SOME ECOLOGICAL PECULIARITIES OF *ANISUS VORTICULUS* (TROSCHEL 1834) (GASTROPODA: PLANORBIDAE) IN NORTHEAST GERMANY

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Abstract *During the EU Habitats Directive monitoring between 2008 and 2010 the ecological requirements of the gastropod species* Anisus vorticulus *(Troschel 1834) were investigated in 24 different waterbodies of northeast Germany. 117 sampling units were analyzed quantitatively. 45 of these units contained living individuals of the target species in abundances between 4 and 616 individuals m^{-2}. More than 25.300 living individuals of accompanying freshwater mollusc species and about 9.400 empty shells were counted and determined to the species level. Altogether 47 species were identified. The benefit of enhanced knowledge on the ecological requirements was gained due to the wide range and high number of sampled habitats with both obviously convenient and inconvenient living conditions for* A. vorticulus. *In northeast Germany the amphibian zones of sheltered mesotrophic lake shores, swampy (lime) fens and peat holes which are sun exposed and have populations of any* Chara *species belong to the optimal, continuously and densely colonized biotopes. The cluster analysis emphasized that* A. vorticulus *was associated with a typical species composition, which can be named as "*Anisus-vorticulus*-community". In compliance with that both the frequency of combined occurrence of species and their similarity in relative abundance are important. The following species belong to the "*Anisus-vorticulus*-community" in northeast Germany:* Pisidium obtusale, Pisidium milium, Pisidium pseudosphaerium, Bithynia leachii, Stagnicola palustris, Valvata cristata, Bathyomphalus contortus, Bithynia tentaculata, Anisus vortex, Hippeutis complanatus, Gyraulus crista, Physa fontinalis, Segmentina nitida and Anisus vorticulus. *Six other species could be assigned as "facultative members" of the "*Anisus-vorticulus*-community".*

Key words Anisus vorticulus, *Planorbidae, EU Habitats Directive, ecological requirements, community, northeast Germany*

INTRODUCTION

The "Little Whirlpool Ramshorn Snail" (in German: Zierliche Tellerschnecke) *Anisus vorticulus*, listed as an endangered species in Germany and in most other European countries is primarily confined to Europe (Fig. 1). The species occurrence ranges from France in the west to the Ukraine and European Russia in the east. The distribution area reaches northwards to southern Scandinavia and southwards to the Mediterranean watershed (see Terrier *et al*., 2006 for more details on distribution). In most European countries extinction and decreasing population densities have been observed. This dramatic change led to the consideration of the species for inclusion within the EU Habitats Directive (expansion, 2004) (Colling & Schröder, 2006; Zettler & Wachlin, 2010). Both in Annex II (species of community interest requiring special areas for conservation) and in Annex IV (strict protection) this species is listed. Due to the smallness and rareness of this snail the knowledge on autecology and environmental requirements is limited. A couple of recently published papers deal with distribution, first records, threats and information on living conditions (e.g. Beran, 2009; Castella *et al*., 2005; Girardi, 2009; Shardlow, 2009). More extensive studies on the biology of *A. vorticulus* were carried out in the southern and southeastern England motivated by the UK Biodiversity Action Plan and the UK Red Data Book in the end of 1990s (Killeen & Willing, 1997; Willing & Killeen, 1998; Willing, 1999; Willing & Killeen, 1999) and later on (Watson & Ormerod, 2004, Niggebrugge *et al*., 2007). On the more global scale Terrier *et al.* (2006) summarized the available literature data about the species, including identification, environmental requirements, life cycle, dispersal, food, geographic distribution and threats and provided a good overview. Afterwards only the studies of Glöer & Groh (2007) for the German locations, Uvayeva & Hural (2008) for the Ukrainian locations and Myzyk (2008) for the laboratory investigations have delivered detailed autecological information.

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The present study has the objectives to 1) expand the knowledge on the distribution of

Figure 1 *Anisus vorticulus* from the Lake Mellen (Brandenburg) (Photo: Zettler).

this rare species, 2) to show some environmental requirements in northeast Germany and 3) to clarify and define the "*Anisus-vorticulus*-community". Therefore about 117 sampling units in 24 populations (waterbodies) of northeast Germany were sampled quantitatively in 2008, 2009 and 2010. All accompanying freshwater mollusc species were determined and quantified.

Material and Methods

The study area is located in northeast Germany in the Federal states of Mecklenburg-West Pomerania and Brandenburg (Fig. 1). The 24 different waterbodies selected for this monitoring were those where *A. vorticulus* was recorded during the previous studies. The monitoring took place during the years 2008, 2009 and 2010 in different months (June to October, see Table 1). Each location was sampled at 3 to 6 (normally 5) different stations (sampling units) distributed along the shoreline or at the area regularly in respect to the quantitative occurrence of *A. vorticulus* and accompanying freshwater molluscs. It was attempt to sample the representative habitats with high probability of occurrence of the target species. At each station a frame of 0.5×0.5 m was used to encircle the sampling unit.

