THE CHIRONOMID COMMUNITIES (PUPAL EXUVIAE) OF GROYNE FIELDS IN A LARGE LOWLAND RIVER IN CENTRAL EUROPE (ELBE, GERMANY) AND THEIR POTENTIAL USE FOR ECOTOXICOLOGICAL FIELD STUDIES

By CLAUS ORENDT[1*], GEORG WOLFRAM[2] & MECHTHILD SCHMITT-JANSEN[3]

With 2 figures

ABSTRACT: Chironomid pupal exuviae were collected along a stretch of the River Elbe (Germany) to test whether they indicated industrial pollution impacts on the river biota. The communities found were typical for a potamal river region. Among the 134 taxa recorded, *Nanocladius dichromus* (Kieffer 1906), *Cladotanytarsus vanderwulpi* (Edwards 1929), *Polypedilum acifer* Townes 1945, and *Rheotanytarsus rhenanus* Klink 1983 were dominant. Other potamal species, such as *Robackia demeijerei* (Kruseman 1933), *Saetheria reissi* Jackson 1977, and *Eurycnemus crassipes* (Meigen 1810), were less abundant. Several community parameters and species abundances showed no substantial pollution-related difference between the polluted sites and the reference, not even where conductivity jumped from 456 to 1778 µS cm^{-1} due to confluence of a tributary. It is concluded that the chironomid communities found are tolerant of the levels and kinds of pollution in the river stretch studied, and that differences between the sites may be caused by factors other than those known or measured here.

RESUMO: Pupas exuviae dos quiromídeos colhidos ao longo do curso do rio Elba (Alemanha) foram testadas como indicadores de poluição industrial e do seu impacto no biota do rio. As comunidades encontradas são típicas das zonas potáveis dos rios. Entre os 134 taxa detectados, *Nanocladius dichromus* (Kieffer 1906), *Cladotanytarsus vanderwulpi* (Edwards 1929), *Polypedilum acifer* Townes 1945, e *Rheotanytarsus rhenanus* Klink 1983 são as espécies dominantes. Outras espécies de águas potável, como por exemplo, *Robackia demeijerei* (Kruseman 1933), *Saetheria reissi* Jackson 1977, e *Eurycnemus crassipes* (Meigen 1810) parecem ser menos abundantes. Vários

[1] Orendt Hydrobiologie – WaterBioAssessment, Arndtstr. 63, 04275 Leipzig, Germany, orendt@hydro-bio.de (* Corresponding author).

[2] DWS Hydro-Ökologie, Consulting Engineers of Ecology, Zentagasse 47, A-1050 Vienna, Austria, georg.wolfram@dws-hydro-oekologie.at

[3] Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany, mechthild.schmitt@ufz.de

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parâmetros da comunidade e a abundância das espécies mostram não existir uma relação diferencial entre os sítios poluídos e os sítios amostrados, mesmo quando a condutividade salta de 456 para 1778 µS cm^{-1} devido à confluência de um afluente. Conclui-se que as comunidades de quiromídeos podem tolerar os níveis de poluição detectados ao longo do curso do rio e que as diferenças entre os sítios amostrados pode ser causada por outros factores diferentes daqueles monitorizados.

INTRODUCTION

The reactions of chironomid communities to different kinds of pollution have been addressed in several field studies. BROOKS *et al*. (2005), for example, studied the impact of copper smelting activities on the chironomid bottom fauna. Collecting pupal exuviae and adults RUSE *et al*. (2000) found species tolerant of, and others sensitive to, heavy metals. WRIGHT *et al*. (1996) showed that bio-assessment with the chironomid pupal exuviae technique is able to detect effects of chlordane on the water community. In a multi-stressed field situation, in contrast to experimental laboratory or mesocosm studies, the various chemical (and hydromorphological) pressures cannot be separated from each other easily (e. g. impact of acid vs. aluminium; see ORENDT, 1998) and often affect the communities in a synergistic manner. This makes it difficult to elucidate which single compound is responsible for a change in the system. A first answer to the question whether an aquatic system is seriously disturbed by chemical pollution can be derived from a comparison of the biota (e.g. of community structure and diversity) at an impacted and an unpolluted (= reference) site. The present study was performed at river sections of the River Elbe (Germany) differing in quantities and kinds of pollution in order to answer the following question: Are there obvious differences between the chironomid communities at sites impacted by different pollutants in the sediment?

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STUDY SITE

The section of the river Elbe studied is situated in the German lowland region of the catchment area, between river km 236 and km 320 (Saxonia-Anhalt). Along this stretch, pollution comes from several different sources, including severe impact from heavy metals and aromatic compounds over the past decades. Swimming was prohibited until 15 years ago. Most of the pollutants have been deposited in the sediments of the river channel and in the floodplains. However, there is still a significant flux of xenobiotic substances from the sediment to the water column.

