Periphytic rotifers in standing waters (Flanders, Belgium) – relations to environmental characteristics

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The distribution and ecology of periphytic rotifers has drawn far less attention than their occurrence in the plankton. Based on a regional survey, we present a first general account of the main communities occurring in standing fresh waters of lower Belgium and explore some apparent autecological characteristics.

Material & methods

Samples: 184 samples were collected from permanent water bodies, selected to cover the range of freshwater conditions in the region (Figure 1); special attention was given to less impaired sites. Most are shallow, small (max. 73 ha) and (hyper)eutrophic (Figure 1). A single sample was collected from May to June in 1998 or 1999, consisting of a balanced mixture of the available submerged plant substrates. *Abundance*: percentages were calculated from counts of 200 (only 150 in one case) to 786 individuals (excl. unidentifiable bdelloids) and with additional taxa added as single individuals (300 ± 53 specimens). *Environmental data*: dimensions (8 variables), water chemistry (28 variables; measured 3-6 times), metabolic and phytoplankton measures (6 variables, 3-5 times), vegetation (4 variables), soil texture and land-use in a 50 m buffer zone (19 variables), isolation (1 variable, number of standing waters within 500 m). Medians and, for some variables, maxima, are used for multiple measurements and log transformation applied to attain a more normal distribution if required.

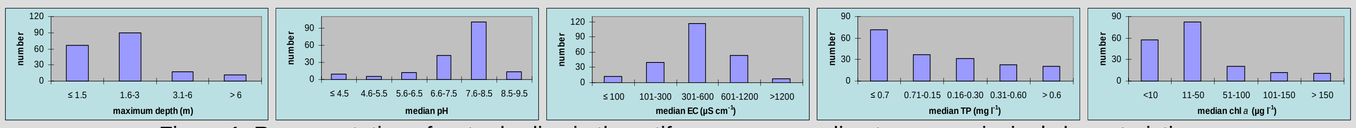


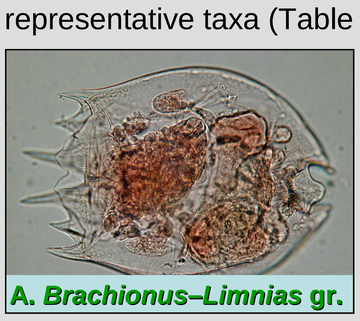
Figure 1. Representation of water bodies in the rotifer survey according to some principal characteristics.

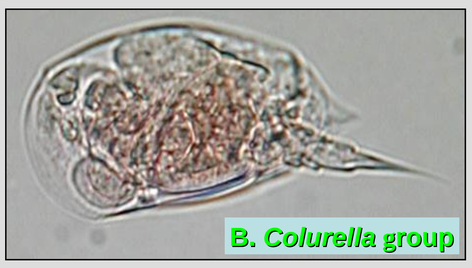
1. Community composition

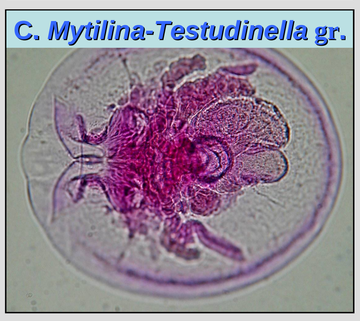
The complete species inventory includes 216 taxa, next to unidentified Bdelloidea. Four major communities can be distinguished (minimum variance clustering with relative Euclidean distance), named for convenience after their most representative taxa (Table 1).