These units (freshwater areas) were sampled using a pole-mounted 20 cm diameter sieve with a 1 mm mesh. This was used to sweep (tenfold) the whole area (water, plants and sediment). Employment of ten-sweeps per unit (station) allowed approximately quantitative comparisons of mollusc populations between sites (see also Killeen & Willing, 1997). The samples were collected in a plastic box and afterwards placed in a labelled bag. After a few weeks the samples

Table 1 Summary of all sampled locations during the monitoring between 2008 and 2010

Location	Water type	Dominant habitat	Trophic level	Date	Area (ha)	Sampling units
Kleiner Plessower See (BB)	lake (bog)	reed	oligo-	15.09.2008	14,8	5
Moorkomplex Gühlen (BB)	fen (lime)	sedges/ferns	meso-	15.09.2008	2	5
Flacher Clöwen (BB)	lake (forest)	reed	meso-	16.09.2008	13	5
Kleiner Baberowsee (BB)	lake (bog)	reed	oligo-	16.09.2008	1,5	5
Hölzerner Krug (BB)	fen (lime)	characeans	oligo-	16.09.2008	1	5
Seechen am Beutelsee (BB)	fen (lime)	characeans	oligo-	17.09.2008	3	5
Stübnitzsee (BB)	lake (forest)	reed	meso-	17.09.2008	4,9	5
Mellensee (BB)	lake (bog)	characeans	meso-	17.09.2008	12	5
Teufelssee (BB)	lake (forest)	reed	meso-	18.09.2008	5	5
Mittl. Giesenschlagsee (BB)	lake (glacial)	characeans	meso-	18.09.2008	1	5
Unter. Giesenschlagsee (MV)	lake (glacial)	reed	meso-	06.06.2009	2,8	5
Kleiner Barschsee (MV)	lake (forest)	sedges/ferns	oligo-	22.06.2009	2	3
Großer Barschsee (MV)	lake (forest)	sedges/ferns	oligo-	22.06.2009	2	3
Bürgermeistersee (MV)	lake (glacial)	reed	meso-	22.06.2009	1	5
Rugia Peat hole 400 (MV)	peat hole	sedges/ferns	oligo-	25.07.2009	1,5	5
Rugia Peat hole 700 (MV)	peat hole	water moss	meso-	25.07.2009	2	5
Wölzensee (BB)	lake (glacial)	sedges/ferns	meso-	17.10.2009	7,9	5
Wittwesee (Südbucht) (BB)	lake (glacial)	reed	meso-	17.10.2009	7,8	5
Drewitzer See (MV)	lake (glacial)	reed	meso-	07.07.2010	1000	5
Krummer See (MV)	lake (glacial)	reed	eu-	19.08.2010	30	5
Mühlensee (MV)	lake (glacial)	reed	meso-	20.08.2010	45	5
Kalkflachmoor Degtow (MV)	fen (lime)	sedges	oligo-	30.08.2010	2	6
Röggeliner See (MV)	lake (glacial)	reed	eu-	30.08.2010	170	5
Peenewiesen Gützkow (MV)	peat hole	characeans	oligo-	08.09.2010	1	5

were dried in open boxes and then a sieving procedure was carried out. Two sieves were used: a 5 mm sieve to retain rough vegetation material and larger mollusc species (detected visually and extracted by hand); and a 1 mm sieve to retain the smaller species. The latter residue was sorted in the laboratory under a stereomicroscope with 10–40x magnification. In both sieve residuals attention was paid to specimens adhering to vegeation. The mollusc samples were identified to species level. All individuals were identified, counted, and living organisms were differentiated from empty shells. In the field specimens from the genus *Stagnicola* were fixed in ethanol separately and later on determined anatomically.

For community analysis a hierarchical clustering procedure was carried based on Bray-Curtis similarity of species abundance data (PRIMER-Software, Clarke & Warwick, 2001).

RESULTS

During the monitoring from 2008 to 2010 more than 25,300 living individuals of freshwater mollusc species and about 9.400 empty shells from 24 different waterbodies in northeast Germany were counted and determined to species level (see Table 2). Altogether 47 species were identified. In 18 waterbodies positive records of *A. vorticulus* were obained and in 6 this species was not found. It should be noted that in previous studies at the 24 locations *A. vorticulus* had been detected at all stations (e.g. Müller & Meier-Brook, 2004; Zettler *et al.*, 2006; Zettler, 2008). Nevertheless, in the current monitoring project only results of the 117 sampling units were analyzed. 45 of these units contained living individuals of the target species in abundances between 4 and 616 individuals m^{-2} (see Table 3). The total number and abundance of all freshwater mollusc species and their diversity (Shannon-Wiener Index) varied widely but was not significantly different between units with or without *A. vorticulus* (Table 2 and 3). Due to the wide range and high number of sampled habitats some knowledge on the ecological requirements of *Anisus vorticulus* were gained.

Both apparently optimal and suboptimal habitats/substrates of *A. vorticulus* were

Table 2 Freshwater mollusc species number and counted specimens (alive and empty) at each locality during the monitoring between 2008 and 2010 are listed. The recent occurrence of *Anisus vorticulus* (only within this study) is indicated.

