6	6	Oedothorax retusus	7.6
Oedothorax apicatus	12.3	2	Oedothorax fuscus	5.5
Erigone atra	4.0	3	Erigone longipalpis	2.5
Erigone dentipalpis	3.4	5	Erigone atra	2.2
Oedothorax retusus		6	Erigone dentipalpis	1.2
Trochosa ruricola	2.8	4	Oedothorax apicatus	1.1
Argenna patula	1.6			
Pachygnatha clercki	0.6			
Pachygnatha degeeri	1.5			
Lepthyphantes tenuis	1.0			
Baryphyma duffeyi	0.7			
***Suaeda* zone**				
1997	%		1998	%
Erigone dentipalpis	28.6	1	Erigone dentipalpis	17.8
Erigone atra	13.8	2	Erigone atra	16.4
Pardosa purbeckensis	9.1	3	Pardosa purbeckensis	13.2
Oedothorax fuscus	8.3	4	Oedothorax fuscus	9.4
Pachygnatha degeeri	4.8	6	Trochosa ruricola	6.7
Trochosa ruricola	3.7	11	Baryphyma duffeyi	5.6
Oedothorax retusus		7	Ozyptila simplex	5.3
Ozyptila simplex	2.7	5	Pachygnatha degeeri	5.2
Erigone arctica	2.5	6	Oedothorax retusus	3.1
Oedothorax apicatus	2.2	8	Erigone arctica	2.2
Erigone longipalpis			Lepthyphantes tenuis	2.0
Centromerita concinna	1.7	9	Erigone longipalpis	1.9
Baryphma duffeyi	1.4	9	Oedothorax apicatus	1.6
Xysticus cristatus				

The "Yzer" salt marsh

The Yzer site has been continuously monitored since 1993. Different habitats were sampled in different years (cf. Material and methods). Therefore we first analysed the data gathered in 1993 and 1997 separately. An analysis was also done on the totality of the data collected in 1993, 1997 and 1998.

During the three years of sampling, 109 species were encountered in the Yzer salt marsh area, of which 103 occurred in the dry habitats (dike, dune and upper flood border) and 43 in the saline habitats (*Limonium* zone and higher salt marsh).

In the "Yzer" salt marsh only the *Limonium* zone is well defined as a vegetation zone and is large enough to be sampled, whilst the other *Puccinellia and Halimione* zones (cf. "Zwin" salt marsh) do not exist as separate zones, although the plant species occur.

The DCA ordination shows a clear variation (eigenvalues of 0.66 in 1993, of 0.37 in 1997 and of 0.61 for the total (Figs 4-6) along the first axis from the dry habitats towards the most saline *Limonium* zone. The saline salt marsh habitats (S, B, E and L) are ordinated along the vertical second axis according to their distance towards the creek mouth.

The dendrogram obtained through a Twinspan analysis gives a clear-cut separation between the dry habitats (dike, dune and upper flood border) and between the saline habitats (higher salt marsh, *Elymus* ridge, *Limonium*). There is, as expected, a pronounced similarity between the data of the different sampling years for the higher salt marsh and the *Limonium* zone (Fig. 7). There are greater differences (cf. Table 2) in the se-

