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Rotifer occurrence and trophic degree

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Abstract

Information on the distribution of planktic, periphytic and benthic rotifers from diverse waters in south and central Sweden was analysed for details on relationships to the trophic degree. Three factors were combined in order to get an estimation of the trophic degree: tot-P-content, electrolytic conductivity and content of dry matter. Indicators of oligotrophic and eutrophic environments are enumerated. As far as the planktic species are concerned, the results are largely compatible with those of earlier investigations (while the non-planktic forms were previously less known in this respect). Some eutrophy indicators have been reported as typical of saprobic environments.

Introduction

The large material collected by Bruno Bērziņš during the years 1945–1982, now having been computerized (see Bērziņš & Pejler, 1987), may be utilized for elucidating various problems. In this paper the emphasis is laid upon trophic degree, estimated by means of tot-P content, electrolytic conductivity and content of dry matter. The relation between planktic rotifers and trophic degree has been dealt with in different publications (see, e.g., Pejler, 1983 and the literature referred to there, as well as Karabin 1983 and 1985a and b), but this is probably the first time that non-planktic species are considered in this connection.

Material and methods

The material derives from about 350 lakes, 50 ponds, 20 pools, 15 mires and 150 running water localities in southern and central Sweden. The localities, as well as the microzoan species, are listed and codified in Bērziņš (1978). In most of the localities only samples from the warmer (ice-free) season were taken but in many cases winter samples were collected as well. Both plankton, periphyton and benthos were investigated.

Water for analysis of abiotic factors was obtained by a water sampler (1 or 5 l). Samples were taken in the open water at different depths, near the bottom and among the vegetation, in all cases as close as possible to the sample of organisms to be investigated at the same time.

The conductivity was measured as $\mu S\ cm^{-1}$ at 20 °C, using a Wheatstone-bridge. Total phosphorus (tot P) content was analysed by acid digestion (H_2SO_4, HNO_3 and $HClO_4$) followed by phosphate determination (Murphy & Riley, 1962). The content of dry matter (dominated by organic substance) was determined after concentration by evaporation. For technique connected with the biological samples, as well as for taxonomic considerations, the reader is referred to Bērziņš and Pejler (1987 and in press).

From plots of abundance versus individual environmental factors patterns of covariation between these parameters were extracted, and for every such constellation a diagram (computer sheet) was obtained (in total many thousand sheets). These sheets are archived at the Limnological Institute in Lund (and as tape at the Limnological Institute in Uppsala).

However, the archived diagrams are too numerous and too spacious for international publication and have been drastically reduced in the present context. First, only species observed in at least 50 of the studied samples are included. Second, only two degrees of abundance are discriminated. Since a strict quantitative analysis was impossible for benthic and periphytic rotifers (i.e. the majority of the species), and because of the compression of the material, the degrees of abundance have mainly to be understood as a relative measure. The median point is also denoted by subjective estimation on the basis of the computer sheets. For further information on computer treatment and diagrams the reader is referred to Bērziņš and Pejler (in press).

Results and discussion

The results obtained in this way are presented in Figs. 1–4 (μS cm^{-1}), 5–6 (tot-P) and 7 (dry matter). Electrolytic conductivity was analyzed already during the early phase of the project, but tot-P was introduced later and dry matter even later. During this later period mainly plankton samples were collected, which explains why only a smaller part of the non-planktic species reached the limit of 50 observations needed for being represented in the diagrams concerned with the two latter factors. This is the reason why there are fewer diagrams for tot-P and dry matter and why planktic species (marked with an asterisk) are dominating in these diagrams, especially in Fig. 7.

None of the three abiotic factors concerned is, of course, a direct measure of trophic degree. Thus, conductivity is often used for analyzing salinity. However, there are no really saline or brackish waters included in the present material (although the chloride concentration may be comparatively high in the samples from a sewage treatment plant), and μS can be regarded as connected mainly with the nutrient standard of the respective localities; the highest values being found in areas with loamy plains and sedimentary rocks, lower values in areas with Archaean rocks mainly covered with coniferous forest. The same applies to the phosphorus content, and it should be recalled that in most cases phosphorus seems to be the predominantly limiting factor for primary production in Swedish freshwater habitats (see, e.g., Forsberg & Ryding, 1980). Finally, it has been found by microscopic analysis that the dry matter in almost all localities mainly derives from biological production and to a large extent consists of particles which can be utilized as food for the rotifers.