Location	Freshwater species	Counted living individuals	Counted empty shells	*Anisus vorticulus*
Kleiner Plessower See (BB)	24	2192	1424	yes
Moorkomplex Gühlen (BB)	23	902	518	yes
Flacher Clöwen (BB)	21	323	79	no
Kleiner Baberowsee (BB)	22	424	244	yes
Hölzerner Krug (BB)	17	2548	576	yes
Seechen am Beutelsee (BB)	20	2828	506	yes
Stübnitzsee (BB)	15	656	128	yes
Mellensee (BB)	28	1990	413	yes
Teufelssee (BB)	24	1920	405	yes
Mittlerer Giesenschlagsee (BB)	19	503	204	yes
Unterer Giesenschlagsee (MV)	26	372	72	yes
Kleiner Barschsee (MV)	22	699	426	yes
Großer Barschsee (MV)	24	566	360	yes
Bürgermeistersee (MV)	26	1122	475	yes
Rugia Peat hole 400 (MV)	21	826	220	yes
Rugia Peat hole 700 (MV)	24	639	263	yes
Wölzensee (BB)	21	561	232	yes
Wittwesee (Südbucht) (BB)	19	371	80	no
Drewitzer See (MV)	32	812	309	no
Krummer See (MV)	18	1767	711	no
Mühlensee (MV)	26	414	211	no
Kalkflachmoor Degtow (MV)	17	717	266	yes
Röggeliner See (MV)	26	1613	1028	no
Peenewiesen Gützkow (MV)	26	537	279	yes
In total	**47**	**25302**	**9429**	

Table 3 The total abundance, species number and the Shannon Wiener index for the freshwater mollusc species differentiated between localities with and without the occurrence of *A. vorticulus* is listed. Also the range of density for *A. vorticulus* is given.

	With *A. vorticulus*	Without *A. vorticulus*
Total abundance (ind. m^{-2})	144–3420	68–3944
Species number	8–19	3–21
Shannon Wiener (log2)	1,95–3,57	0,89–3,65
Abundance of *A. vorticulus* (ind. m^{-2})	4–616	–

sampled. It was noted that in all where the habitat appeared suitable the adjacent waters were always clear and oligotrophic to mesotrophic. Furthermore only very shallow waters (0 to 0.5 m) were found to be occupied by *A. vorticulus*. Amphibian zones of sheltered shores or swampy calcareous fens which are sun exposed and have populations of *Chara* appeared to be optimal, continuously and densely colonized biotopes. Here abundances of several hundred individuals per square meter were recorded. The sediment varied between peaty and compact vegetation fixed muddy sand. Another suitable biotope, but with decreased abundances, were the same shore type but with overhanging sedges (*Carex*) and ferns (*Thelypteris*). The sediment was muddier, and covered with leaf and decayed plant material. Here several tens of individuals per square meter were observed. A third suitable biotope was in open reed beds (*Phragmites*) with low densities of stems. The sediment here was sandy, without strong shading and sometimes with higher levels of submerged macrophytes (e.g. *Chara*) between emergent stems. Here the abundances ranged between single records and 30 individuals m^{-2}. In shaded and cool swampy alder (*Alnus*) carr with small water bodies and muddy substrates,

Figure 2 Investigation area in northeast Germany with 24 sampled locations.

A. vorticulus was never observed. Also, strongly shaded lake shores with marginal trees and thick leaf covering of the sediment were avoided. Denser *Phragmites* beds with little light reaching the bottom, with oxygen deficiency in the sediment or the absence of submerged macrophytes was not colonized by *A. vorticulus*.

Results of the cluster analysis emphasized that *A. vorticulus* was typically found in association with other species, which can be described as the "*Anisus-vorticulus*-community" (cluster "A" in Fig. 3). Both the frequency of combined occurrence of particular species and their similarity in relative abundance terms were used to support this concept. In the case of high *A. vorticulus* density at a site the probability of occurrence of associated species (cluster "A" species) and their density were also high. The ecological requirements of species in cluster "A" are similar.

The following species belong to the "*Anisus-vorticulus*-community" (see Fig. 3 to 5): *Pisidium obtusale, Pisidium milium, Pisidium pseudosphaerium, Bithynia leachii, Stagnicola palustris, Valvata cristata, Bathyomphalus contortus, Bithynia tentaculata, Anisus vortex, Hippeutis complanatus, Gyraulus crista, Physa fontinalis, Segmentina nitida* and *Anisus vorticulus*. In the neighbouring cluster "B" (see Fig. 3) six further species (*Acroloxus lacustris, Gyraulus riparius, Planorbis carinatus, Sphaerium corneum, Marstoniopsis insubrica* and *Gyraulus albus*) also showed a high similarity in frequency and abundance. Therefore these species could be assigned as "facultative members" of the "*Anisus-vorticulus*-community". In general, cluster "C" species co-occur with *A. vorticulus* at low frequency and low density (Fig. 4 and Fig. 5, respectively). Whereas cluster "A" species are the most *A. vorticulus*-associated and abundant species. It should be noted that all members of the "*Anisus-vorticulus*-community" do not necessarily find their optimum conditions within the same places as *A. vorticulus*. As an example, Fig. 6 shows the density of freshwater mollusc species at the nine most abundant *A. vorticulus* stations. It is clear that *V. cristata* and *P. pseudosphaerium* are the most common species at these localities. Other relevant species are the gastropods *S. nitida, B. tentaculata, G. crista* and *B. leachii*.