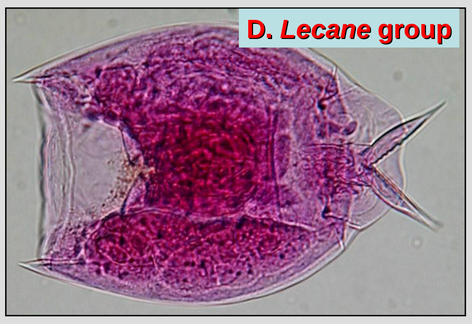
	ABUNDANCE				FREQUENCY				IndVal (p ≤ 0.05)			
main group	**D**	**C**	**B**	**A**	**D**	**C**	**B**	**A**	**D**	**C**	**B**	**A**
number of subgroups	5	5	7	7	5	5	7	7	5	5	7	7
number of sites	39	52	54	39	39	52	54	39	39	52	54	39
Aspelta circinator	**97**	-	3	-	**21**	-	2	-	**20**	-	-	-
Euchlanis meneta	**98**	1	1	-	**26**	2	2	-	**25**	-	-	-
Lecane luna	**83**	1	9	7	**85**	33	33	38	**70**	-	3	3
Lecane stichaea	**100**	-	-	-	**51**	-	-	-	**51**	-	-	-
Taphrocampa annulosa	**95**	1	1	2	**38**	4	4	8	**37**	-	-	-
Lecane flexilis	**58**	4	13	25	**72**	19	31	23	**42**	1	4	6
Lecane tenuiseta	**62**	12	21	6	**44**	15	17	10	**27**	2	3	1
Dicranophorus luetkeni	**75**	25	-	-	**28**	4	-	-	**21**	1	-	-
Cephalodella gracilis	**77**	6	14	3	**44**	21	22	8	**33**	1	3	-
Lepadella acuminata	**50**	24	26	-	**44**	**44**	17	3	**22**	11	4	-
Mytilina ventralis	7	**88**	2	3	8	**42**	6	10	1	**37**	-	-
Mytilina mucronata	-	**93**	6	-	5	**67**	11	3	-	**63**	1	-
Lepadella quadricarinata	10	**78**	10	2	13	**42**	20	5	1	**33**	2	-
Colurella uncinata	13	**63**	20	4	18	**50**	15	10	2	**32**	3	-
Lepadella ovalis	4	**67**	27	2	15	**75**	30	10	1	**51**	8	-
Testudinella patina	10	**56**	13	21	28	**94**	46	67	3	**53**	6	14
Trichocerca rattus	6	**52**	25	17	13	**62**	26	31	1	**32**	6	5
Lecane closterocerca	16	**32**	**34**	18	64	**94**	93	77	11	**30**	**32**	13
Cephalodella segersi	1	35	**61**	3	8	**52**	**44**	15	-	18	**27**	-
Cephalodella sterea	7	10	**69**	14	26	35	41	36	2	3	**28**	5
Euchlanis deflexa	6	16	**64**	14	10	31	**43**	28	1	5	**27**	4
Euchlanis dilatata	-	8	**89**	2	5	**40**	**50**	23	-	3	**45**	-
Colurella adriatica	1	12	**75**	11	8	50	**89**	51	-	6	**67**	6
Proales fallaciosa	7	7	**76**	11	21	21	**43**	15	1	1	**32**	2
Cephalodella hoodii	16	8	**56**	19	23	25	37	23	4	2	**21**	4
Cephalodella sp. A	3	6	25	**66**	10	15	22	**41**	-	1	6	**27**
Collotheca sp.	7	21	18	**54**	28	29	33	**59**	2	6	6	**32**
Brachionus quadridentatus	-	9	15	**76**	8	27	28	**62**	-	2	4	**47**
Brachionus urceolaris	-	4	19	**77**	-	8	17	**28**	-	-	3	**22**
Limnias ceratophylli	6	1	2	**91**	5	10	17	**49**	-	-	-	**44**
Trichocerca similis	15	1	1	**83**	18	2	4	**26**	3	-	-	**21**

Table 1. Most characteristic taxa of the four cluster groups according to Indicator Value Analysis (only taxa with p ≤ 0.05 and IndVal > 20 are shown).









Free-living periphytic species are most abundant in all four groups (Figure 2A); sessile taxa (*Collotheca*, *Limnias*) are somewhat better represented in group A, which possibly reflects substrate differences or availability of food particles. The periphytic community is largely microfagous (Figure 2B), feeding mainly on bacteria and detrital matter (Figure 2C). The bulk consists of bdelloid species; predators are slightly more common in the *Colurella* group.