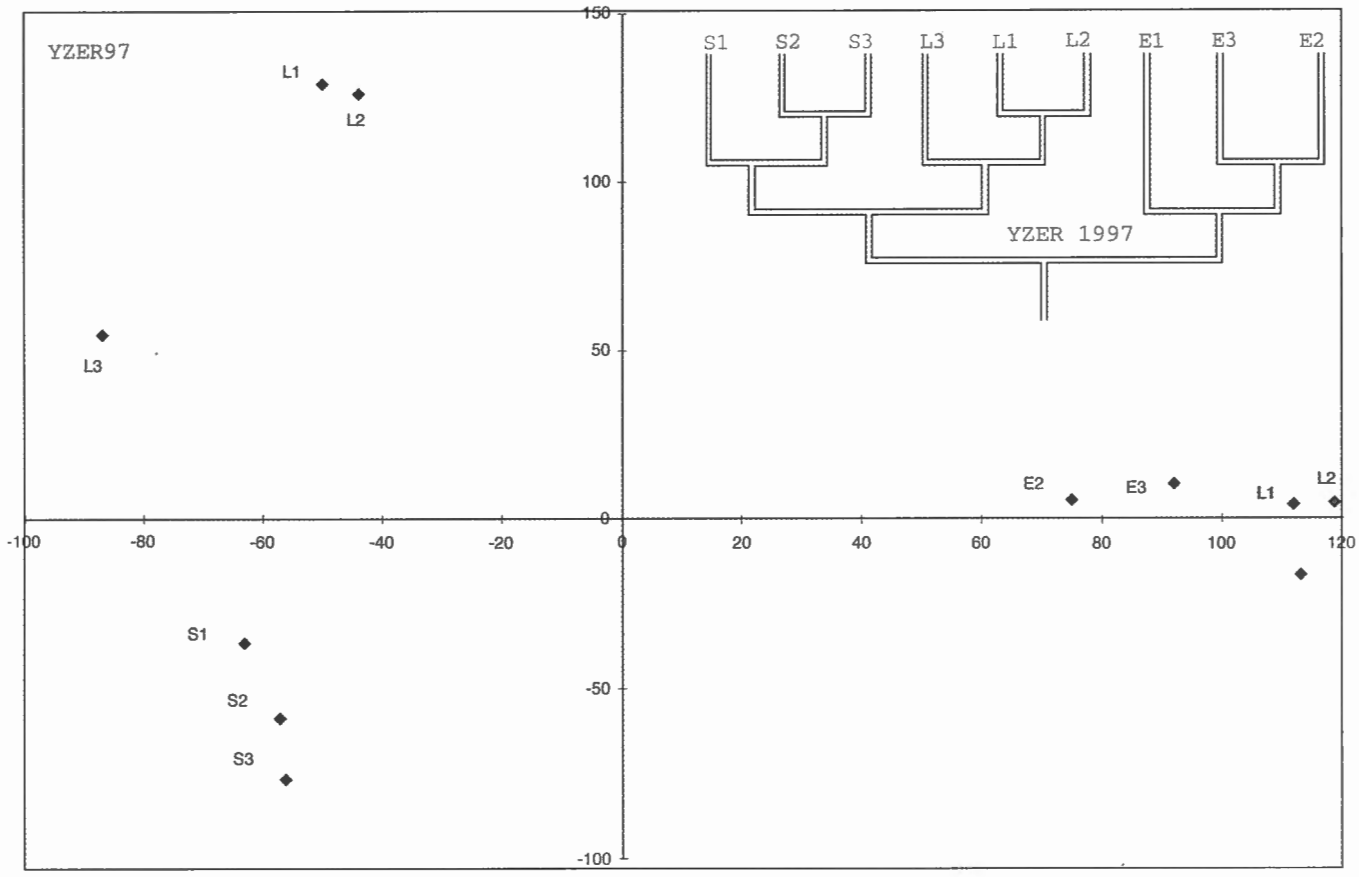

Fig. 5 — DCA ordination of the Yzer samples 1997/98.