DISCUSSION

From a number of other studies we know that the species compositions of molluscan communities where *A. vorticulus* occurs are often very similar. Terrier *et al.* (2006) cited some of these studies. For example, in southern England Willing & Killeen (1998) and Willing (1999) observed *B. tentaculata, A. vortex* and *P. pseudosphaerium* frequently and abundantly associated with *A. vorticulus*. In general, the spectrum of mollusc species found was very comparable to the present study. Watson & Ormerod (2004), also in southern England, investigated the distribution of *A. vorticulus, S. nitida* and *V. macrostoma*. The authors pointed out the different small scale environmental requirements (e.g. oxygen, chloride, vegetation) of these three species and concluded confirming the pattern from PCA that the occurrence of none of these three species was significantly associated with any other. In the present study only at one locality in northeast Germany (Lake Plessow) a co-occurrence of these three species was observed. Glöer & Groh (2007) investigated 16 locations in southwestern and northern Germany (8 near Karlsruhe and 8 in Hamburg). *Valvata cristata* and *H. complanatus* (both cluster with the "A" species of the present

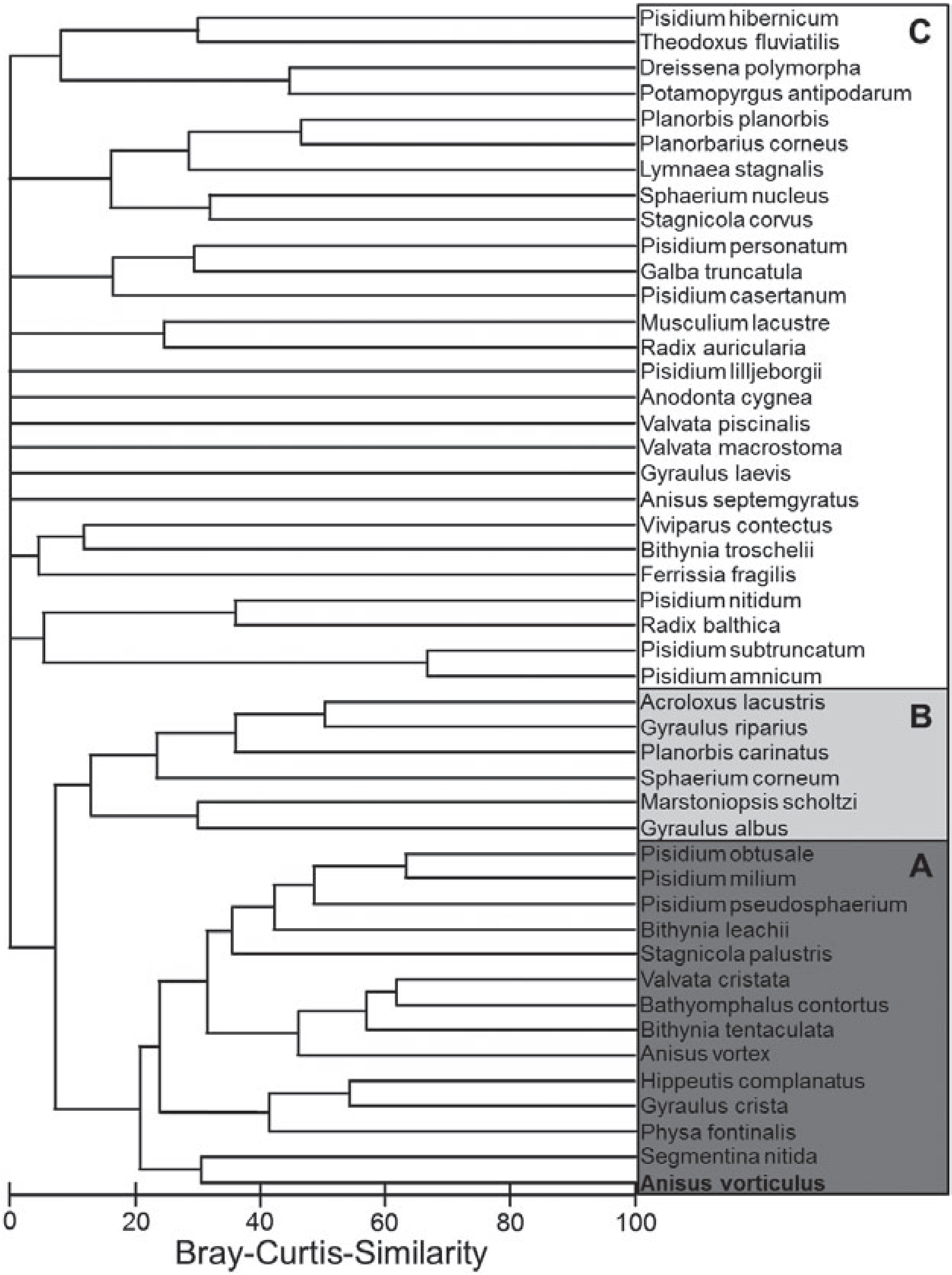

Figure 3 Cluster analysis (complete linkage) of the abundance of freshwater mollusc species (Bray-Curtis-similarity, abundance data transformed by square-root) of 117 sampling units. Only living individuals of all 47 observed species were considered. Three main clusters are indicated, whereof cluster "A" is named as "*Anisus vorticulus*-community".