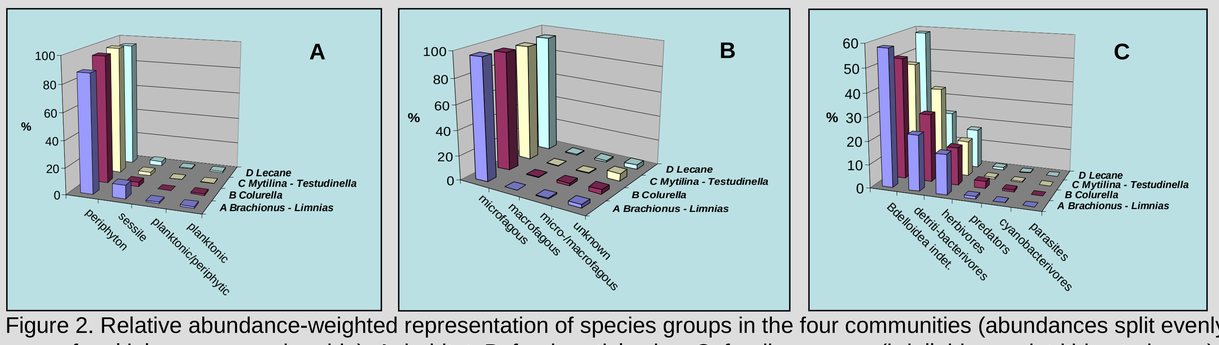


Figure 2. Relative abundance-weighted representation of species groups in the four communities (abundances split evenly in case of multiple group membership); A. habitat, B. food-particle size, C. feeding groups (bdelloids are detriti-bacterivores).

2. Geographic distribution

Except for the *Lecane* group, which only occurs in regions with carbonate and nutrient-poor cover sands, distribution patterns in relation to major physiogeographic regions are not apparent at this level of aggregation (Figure 3).

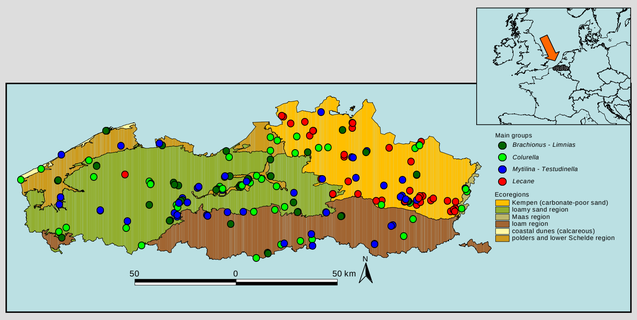


Figure 3. Distribution of sampling sites and the four community types.

4. Species response to environmental variables

We use Huisman-Olff-Fresco-models (HOF) to examine the response of individual taxa to selected variables. A large majority shows a unimodal distribution with respect to pH and DIC (Table 3). At least ¼ appears to be insensitive to variables related to trophic status and organic load, such as potential net oxygen production, TP or COD, although a symmetric relation is most common for the latter. One in three taxa declines or increases monotonically with TP.

response model	pH	log DIC	log pGOP	log $TP_{max.}$	log COD
no response	8.1	14.9	29.7	27.0	25.7
increase/decrease	17.6	27.0	14.9	32.4	8.1
increase/decrease to plateau	1.4	-	-	4.1	-
skewed symmetric	48.6	40.5	36.5	24.3	35.1
symmetric	24.3	14.9	18.9	10.8	31.1

Table 3. Proportion of taxa showing no or an increasingly complex significant relation to selected variables (p ≤ 0.05; only taxa with at least 10 occurrrences are tested).

To discriminate the best indicators, taxa are arranged by their optimum and tolerance to specific variables. For instance, the association of *Euchlanis meneta* with extremely low pH suggests that it may serve as an acidification indicator, while *Brachionus quadridentatus* and *Rotaria neptunia* are favoured by high phytoplankton concentrations (Figure 5). Species with conspicuously low optima for organic matter (COD) appear to be absent from more alkaline waters.