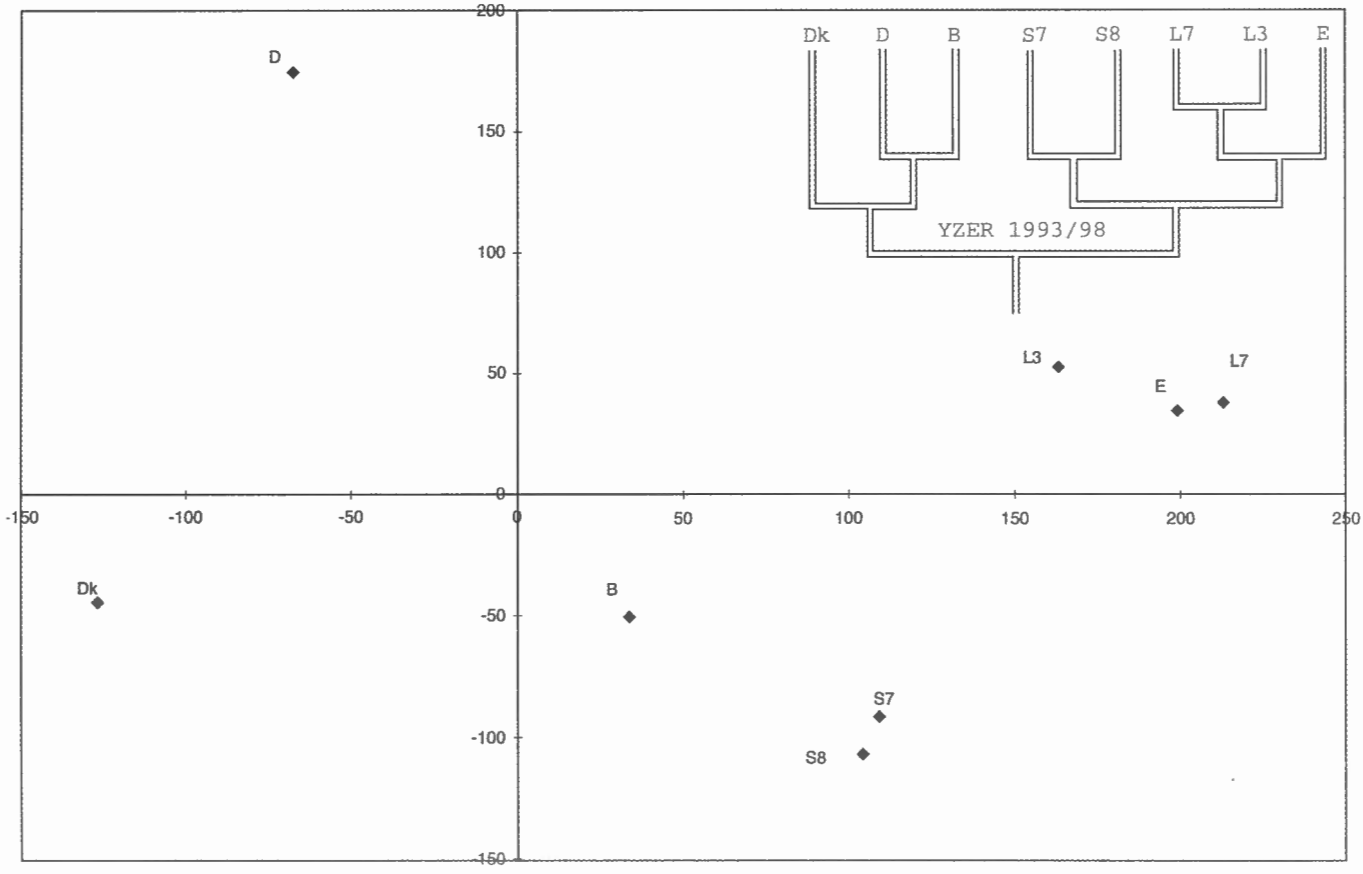

Fig. 6 — DCA ordination of the Yzer habitats 1993/98.

Table 3 — Total number of males and females of the dominant halophilic species.

	Zwin					Yzer							
	D	B	L	H	P	Dk 93	D 93	B 93	S 97	S 98	E 97	L 93	L 97
Allomengea scopigera							1/0	2/0	1/0		35/10		1/0
Argenna patula				4/0	11\1			1/0	5/0	1/0	35/5	16/0	3/0
Baryphyma duffeyi		0/1	5\5					1/0	3\6	36/15	171/173	7/0	279/507
Enoplognatha mordax				1/0	8\9								
Erigone arctica		3\6							16/0	17\3	2/0		1/0
Erigone longipalpis		45/11	48/206	11\43	199/512		4/0	5\1	12\2	16\1	5\1	87/42	31/6
Oedothorax apicatus	1/0	2\1	3\3	15\4			12\3	5\1	14/0	8\7	54/18	50/76	9\7
Oedothorax fuscus	1\1	11\37	4\9	1\20	107/767		1\3	23/38	26/26	27/59	21/85	27/117	7\74
Oedothorax retusus			0/3	2\10			2\1	27/15	15\8	11\17	235/186	15/20	31/80
Pardosa purbeckensis	3/0	29/15	474/126	548/270	233/86	2/0	1\1	220/50	48/9	98/22	356/98	294/73	243/63
Silometopus ambiguus	2\1	24\4	1\2	6\38	12\97								

quence of the dominant species between both years for the *Limonium* zone than for the higher salt marsh. This habitat is of course more influenced by the incoming tide, being therefore more unstable, than the higher situated habitats which may be the reason for the observed differences.

As at the "Zwin" site, we have the same groups of species:
* species restricted to the saline situations: *Erigone arctica, Prinerigone vagans, Argenna patula* and *Baryphyma duffeyi*;
* species with a preference for the saline situations but which can also occur in drier habitats;
* species with a preference for the drier habitats, but which can also occur in saline environments;
* species restricted to the drier habitats:
— *Tegenaria agrestis, Agroeca cuprea, and proxima, Troxochrus cirrifrons and scabriculus*;
— *Ozyptila praticola, Walckenaeria antica* and *Zelotes pedestris* (restricted to the ruderal dike);
— *Walckenaeria acuminata, Centromerus sylvaticus* and *Tapinocyba praecox* (restricted to the dike and dune).

Comparison between the "Zwin" and the "Yzer" species-composition

* Species composition

There is a certain difference between the spider faunas found in both dune-salt marsh complexes. The SØRENSEN similarity amounts to 60%. 30 species were only found in the "Zwin" area and 42 only in the "Yzer" area.

The most important (13 most abundant) species that were found at the "Zwin" area are:
– *Bolyphantes luteolus, Centromerus prudens, Hypsosinga albovittata, Trichopterna cito, Typhochrestus digitatus, Walckenaeria stylifrons and Xerolycosa miniata* are restricted to the old land dune;
– *Walckenaeria monoceros h*as a clear preference for the old dune;
– *Enoplognatha mordax* was only found in the *Puccinellia* zone;
– *Silometopus ambiguus* showed a clear preference for the *Puccinella* zone;
– *Trochosa terricola* and *Walckenaeria atrotibialis* prefer the higher flood border;
– *Haplodrassus signifer* was found in most habitats.

The most important species for the "Yzer" area are:
– *Pelecopsis nemoralis and Tibellus maritimus* show a preference for the embryonic dune;
– *Clubiona frisia, Troxochrus scabriculus and cirrifrons* show a clear preference for the dry habitats;
– *Ozyptila praticola, Walckenaeria antica and Zelotes pedestris* were only found on the dike.