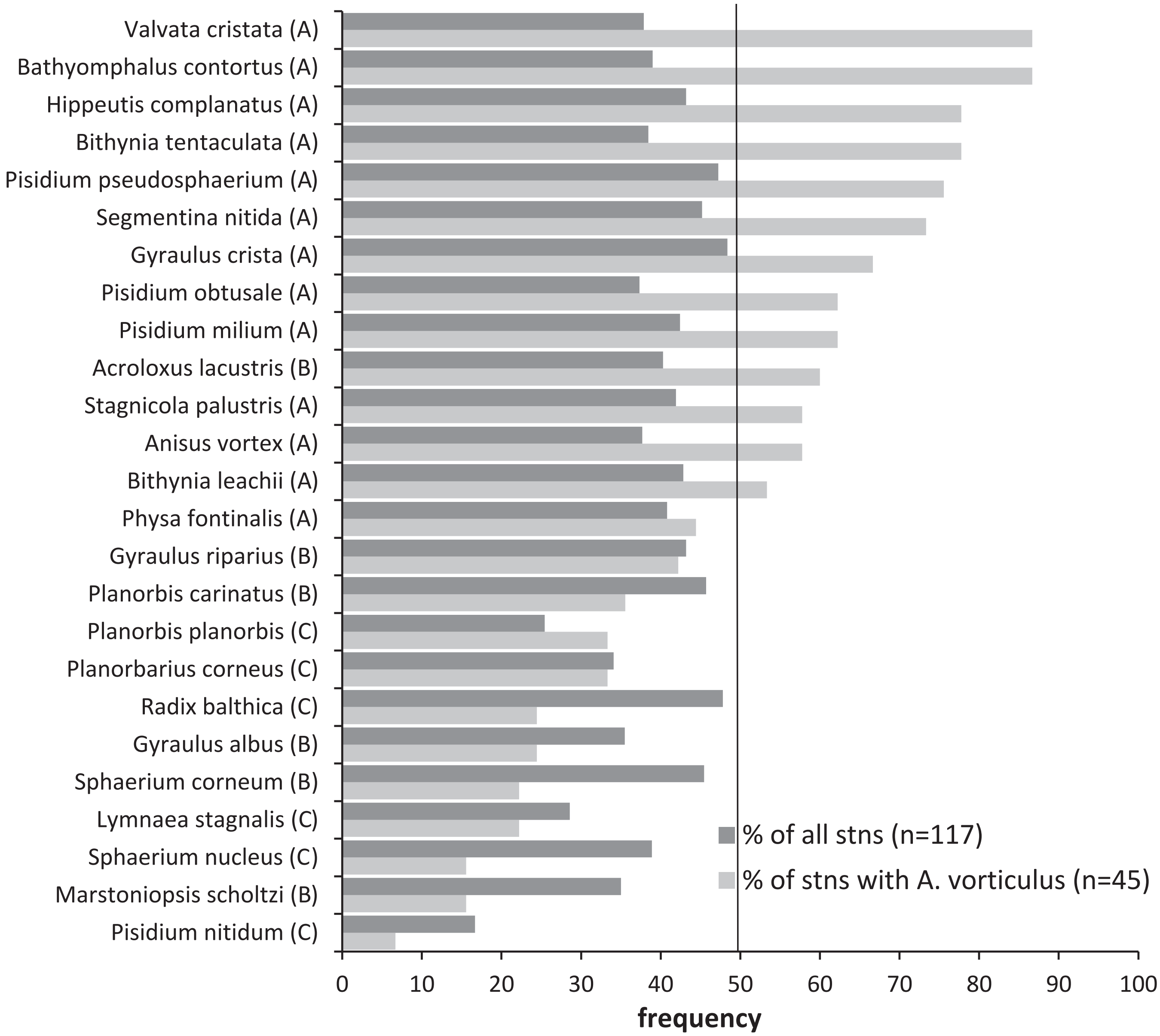

Figure 4 Frequency of freshwater mollusc species in respect of the occurrence of *Anisus vorticulus* in 117 sampling units. Only living individuals of species with more than 10 records and more than 200 counts were considered. The membership of three distinct clusters (see Fig. 3) is indicated by "A", "B" or "C".

study) were associated with *A. vorticulus* at more than two thirds of the sites in both regions. The latter was observed in densities up to 482 individuals m^{-2}. Other very common accompanying species in Hamburg were *B. leachii*, *S. corvus*, *L. stagnalis*, *P. fontinalis*, *P. corneus*, *P. planorbis*, *A. vortex*, *B. contortus*, *S. nitida* and *S. nucleus*. Near Karlsruhe very often *B. tentaculata* and *A. lacustris* completed the community picture. Both similarities are obviously confirmed by the present study. The dissimilarities are based mainly on differences in the investigated habitats. Whereas in Hamburg mainly lentic regions of rivers and canals were colonized, in Karlsruhe the main biotopes were pond-like oxbows behind dams (groundwater influenced). In the present study amphibian lake shore, calcareous fens and artificial peat holes were occupied by *A. vorticulus*. It has to be stressed that, as has already been mentioned by Glöer & Groh (2007), *A. vorticulus* occurs in many different habitat types (see above) but only a few of these represent optimum environmental conditions. In the optimal habitats densities between 50 and 100 m^{-2} and more could be observed regularly. In concordance with Watson & Ormerod (2004) in northeast