The three abiotic factors mentioned are not directly coupled to each other. Consequently, each of them may individually be regarded as an indicator of trophic degree, but still more so if combined. For this reason the ranking numbers of a species, for the individual factors, are added in the following list, beginning with the species being found to indicate the most oligotrophic conditions. Only species correlated with all three factors are included. The summed ranking number is mentioned after each species name: *Collotheca lie-petterseni* 25, *Conochilus unicornis* 61, *Ascomorpha ecaudis* 62, *Gastropus stylifer* 64, *Postclausa hyptopus* 65, *Bipalpus hudsoni* 72, *Asplanchna herricki* 75, *Kellicottia longispina* 77, *Polyarthra remata* 77, *Ploesoma truncatum* 78, *Testudinella emarginula* 79, *Trichocerca intermedia* 79, *Ascomorpha ovalis* 96, *Collotheca mutabilis* 98, *Cephalodella h. hoodi* 99, *Keratella cochlearis robusta* 112, *Polyarthra major* 112, *Trichocerca p. porcellus* 121, *Cephalodella auriculata* 122, *Collotheca pelagica* 125, *Polyarthra vulgaris* 131, *Asplanchna priodonta* 134, *Synchaeta stylata* 149, *Trichocerca rousseleti* 149, *Polyarthra dolichoptera* 151, *Keratella c. cochlearis* 157, *Proales decipiens* 160, *Polyarthra euryptera* 180, *Synchaeta oblonga*