* DCA and Twinspan analysis's

The data used for comparison are those obtained by pitfalls and therefore reflect the activity densities of the species. As the data were obtained in different years, the numbers caught might be influenced by climatic and environmental factors. To minimize these possible influences on the activity densities of the species we transformed the data. We consider, for each habitat, the number of caught specimens of each species as a percentage of the number of the most caught species of that habitat.

The DCA analysis gives, as for each area separately, an ordination of the different habitats along the first axis (eigenvalue of 0.64) according a transect running from the dry habitats (left of Fig. 7) towards the most saline situations (right of Fig. 7): dike, dunes, upper flood

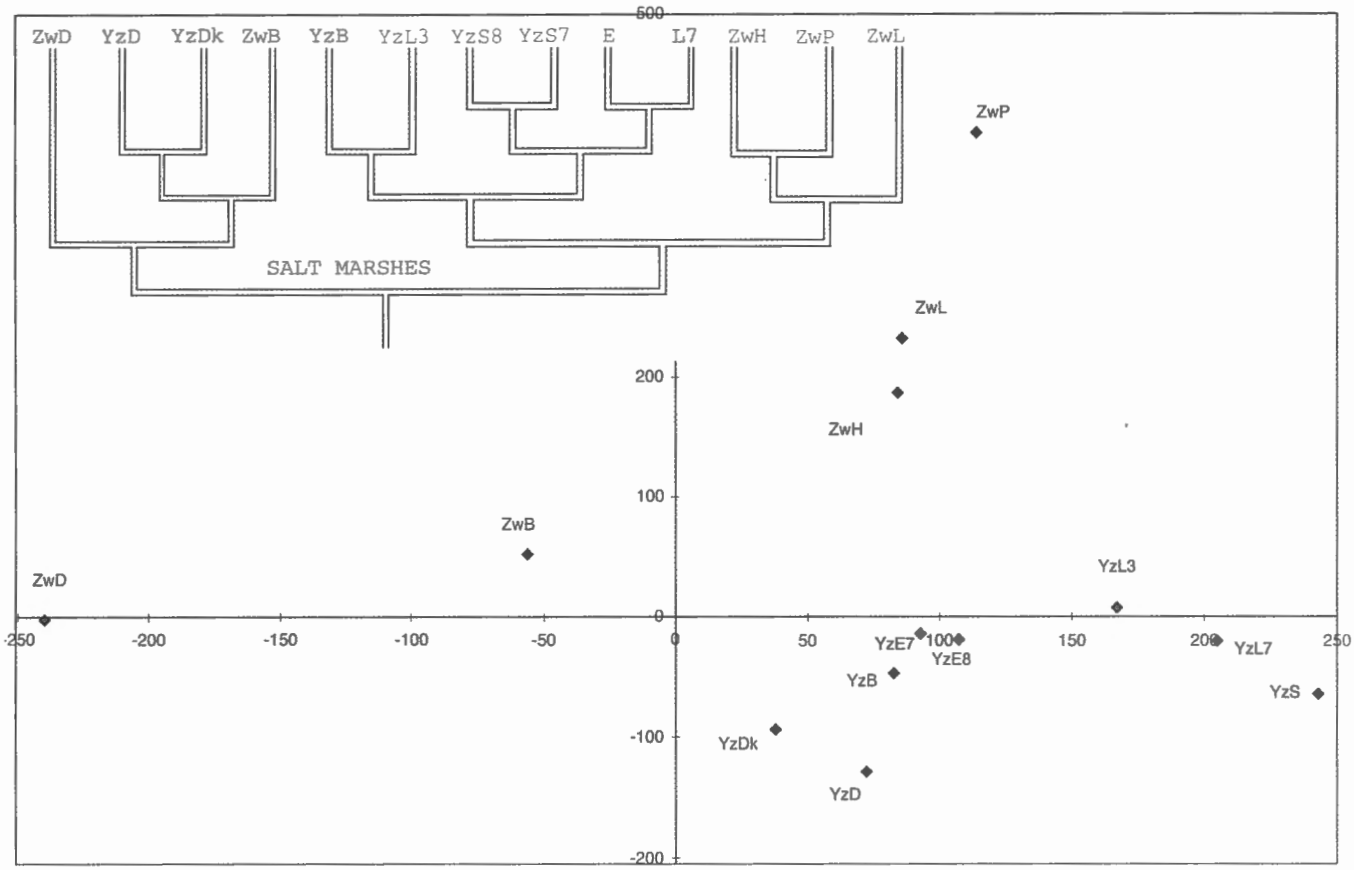

Fig. 7 — DCA ordination of all sampled salt marsh habitats

borders, higher salt marsh, *Puccinellia*, *Halimione* and *Limonium*.

There is an ordination along the second axis (eigenvalue 0.46) according to their geographical location, the "Zwin" habitats above the horizontal axis, the "Yzer" under the horizontal axis.

* Saline habitats

The typical halophilic species *Baryphyma duffey, Pardosa purbeckensis, Argenna patulata, Erigone longipalpis* are found in both coastal salt marshes. The halophylic *Enoplognatha* mordax is only found in the "Zwin" marsh.