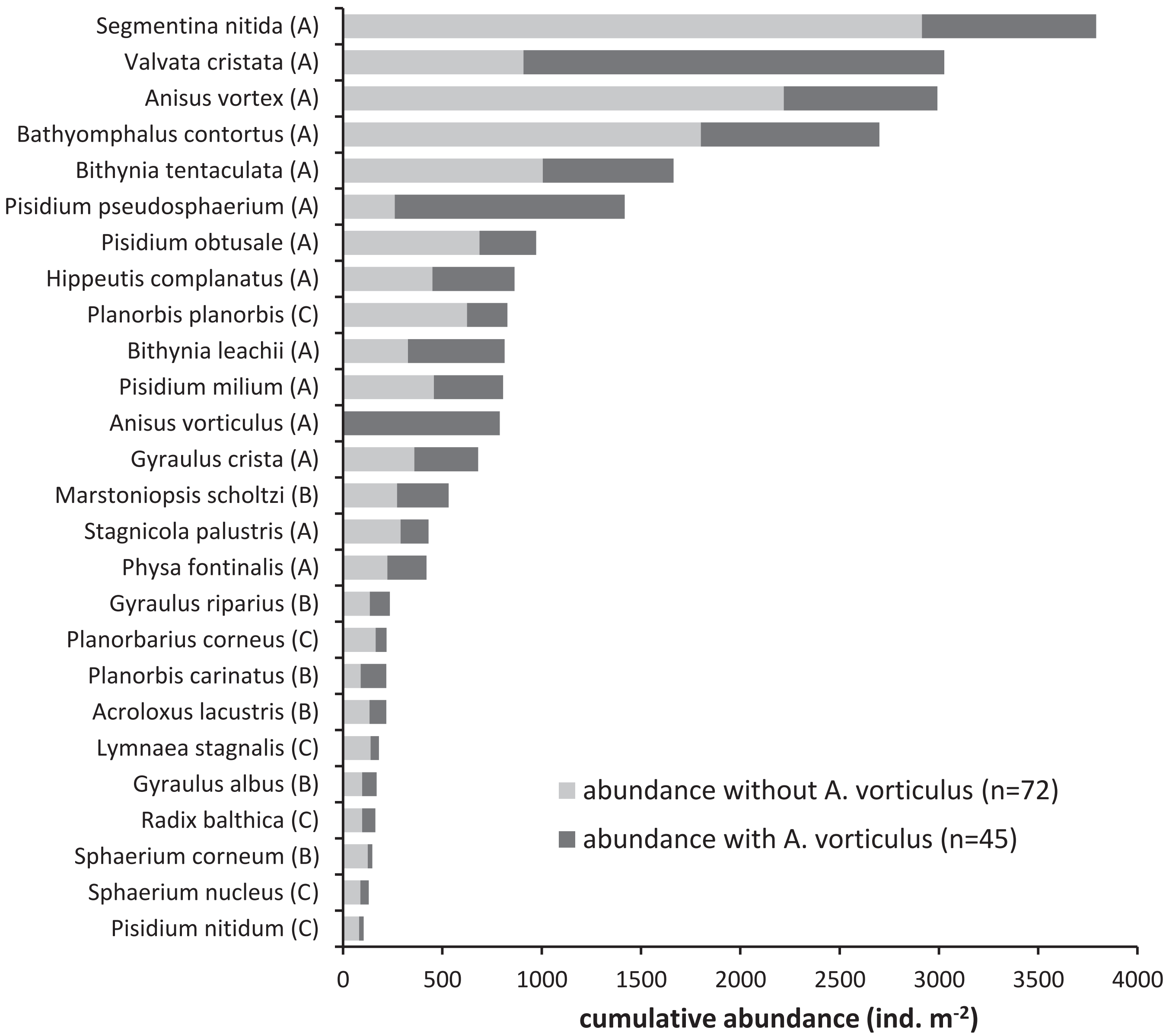

Figure 5 Density of freshwater mollusc species in respect to the occurrence of *Anisus vorticulus* in 117 sampling units. Only living individuals of species with more than 10 records and more than 200 counts were considered. The membership of three distinct clusters (see Fig. 3) is indicated by "A", "B" or "C".

Germany *A. vorticulus* occurred in swampy habitats with a range of vegetation structures representing high diversity and increased cover, particularly of amphibious plants. In deeper and more open waters *A. vorticulus* was not observed. An Ukrainian study pointed out that *A. vorticulus* is phytophilous (six associated plant species are listed) and is predominantly found at depths of between 5 and 30 cm during the summer season (Uvayeva & Hural, 2008). Several other investigations emphasized the close interconnection with plant species (Terrier *et al*., 2006) of both submerged and/or terrestrial origin. In northeast Germany it appears that either the amphibian zones of sheltered mesotrophic lake shores or swampy calcareous fens and peat holes which are sun exposed and have populations of any *Chara* species, can be described as optimal, and continuously and densely colonized biotopes. Several of these places were investigated over periods of 5 to 15 years.