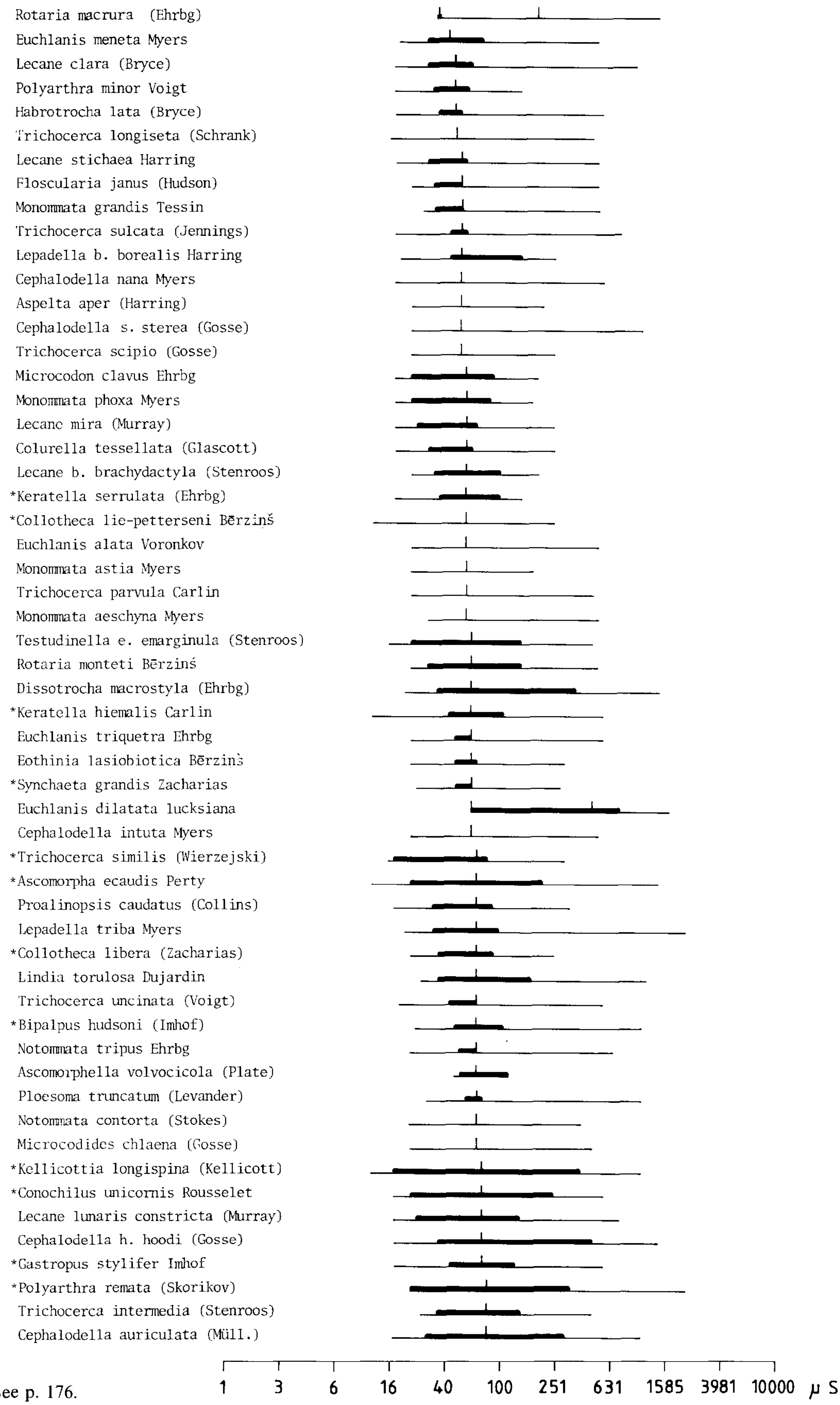

Fig. 1. See p. 176.

