epilithic species are typical mountain-species forms, because of the rise in water temperatures during the summer period. Barbel and nase are the prevalent first species. The effects of effluents have led to a considerable decline in fauna species diversity here as well (Schwoerbel, 1959). Quite recently, however, the conditions for colonization have become somewhat better again, as with the Upper Rhine. These improvements are due primarily to the reduction in waste load and the resulting higher oxygen concentrations in the Rhine (Conrath *et al.*, 1977). An impressive example spotlighting the biological situation in the Rhine is given by the phenomenon of the appearance of abundant caddis flies (*Hydropsyche contubernalis*) in the Koblenz region during 1975-1977. Increased oxygen concentration, the existence of flat-water zones, favourable substratum and the inflow of Mosel water rich in phytoplankton led to the widespread propagation of this insect. Disturbed trophic conditions (absence of consumers and nutritional rivals for the caddis flies) probably played an equally great role in this process (Tittizer, 1977). The general regeneration in the ecological state of the Rhine has led to an extension of the distribution range for this species (Caspers, 1980b). As a result of growing diversity in trophic relations, however, a decrease in the mass occurrence of this species has taken place. Further information on the distribution of chironomids in the Rhine is given by Wilson & Wilson (in press), who analyzed the composition of exuviae collected from sites down the whole river.

Soppe (1983) has conducted several studies with the help of a diving bell on the benthos in the zone of the Lorelei Cliff where the Rhine has only a width of 130 m but its deepest spot with a depth of 23 m. Of the two types of substrata distinguished, solid boulder gravel was almost free from faunal colonization, whereas the native bedrock served as a biotope mainly for *Hydropsyche* larvae and *Ancylus fluviatilis*. In current-free places, however, the boulder gravel substratum had about 30 species of macroinvertebrate. Similar data have been obtained near Bonn, i.e. the transition from Middle Rhine to the Lower Rhine (Caspers, 1980b). The disappearance of pollution-sensitive species, caused by the increasing pollution load and bank development, has become obvious here as well. The river regulation measures have led to the disappearance of macrophytes as microbiotopes e.g. for the dragon-flies *Calopteryx splendens* and *C. virgo*. Bless (1981) reports on the reappearance of the lamellibranchs *Unio pictorum* and *Anodonta cygnea* in the lower section of the Middle Rhine and in the upper section of the Lower Rhine. Both have now spread again far into the Lower Rhine (G.F., unpublished).

Lower Rhine

The Lower Rhine is characterized by an extreme uniformity in environmental conditions for the fauna. The whole of the bank is protected, mainly with basalt stones. The "Greater Köln area" adds a heavy point-source pollution load to the upper section of the Lower Rhine. Modern studies are not yet complete enough to make a detailed

national efforts for improving the condition of the Rhine will continue till the end of the century, so that the condition of the river will match its importance as the artery of central Europe.

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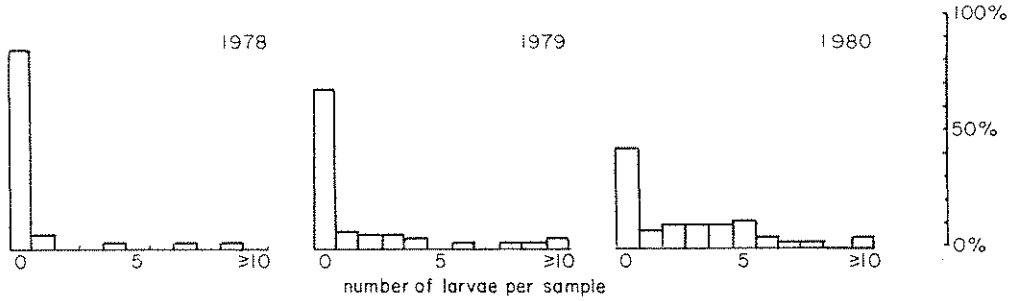

Fig. 16.10 Frequency distribution of numbers of Chironomidae in grab samples (surface area 0.03 m^2) from the sediments of the IJssel at km 1000.

In the IJssel a quite different association of Tubificidae is found among vegetation near the banks. The main species are *Psammoryctides albicola, P. barbatus* and *Limnodrilus udekemianus* (Van Urk, 1978). *Tubifex tubifex, Potamothrix hammoniensis* and *P. moldaviensis* are found in all habitats in low numbers. Chironomidae occur at much lower densities than Tubificidae, but appear to increase slightly (Fig. 16.10). The species (or larval groups) that are found regularly, are: *Procladius* s.l, *Dicrotendipes* gr. *nervosus, Cryptochironomus* gr. *defectus, Parachironomus* gr. *arcuatus* and *P.* gr. *longiforceps, Microchironomus tener, Chironomus* f.l. *fluviatilis* and *reductus, Glyptotendipes* sp., *Cricotopus* sp. Their densities are too low to detect any periodicity or trends for individual species. Comparison of species composition with that of other rivers is difficult for the same reason. Besides Chironomidae, occasional specimens of Unionidae, in particular of *Anodonta anatina* and *Unio pictorum*, were found in grab samples in 1978-1980. As mentioned above (16.451), Wolff (1968) was unable to find any Unionidae in the Rhine branches. This absence was attributed to the pollution of the river water and it seems reasonable to conclude that their present occurrence has been permitted by recent improvements in water quality, such as the increase in oxygen content. Among the Pisidiidae only *Pisidium henslowanum* and *Sphaerium corneum* are found, both in relatively low numbers. The fluviatile species *S. rivicola* and *S. solidum* have so far not been encountered in the IJssel.

16.524 *Prospects*

Monitoring the macroinvertebrate fauna of the IJssel has revealed some

signs of restoration of the river's ecosystem. However, it is far from being unpolluted, and even further from being a natural river. Many species, such as the burrowing Ephemeroptera that were reported once to have been abundant, may have disappeared forever, since there may be no suitable refuge left to permit re-introduction. Nevertheless, biological surveillance of the Rhine is not only valuable from a viewpoint of pollution monitoring, but may also contribute to knowledge of the autecology of species whose occurrence is restricted to the lower reaches of large rivers, which form a very vulnerable habitat in a densely populated area like Western Europe.

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