Some of these optimal habitats are relatively undisturbed. At any rate, natural succession and development in these habitats have not led to a decrease or the disappearance of *A. vorticulus* in the past. Anthropogenically modified wetlands

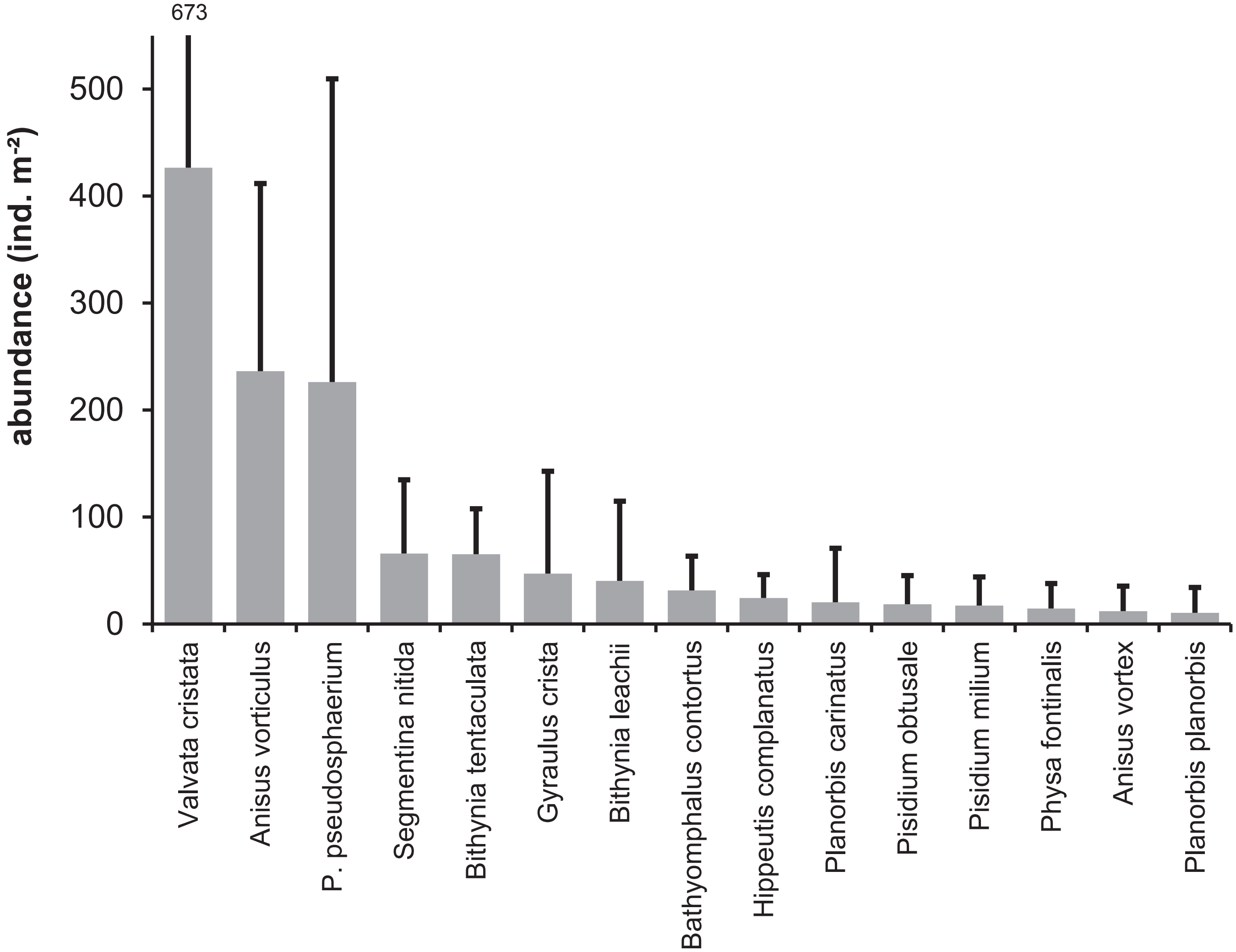

Figure 6 The mean density of freshwater mollusc at 9 sampling units with the highest abundances of *Anisus vorticulus* (> 90 individuals m^{-2}) during the monitoring project. Only living individuals of the most relevant species were considered. Standard deviation is indicated.

with ditches like most southern English habitats probably require a management strategy to maintain optimal conditions (see Glöer & Groh, 2007; Niggebrugge *et al.*, 2007; Willing & Killeen, 1999). In general, there is a need to expand knowledge on the autecology of *A. vorticulus*. It is insufficiently well known to allow for authoritative statements to be made on how to manage the species and its habitat to maintain healthy populations throughout its range (see Terrier *et al.*, 2006). The results of the present study, especially the definition of optimal habitats and the quantitative and qualitative information on the "*Anisus-vorticulus*-community" will serve as additional assessment criteria of *A. vorticulus* populations in northeast Germany in terms of the EU Habitats Directive (see Zettler & Wachlin, 2010).