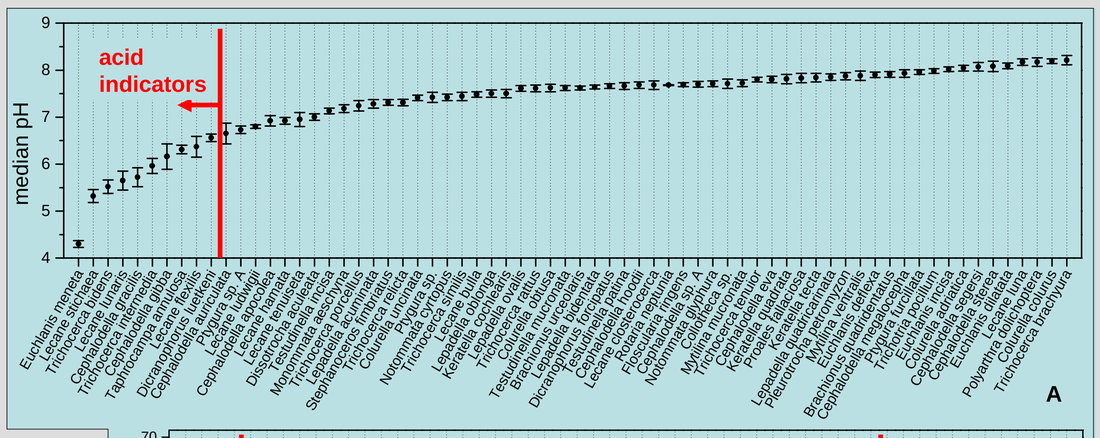


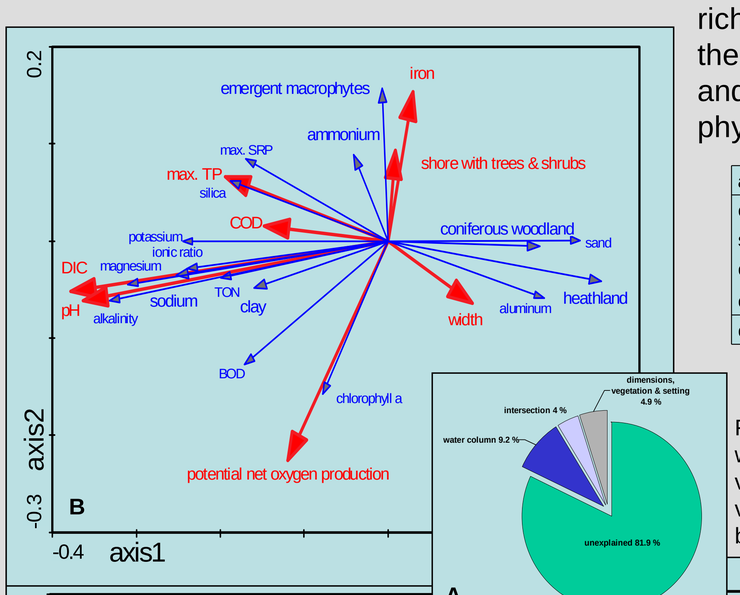
Figure 5. Taxa arranged by increasing weighted-average optimum for A. median pH, B. median COD and C. median potential net oxygen production (back-transformed values with tolerances; only taxa with at least 10 occurrences and a significant relation to the variable of interest according to HOF analysis).

3. Environmental relations – important variables

The data set is heterogenous and sparse. Consequently, CCA captures only a small amount of the variation in species composition (Table 2). Variance partitioning indicates that water chemistry variables are most influential (Figure 4A), with particularly variables reflecting pH/buffering status, but also trophic status and phytoplankton abundance, exerting stronger effects (Figure 4B). Larger, less nutrient-rich and lower pH waters are the preferred habitat of the *Lecane* group, whereas the *Brachionus – Limnias* and *Colurella* communities generally occur in more phytoplankton-rich conditions (Figure 4C-D).

all groups	axis 1	axis 2	axis 3	axis 4
eigenvalues	0.23	0.13	0.08	0.07
species-environment correlation	0.88	0.77	0.78	0.71
cumulative % species variance	5.2	8.1	10.0	11.6
cumulative % species-environment relation	28.4	44.8	55.1	64.1
canonical/unconstrained eigenvalues	0.80/4.41			

Table 2. Results of CCA with all 184 samples.