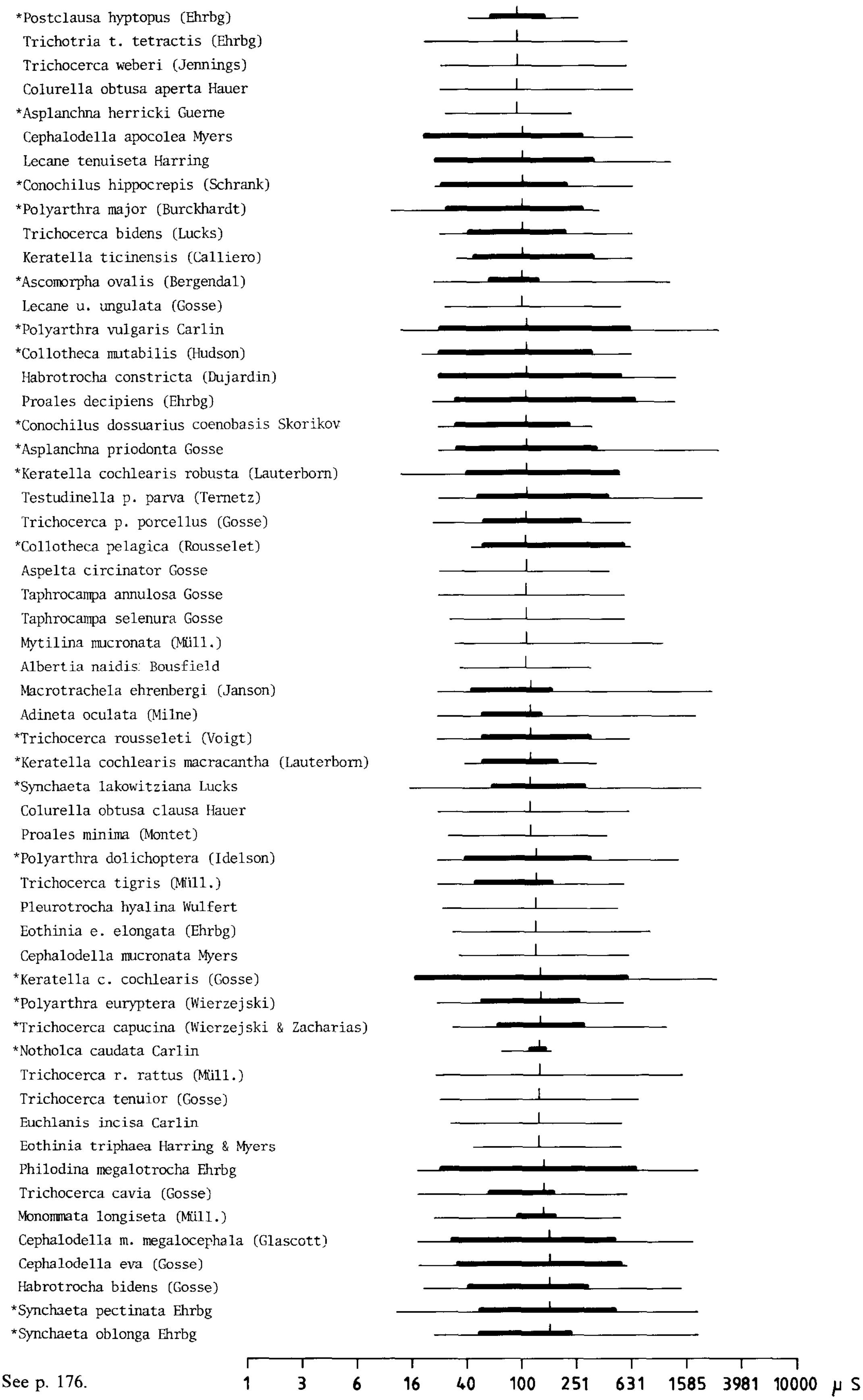

Fig. 2. See p. 176.