Baryphyma duffeyi reaches, by far, its highest densities in the "Yzer" salt marsh, especially in the *Limonium* and *Elymus* zones. *Erigone longipalpis* reaches, by far, the highest densities in the *Puccinellia* zone of the "Zwin" salt marsh.

A study of the tidal marshes along the river Scheldt (HENDRICKS *et al.*, 1998) revealed the presence of *Baryphyma duffeyi, Pardosa purbeckensis and Erigone longipalpis* in the brackish marshes of the estuary, whilst *Argenna patula* seems to be restricted to the coastal salt marshes.

The *Oedothorax species (retusus, fuscus & apicalis)*, *Allomengea scopigera* (for this species the Elymus zone) and *Erigone arctica* were also restricted to the saline zones of both dune — salt marsh complexes. These are species living in wet situations along the water edge in marshy habitats and wet grasslands.

The Sorensen similarity index between the *Limonium* zones of the studied areas amounts to 55.6%.

* Dune habitats

There is a 60.5% Sorensen species similarity between the old "Zwin" inland dune and the embryonic coastal "Yzer" dune.

The species restricted to the older "Zwin" dune are *Bolyphantes luteolus, Centromerus prudens, Haplodrassus signifer, Hypsosinga albovittata, Pardosa palustris, Pardosa pullata, Trichopterna cito, Trochosa terricola, Typhochrestus digitatus, Walckenaeria monoceros, Walckenaeria stylifrons, Xysticus kochi* and *Xerolycosa miniata*. Most of these species can also be found in the inland moss dunes of the "Yzer" area (BAERT. & DESENDER., 1993)

The species restricted to the embryonic "Yzer" dune are *Clubiona frisia, Pelecopsis nemoralis, Tibellus maritimus, Troxochrus cirrifrons, Troxocrus scrabiculus and Agroeca cuprea*. These non halophilic

species are commonly found on coastal dunes with an *Ammophila* grass vegetation (BAERT & DESENDER, 1993).

Autecological data of the halophilic species (Tables 3 & 4)

Allomengea scopigera
This species was only found in the ''Yzer'' salt marsh with its highest activity density along the *Elymus* ridge separating two *Limonium* parcels. The males and females were active from July till December with a male activity peak in September.

Argenna patula
This halophilic species is a typical salt marsh species occurring in the most saline habitats. In the Zwin it was most numerous in the lowest *Puccinellia* zone, in the Yzer it was most numerous on the drier *Elymus* ridge.

In both areas the males were active in May and June, the females in June and in the ''Yzer'' area even in August. At the Lauwerszeepolder in the Netherlands MEIJER & VAN WINGERDEN (1975) found the same male activity, but the females were active till October while the sub-adults could be found all year round illustrating the poor synchronisation of the species life cycle.

Baryphyma duffeyi
Also a typical halophilic species which reached in 1993 its highest activity densities along the *Elymus* ridge and in the *Limonium* zone. The pronounced differences between the activity densities observed in 1993 and 1997 in the *Limonium* zone, shows that this species can be subject to great fluctuations in their population densities. This can may be also explain the low observed activity densities in the ''Zwin'' area in 1992.

The species hibernates as sub-adult (see Table). Males are active from April till June with a peak in May, females from April till August with also a peak in May.

This species is only known from the salt marshes of England, the Netherlands and Germany (BAERT, 1996). In Germany it only seems to occur in the salt marshes along the North Sea coast (REINKE & IRMLER, 1994).

Enoplognatha mordax
It was only encountered during the month of June in the low *Halimione* and lowest P*uccinellia* salt marsh zones of the ''Zwin'' area.

Erigone arctica
It seems to prefer drier disturbed situations as the transition dune/salt marsh (Zwin) and the higher *Suaeda* and *Elymus* salt marsh environments (Yzer).

Erigone longipalpis
A species showing a clear preference for saline environments, but which can also be encountered in immediate adjacent habitats as, for instance, the high tide border line. It reached its highest activity densities in the *Puccinellia* and *Limonium* zones of the ''Zwin'' in 1992/93.

Males and females seem to be active all year round. In the Zwin habitat, males reached a low peak in March 92 and a more substantial one in November 92; females reached in the *Puccinellia* zone a peak in March , whilst in the *Limonium* zone in April 92 as did females in 93 in the ''Yzer'' *Limonium* zone. Males reached a low peak in June 93 in the *Limonium* zone. The observed differences might be the cause of population fluctuations occurring between years according to different environmental conditions. MEIJER (1973) observed analogous density differences between two following years during a study of the colonisation of the Lauwerszeepolder in the Netherlands.

Oedothorax apicatus
This species shows, as does the former species, a clear preference for the saline environments but can also be encountered in the adjacent habitats (see Table 3). High activity densities were found on the the *Elymus* ridge (in 1997) and in the *Limonium* zone (in 1993) of the ''Yzer'' area. There is again an important difference in densities between *Limonium* 93 and *Limonium* 97.