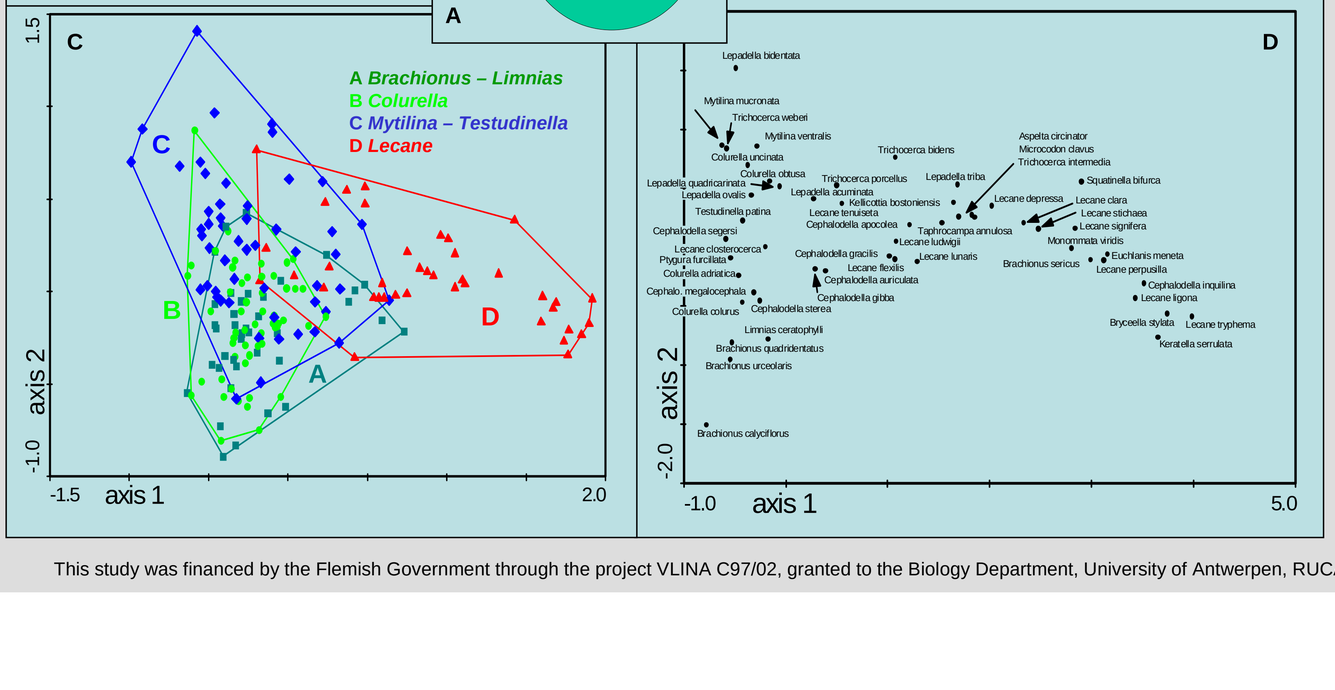


Figure 4. Results of variance partioning by means of partial CCA with forward-selected (p ≤ 0.05) water column vs. non-water column variables (A) and ordination plots for variables (B; forward-selected variables with Bonferroni adjustment in red, passive variables in blue), samples with species groups (C) and selected taxa (D).

5. Taxonomic richness

Species richness is rather similar for the four communities (Figure 6). It is positively related to diversity of obligate wetland plants, reflecting habitat (and sample) heterogeneity, whereas a negative correlation occurs with ionic concentration (Figure 7).

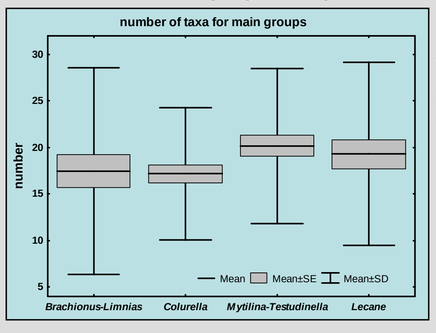


Figure 6. Box plots of the number of taxa per sample for the four communities.

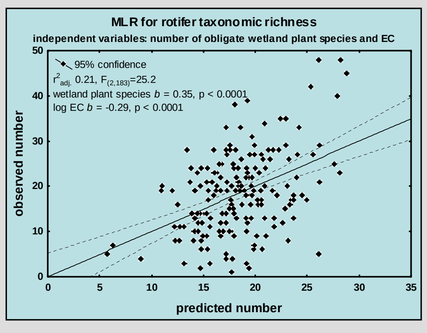


Figure 7. Results of MLR (forward selection) for the number of taxa per sample.

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