The tributary River Mulde (confluence at km 263) delivers high loads of Arsenic (255 mg kg^{-1} in suspended sediments) and Cadmium (21 mg kg^{-1}), which indicates industrial activities. Downstream from the River Saale (at km 291), elevated concentrations of Mercury (6.63 mg kg^{-1}) were recorded, as was a higher conductivity (1778 µS cm^{-1} vs. 456 µS cm^{-1} upstream of the inflow). At Magdeburg (km 320), high concentrations of hexachlorbenzole (HCB) have been measured (89 µg kg^{-1}). High HCB levels were also found not far upstream of the reference site at Coswig (km 236; 219 µg kg^{-1}). Consequently, the situation there cannot be regarded as absolutely unimpacted with respect to HCB loads, as it can for the other compounds. The values for the pollutants mentioned (all are annual averages of data from EWQMA, 2003) are 10- to 20-fold above the natural geochemical background concentrations.

In terms of hydromorphology, the Elbe section studied is unregulated as regards its course. The shoreline characterized by transverse groynes at intervals from 100 to 200 m. The area between two groynes (= groyne fields) is the most important sedimentation area in the river channel (SUKHOLODOV *et al.*, 2004). This apparent uniformity or repetition in morphology is assumed to reduce the dominance of morphological habitat factors over chemical impacts. Substrates for chironomids were mainly sand (with different layers of organic matter) and, to a lesser extent, riparian grasses and stones.

MATERIALS AND METHODS

Pupal exuviae were sampled in May, July and September 2005) for a quick overview of the chironomid communities at potentially impacted sites. Exuviae were collected from 6 sites (river km 236, 263, 287, 291 left shore, 291 right shore, 320) close to the shoreline, where pupal skins accumulated or drifting was reduced. At each site, three successive groyne fields were sampled by pulling a hand net (250 µm mesh) for 8 minutes from one groyne to the next. Exuviae were preserved in 70% ethanol and counted in the lab under a stereomicroscope. For identification, the key of LANGTON & VISSER (2003) was used. The results are semi-quantitative (abundances in %). Data from the three sampling dates were pooled for each site.

Conductivity, water temperature, and oxygen concentration and saturation were measured in each field campaign. The epiphytic diatom community was surveyed at each sampling site on 9 September 2005 for calculation of the index of salinity after ZIEMANN (1999). This was done in order to estimate whether changes in salinity along the section studied has any obvious effect on the ecology of the system.

RESULTS

A total of 134 chironomid taxa was recorded. 116 taxa were determined at species level, 18 at higher levels (the full list will be published elsewhere). According to the ecological preferences of the taxa and the dominance structure, the community can be identified as "potamal". Among feeding types, sediment feeders (38.1% on average of all sites), gatherers/scrapers (28.1%), and filter feeders (11.8%) dominated, but without significant variation between the study sites. The most important species were *Nanocladius dichromus* (Kieffer, 1906) (17% relative abundance on average of all sites), *Cladotanytarsus vanderwulpi* (Edwards, 1929) (10%), *Polypedilum acifer* Townes, 1945 (7%), and *Rheotanytarsus rhenanus* Klink, 1983 (8%). Other typical potamal species (*Robackia demeijerei* (Kruseman 1933), *Saetheria reissi* Jackson 1977, *Eurycnemus crassipes* (Meigen, 1810) were recorded in lower abundances (2.4 %, <1 % and <1 %, respectively).

The dominance of *N. dichromus* and, temporarily, also of *C. vanderwulpi* increased dramatically at km 287. However, this was not associated with the obvious increase in conductivity at km 291 left shore (from 456 to 1778 µS cm^{-1}; Fig. 2), where the Saale river enters the Elbe.

Community parameters such as taxa richness, Shannon Wiener index and evenness (Fig. 1) did not show greater variability either within the section studied, nor did water quality indicators (saprobity indices based on both chironomids and diatoms; diatom salinity index) when compared to conductivity changes.