This is the first time that this species is encountered in firmly established populations in a salt marsh. FOUILLET (1988) on the contrary states that *Oedothorax apicatus* is not able to colonise salt marshes for a longer period. It is generally found in a variety of wet situations such as marshes, fields, meadows, orchards, dune slacks and dune meadows (BAERT, 1996).

Oedothorax fuscus and Oedothorax retusus
Both species can generally be found in wet meadow or wet marsh situations all over the country. The figures of table show that both species are tolerant to saline situations and that they even can reach high densities in salt marshes (*cf.* FOUILLET, 1988; KNÜLLE, 1953; REINKE & IRMLER, 1994). Adults are found all year round.

Pardosa purbeckensis
Though generally considered as a morph of *Pardosa agrestis* (ROBERTS, 1998), we use the name *purbeckensis* to emphasise the preference of this morph for saline habitats.

Within the saline environments of the ''Zwin'' area it reached its highest activity densities in the *Halimione* zone, whilst in the saline environments of the ''Yzer'' area it reached its highest densities along the *Elymus* ridge. For this species we can find no substantial difference in density between the years '93 and '97.

The species hibernate as sub-adult. Males are active from April to July, with a peak in May, females

Table 4 — Phenology of the halophilic species.

			III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II
Allomengea scopigera	Yz-*Elymus* zone 97	MM						4	27	2		2		
		FF						2	2	3	1	2		
Argenna patula	Zw-*Puccinellia* zone	MM			6	5								
		FF				1								
	Yz-*Elymus* zone 97	MM			20	15								
		FF				3		2						
Baryphyma duffeyi	Yz-*Suaeda* zone 98	MM		13	24									
		FF			14	6								
	Yz-*Elymus* zone 97	MM	1SA	1SA/41	119	11								
		FF		1SA/21	113	28	4	6						
	Yz-*Limonium* zone 97	MM	8SA	1SA/95	179	5					2SA			2SA
		FF	4SA	71	284	143	9	2						1SA
Enoplognatha mordax	Zw-*Puccinellia* zone	MM				8								
		FF				9								
Erigone longipalpis	Zw-*Puccinellia* zone	MM	21	9	6	10	5		2	23	87	33		3
		FF	184	95	19	3			3	7	47	48	45	52
	Yz-*Limonium* zone 93	MM	1	1	3	31	25	15		1	8			1
		FF	7	15	4	3	5	12						1
Oedothorax apicatus	Zw-*Halimione* zone	MM				15								
		FF				4								
	Yz-*Elymus* zone 97	MM		1			39	12	2					
		FF	1				7	7	1	1	1			
	Yz-*Limonium* zone 93	MM				26	16		3	1	4			
		FF	3		2	9	31	29						
Oedothorax fuscus	Zw-*Puccinellia* zone	MM	5	4	4	12	1		71	8	1	1		
		FF	263	187	150	35	8		26	20	32	17	14	15
	Yz-B93 + L93	MM		1	1	5	6	10	7	15	5	1		
		FF	39	22	21	22	23	19	1	5		5	1	6
	Yz-S97+E97+L97	MM	6	1		2	15	5	1	10	10	1		1
		FF	14	24	28	13	27	40	6		2	1		16
Oedothorax retusus	Yz-*Elymus* zone 97	MM		7	17	5	128	57	7	5		1	2	5
		FF	30	25	37	33	26	23	4	1	1			2
	Yz-*Limonium* zone 97	MM		1	7	4	7	5	4	1	2			
		FF	16	6	13	12	1	25	5			1		1
Pardosa purbeckensis	Zw-*Limonium* zone	MM		2	285	173	14							
		FF			74	47	5							
	Zw-*Halimione* zone	MM			322	221	5							
		FF			133	125	12							
	Zw-*Puccinellia* zone	MM		8	177	45	3							
		FF			48	32	5		1					
	Yz-Border 93	MM		52	187	59	1							
		FF		7	38	11	1							
	Yz-*Suaeda* zone 97	MM		13	30	1			1					
		FF		1	3			3	1					
	Yz-*Suaeda* zone 98	MM			61	34								
		FF			14	6	2	1						
	Yz-*Elymus* zone 97	MM	5SA	5SA/31	204	105	15	1		j	j			27SA
		FF	3SA	1SA/7	30	39	12	8	2	j	j			28SA
	Yz-*Limonium* zone 97	MM	3SA	48	143	48	4		j	j		1SA		2SA
		FF	2SA	9	22	25	4	1	j	j/2				1SA
	Yz-*Limonium* zone 98	MM		94	153	45	2							
		FF		24	24	21	2	2						
Silometopus ambiguus	Zw-Border	MM	10	7								1		5
		FF			1					1		1		1
	Zw-*Halimione* zone	MM		2	1	1					2			
		FF		11	14	17								
	Zw-*Puccinellia* zone	MM	3	3	1	1				1				2
		FF	18	24	44	7	1		1	1				1

Table 5 — Species list.