ACKNOWLEDGEMENTS

Sincere thanks are given to Dr. Mayya Gogina (Rostock) for proof reading and comments. This project was supported by the Ministries for Environment of Mecklenburg-West-Pomerania and Brandenburg.

REFERENCES

BERAN L 2009 The first record of *Anisus vorticulus* (Troschel, 1834) (Gastropoda: Planorbidae) in Croatia? *Malacologica Bohemoslovaca* **8**: 70.

CASTELLA E, TERRIER A, PELLAUD M & PAILLEX A 2005 Distribution *d'Anisus vorticulus* (Troschel 1834) dans la plaine alluviale du Haute-Rhône francais. Un gastéropode Planorbidae listé en annexe de la "Directive habitats". *Bulletin Mensuel de la Société Linnéenne de Lyon* **74**: 255–269.

CLARKE KR & WARWICK RM 2001 *Change in marine communities: an approach to statistical analysis and interpretation*, second ed. PRIMER–E, Plymouth.

Colling M & Schröder E 2006 *Anisus vorticulus* (Troschel, 1834). *In* Petersen B & Ellwanger G Das europäische Schutzgebietssystem Natura 2000. Ökologie und Verbreitung von Arten der FFH-Richtlinie in Deutschland, Band 3: Arten der EU Osterweiterung. *Schriften reihe für Landschaftspflege und Naturschutz* **69**(3): 155–163.

Girardi H 2009 Supplément à la connaissance des Planorbes. Sur la présence *d'Anisus (Disculifer) vorticulus* (Troschel, 1834), en Camargue et dans la Petit Camargue, France. (Mollusca: Gastropoda: Planorbidae). *Documents Malacologiques, Hors-Série*. **3**: 35–36.

Glöer P & Groh K 2007 A contribution to the biology and ecology of the threatened species *Anisus vorticulus* (Troschel, 1834) (Gastropoda: Pulmonata: Planorbidae). *Mollusca* **25**: 33–40.

Killeen IJ 1999 Species recovery programme: 1998 Monitoring survey of ditches in East Anglia for the freshwater snail *Anisus vorticulus* (Troschel, 1834). English Nature Research Reports 331. 19 pp + annex.

Killeen IJ & Willing MJ 1997 Survey of ditches in East Anglia and South East England for the freshwater snails *Segmentina nitida* and *Anisus vorticulus*. English Nature Research Report 229: 1–20 and annex.

Müller R & Meier-Brook C 2004 Seltene Molluskengesellschaften im Litoral brandenburgischer Kleinseen. *Malakologische Abhandlungen* **22**: 57–66.

Myzyk S 2008 Life cycle of *Anisus vorticulus* (Troschel, 1834) (Gastropoda: Pulmonata: Planorbidae) in the laboratory. *Folia Malacologica* **16**: 207–215.

Niggebruge K, Durance I, Watson AM, Leuven RSEW & Ormerod SJ 2007 Applying landscape ecology to conservation biology: spatially explicit analysis reveals dispersal limits on threatened wetland gastropods. *Biological Conservaton* **139**: 286–296.

Shardlow M 2009 UK slow to implement protection of the little whirlpool ramshorn snail (*Anisus vorticulus*). *Tentacle* **17**: 18–19.

Terrier A, Castella E, Falkner G & Killeen IJ 2006 Species account for *Anisus vorticulus* (Troschel, 1834) (Gastropoda: Planorbidae), a species listed in annexes II and IV of the Habitats Directive. *Journal of Conchology* **39**: 193–205.

Uvayeva A & Hural R 2008 Pecularities of distribution and ecology of freshwater snails of the family Planorbidae (Gastropoda, Pulmonata) of Ukraine (in Russian). *Ruthenica* **18**: 25–38.

Watson AM & Ormerod SJ 2004 The microdistribution of three uncommon freshwater gastropods in the drainage ditches of British grazing marshes. *Aquatic Conservation: Marine and Freshwater Ecosystems* **14**: 221–236.

Willing MJ 1999 *Monitoring populations of* Anisus vorticulus *(the little whirlpool ramshorn snail) in West Sussex (May-November 1998)*. English Nature Research Reports 310. 26 pp.

Willing MJ & Killeen IJ 1998 *The freshwater snail Anisus vorticulus in ditches in Suffolk, Norfolk and West Sussex*. English Nature Research Report 287. 86 pp.

Willing MJ & Killeen IJ 1999 *Anisus vorticulus* – a rare and threatened water snail. *British Wildlife* **10**: 412–418.

Zettler ML 2008 Die Wassermollusken des Naturschutzgebietes "Drewitzer See mit Lübowsee und Dreiersee" in Mecklenburg. *Lauterbornia* **63**: 3–13.

Zettler ML, Jueg U, Menzel-harloff H, Göllnitz U, Petrick S, Weber E & Seemann R 2006 Die Land- und Süßwassermollusken Mecklenburg-Vorpommerns. Obotritendruck, Schwerin. 318 pp.

Zettler ML & Wachlin V 2010 Steckbriefe der in M–V vorkommenden Arten der Anhänge II und IV der FFH-Richtlinie: *Anisus vorticulus* (Troschel, 1834). Online at http://www.lung.mv-regierung.de/dateien/ffh_asb_anisus_vorticulus.pdf, accessed February 2012.