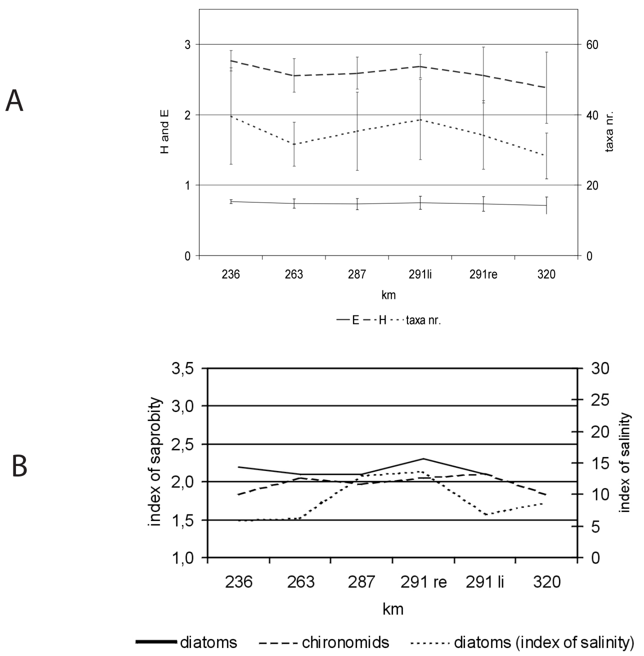

Fig. 1. A: Evenness (E), Shannon Wiener index (H), and taxa richness of the chironomid communities (average of 3 dates and standard errors). B: Indices of saprobity calculated from the chironomid and diatom communities, and indices of salinity (diatoms) at the stations studied (river km).

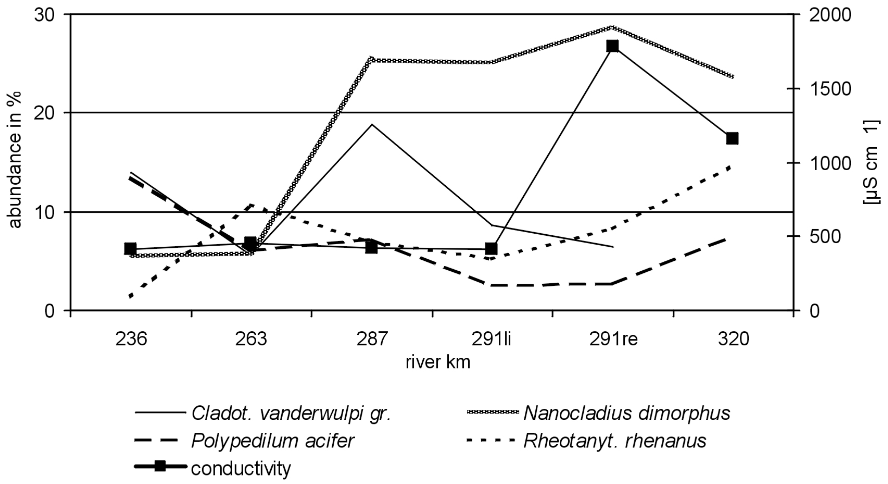

Fig. 2. Relative abundances of dominant species and conductivity values (all data averages of 3 sampling dates) at the river stations (river km); li = left shore, re = right shore.

DISCUSSION

The chironomid community of the river section studied was well characterized as "potamal" by typical taxonomic and ecological profiles, but a clear ecological differentiation between sites could not be detected. This may reflect insignificant differences in terms of both habitat structure (which would be of advantage to tracing chemical pollution in field studies) and pollution qualities and quantities. Although the conductivity readings showed an apparently dramatic increase in salinity (Figs. 1, 2), the diatom salinity index indicates that this does not affect severely the functioning of the system. CASAS & VILCHEZ-QUERO (1996) found differences of chironomid communities in waters of different salinity, however, the conductivity values of the waters studied there were much higher than observed in this section of River Elbe. In this respect, the increasing abundances of *N. dichromus* and *C. vanderwulpi* may be due to other, unknown factors.

These results suggest that the concentrations of pollutants stored in the upper layers of the sediment (HPA, 2005) apparently had no major influence on community parameters despite remarkable point influxes of serious pollutants. On the other hand, sediments sampled with corers smelled of petrol and other aromatics (esp. at site km 320), but obviuosly this had no effect on the chironomid community. This striking finding may be explained by the contaminated sediments being covered with unpolluted sediments from upstream during floods. Probably, the pollutants are held in deeper sediment where they do not affect the benthic community living in the upper layers (down to 3 cm) or at the surface. Each spate may erode the sediment and cause a release of the stored pollutants. However, it is unclear whether this remobilisation of contaminated sediments affects the benthic community only locally or at other sites. Although chironomids reportedly are useful indicators for both inorganic (e.g. metals) and organochemical pollution (WRIGHT *et al*., 1996, BROOKS *et al*., 2005), the present study indicates no sustained effects of the noted types of pollution on the potamal chironomid community, as sedimentological factors may mask the contamination measured in earlier campaigns (EWQMA, 2003).

As pollution quality changed along the river, but had no significant effect on the chironomid community, the latter can be considered as tolerant of the kinds and quantities of pollution occurring in this stretch of the river. Community differences between the sites may be explained by factors other than those measured here. The "reference site" chosen proved too similar to the "polluted" sites for useful tracing of possible contamination as indicated by the community.

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