Species list	ZwD	ZwB	ZwP	ZwH	ZwL	YzDk	YzD	YzB	YzL3	YzS7	YzL7	YzE	YzS8	Total
Agroeca cuprea		4				18	4	3						29
Agroeca lusatica	32	64	3	6			1	1						107
Agroeca proxima	15	46				15	6	13						95
Agyneta conigera						1								1
Allomengea scopigera										1	1	45		47
Alopecosa barbipes								2		1				3
Alopecosa cuneata	5		3		1									9
Alopecosa pulverulenta	36	151	13	17	3	44	1	61		6		4	4	340
Arctosa perita	13	1				1	27	6	5	4	6		1	64
Argenna patula			12	4				1	16	5	3	40	1	82
Argenna subnigra	4	31			1	45	2	4		2				89
Baryphyma duffeyi		1			10			1	7	9	786	344	51	1209
Baryphyma maritimus	3													3
Bathyphantes gracilis	16	17	3	1		37	80	32	4	7		15		212
Bathyphantes parvulus						6	1							7
Bathyphantes setiger	1													1
Bolyphantes luteolus	11													11
Centromerita bicolor	60	82	7	9		16	4	31	2	2	8		5	226
Centromerita concinna	224	13		3		37	4	6		11			1	299
Centromerus sylvaticus		11				51	3							65
Centromerus prudens	23													23
Ceratinella brevipes													1	1
Ceratinella brevis		1				1								2
Chiracanthium virescens	3		1			1								5
Clubiona frisia						11	21	3	1				1	37
Clubiona neglecta		5												5
Clubiona phragmitis							1							1
Clubiona reclusa						3	1	2					2	8
Clubiona stagnatilis		3	4											7
Clubiona subtilis	1						1	2						4
Collinsia inerrans		1	1	3			1		2	2				10
Dicymbium nigrum	3	8								1		1		13
Diplostyla concolor		3		1		91	6	10		5		18	6	140
Dismodicus bifrons						1								1
Drassodes cupreus	22	29	1	1		20	6	2	1	1	1	3	2	89
Dysdera crocuta						35	7	5		3				50
Enoplognatha mordax			17	1										18
Enoplognatha thoracica	1	2				1							1	5
Erigone atra	136	197	68	13	16	16	18	62	41	87	33	144	149	980
Erigone arctica		9								16	1	2	20	48
Erigone dentipalpis	11	16	10	1	2	2	13	53	35	180	18	61	162	564
Erigone longipalpis		56	711	54	254		4	6	129	14	37	6	17	1288
Erigone promiscua						1						1		2
Euophrys frontalis		1					1							
Ero cambridgei		1												1
Ero furcata		3				3	1							7
Hahnia helveola	4			1										5
Hahnia nava	1													1
Hahnia pusilla		8												8
Haplodrassus dalmatensis	2	2						4	1	1	1	1	3	15
Haplodrassus signifer	23	17	36	8							1	1		86
Heliophanus flavipes								1			1			2
Hypomma bituberculata									4		1	4		9
Hypomma cornutum									1					1
Hypsosinga albovittata	14													14
Lepthyphantes ericeus	2	1					1							4
Lepthyphantes insignis	4													4
Lepthyphantes pallidus						5	3		1	1	1	1	2	14
Leptyphantes tenuis	34	29		4	2	168	72	55	10	3	1	27	18	423
Linyphia clathrata						2	1							3
Meioneta beata	2					4	1	1						8
Meioneta mollis								2						2
Meioneta rurestris	2	9				4		2		2			5	24
Meta segmentata													5	5
Metopobactrus prominulus							2							2

Species list	ZwD	ZwB	ZwP	ZwH	ZwL	YzDk	YzD	YzB	YzL3	YzS7	YzL7	YzE	YzS8	Total
Micaria pullicaria	2	2				3				1			3	11
Micrargus laudatus											1			1
Micrargus subaequalis						17		2	1					20
Mioxena blanda						3		2						5
Oedothorax apicatus	1	3		19	6		15	6	126	14	16	72	15	293
Oedothorax fuscus	2	49	874	25	13		4	61	144	52	81	106	86	1497
Oedothorax retusus			8	10	3		3	42	35	23	111	421	28	684
Ozyptila atomaria						1								1
Ozyptila praticola						27								27
Ozyptila sanctuaria						1								1
Ozyptila simplex		65	5	2	2	67	3	15	5	17	5	27	48	261
Pachygnatha degeeri	7	35	8	1		201	59	797	15	30	1	31	47	1232
Pachygnatha clercki		3	6	15	2	1	6	39	6	2	9	9	1	99
Pardosa lugubris			1											1
Pardosa monticola	798	61	47	16	11		1	5	14	6	7		7	973
Pardosa nigriceps	18	130	1	2	1	165	22	25	6	4	2	2	1	379
Pardosa palustris	11	57	9	9							4		1	91
Pardosa pullata	29	123	2	4	1	8		2	2	1	1	4	4	181
Pardosa purbeckensis	3	44	319	818	590	2	2	270	367	57	306	454	120	3352
Pelecopsis nemoralis						1	29	3		2			1	36
Pelecopsis parrallelus	2	6		1					1					10
Pelecopsis radicicola	1												1	2
Philodromus cespitum						2								2
Phlegra fasciata	2	2						3					1	8
Pirata piraticus												1		1
Pisaura mirabilis						9	1						5	15
Pocadicnemis juncea						5	2	6	3					16
Poeciloneta globosa	1													1
Porrhomma microphthalmum	1			2			2	1	1		3	2		12
Prinerigone vagans										5	2	1	9	17
Robertus arundineti							3		1					4
Robertus lividus		2				14	3	2	1	3			2	27
Robertus neglectus							1							1
Stemonyphantes lineatus	29	74	5	73	1	33	82	24	2	5	5	6	1	340
Silometopus ambiguus	3	28	109	44	3									187
Sitticus saltator	8													8
Tapinocyba praecox	4	12				25	2							43
Tegenaria agrestis	24	1					7	1						33
Tegenaria atrica	8	1					3					1	1	14
Tetragnatha extensa							1							1
Thanatus striatus	3	2				1		4			2			12
Theridion bimaculatum							1							1
Tibellus maritimus							8		1					9
Tibellus oblongus							1					1		2
Tiso vagans	3	30	2			143	2	7		1	1			189
Trichopterna cito	59	2												61
Trichopterna thorelli									2					2
Trochosa ruricola	10	32	8			22	48	115	29	23	6	10	61	364
Trochosa terricola	76	213	2		1									292
Troxochrus cirrifrons						3	8	1						12
Troxochrus scrabiculus						39	33	5				1		78
Typhocrestes digitatus	12				1									13
Walckenaeria acuminata	4	1				8	2							15
Walckenaeria antica	2	8				14								24
Walckenaeria atrotibialis		10												10
Walckenaeria capito	5													5
Walckenaeria monoceros	54	8												62
Walckenaeria nodosa		1												1
Walckenaeria stylifrons	36													36
Xerolycosa miniata	13	3												16
Xysticus cristatus	17	43	1			22	1	6	1	9		2	4	106
Xysticus erraticus	1													1
Xysticus kochi	37	18	1							8	5		4	73
Zelotes electus	91	138	25	1	3	25	2	2					5	292
Zelotes latreillei	1													1
Zelotes longipes	5													5
Zelotes pedestris	3	2		1		19								25

are active from April to September with a peak in May/June.

Pardosa purbeckensis occurs only in the salt marshes of England, the Netherlands, Denmark and Germany.

The salt marshes around the Mont Saint Michel (France) are instead inhabited by *Pardosa monticola* (FOUILLET, 1988), a species known to be xerophilic in our region and occurring in our dunes (see species list of the old Zwin dune).

Silometopus ambiguus

This species was only found in the "Zwin" area, both in the saline and in the drier environments but with a clear preference for the saline ones. Males seem to be active from February to June, but some specimens were caught in October and December, suggesting hibernation as adult.

Red list species

MAELFAIT *et al.* published in 1998 a red list for the spiders of Flanders. According to this list there are:

* in the Zwin area 4 critical species (the typical salt marsh species *Baryphyma duffeyi, Pardosa purbeckensis, Argena patula and Silometopus ambiguus*), 16 endangered species, 11 vulnerable species, 2 rare geographical restricted species and 3 indeterminate species;
* in the Yzer area 5 critical species (the 3 typical salt marsh species as in the Zwin plus *Allomengea scopigera* and *Erigone promiscua*, a typical dune species of dry ologotrophic grasslands with patches of bare sand), 15 endangered species, 11 vulnerable species, 2 rare geographically restricted species and 1 indeterminate species.

Critical are those species that became very rare in our region due to a drastic reduction of their habitats. These species will go extinct if the causal factors for that habitat loss continue operating.

As endangered are those species that are rare because of extensive deterioration and destruction of their habitats.

As vulnerable are those species that became quite uncommon because of their habitat loss during the past decades.

Rare geographically restricted species are species for which Flanders lays at the northern, southern or western limit of their geographical range.

Indeterminate species are species of which not enough information is available to decide in which of the former categories they belong.

Conclusions

The above given results show the outstanding importance of the two sampled saltmarsh areas for the conservation of stenocious spider species bound to these coastal habitats and thus the overall biodiversity of the region.

Acknowledgements

Many thanks are due to Mrs. Rudy CLAUS, Guy HAGHEBAERT and Konjev DESENDER for their valuable help with field work. We are also much indebted to Guido BURGGRAEVE, conservator of the "Zwin" reserve, and Jean-Louis HERRIER, administrator AMINAL.

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L. BAERT
Koninklijk Belgisch Instituut voor Natuurwetenschappen
Department of Entomology
Vautierstraat 29, B-1000 Brussel

J.-P. MAELFAIT
Instituut voor Natuurbehoud
Kliniekstraat 25, B-1070 Brussel
Laboratorium voor Ecologie
Ledeganckstraat 35, B-9000 Gent