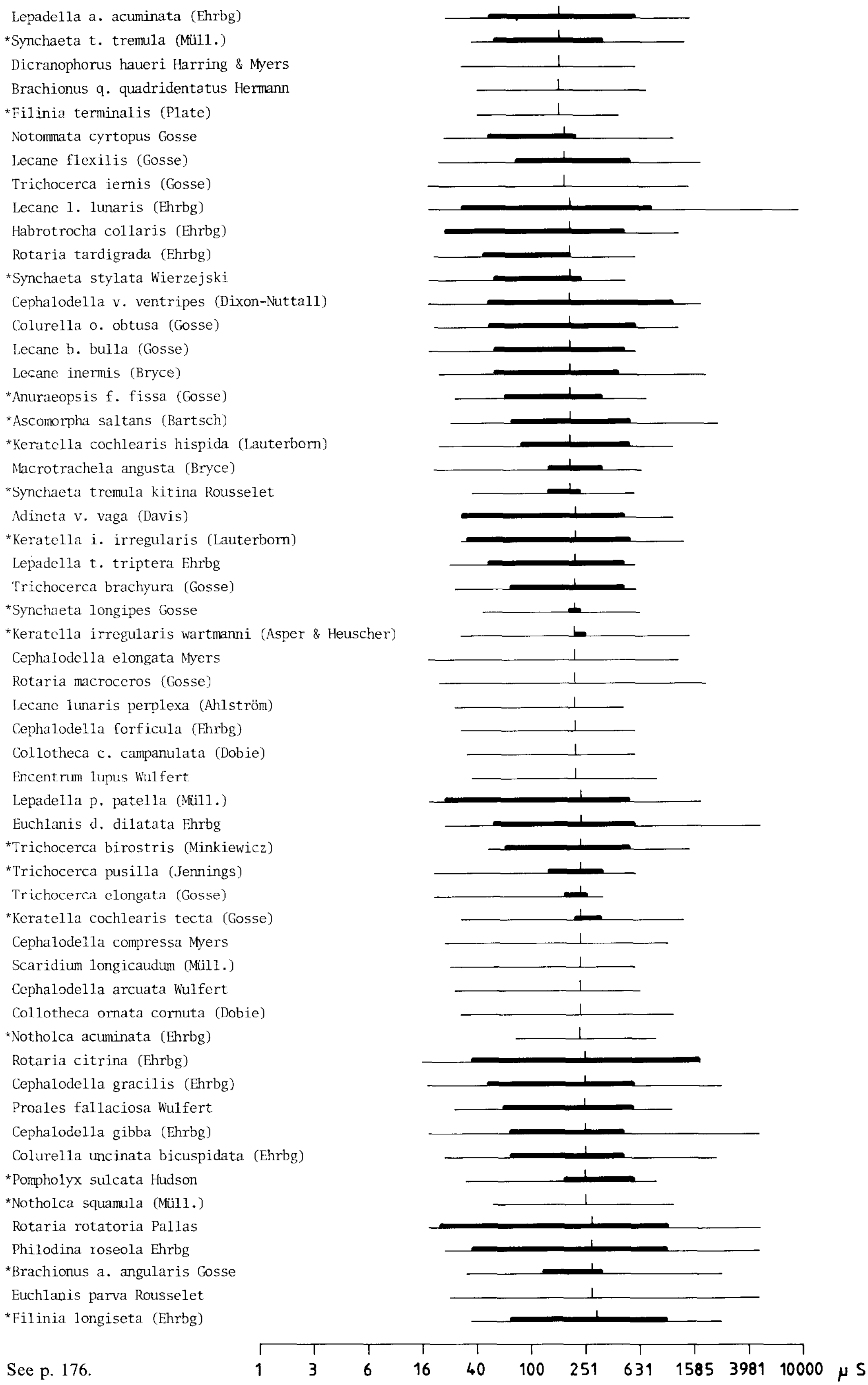

Fig. 3. See p. 176.

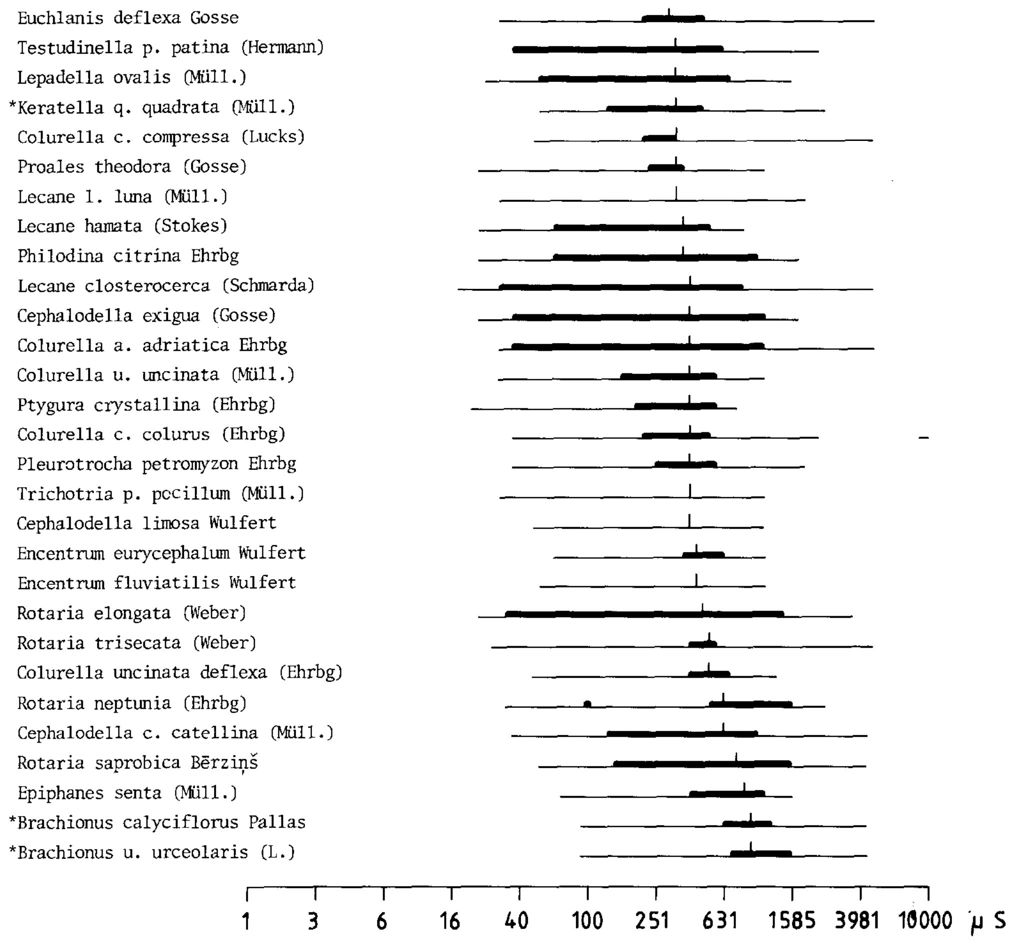

Fig. 5–6. Occurrence of rotifers in relation to tot-P content of the water. The species are ranked in a series, beginning with those showing their maximum abundance at relatively low tot-P values (Fig. 5). For other explanations, see the text of Figs. 1–4. The species are ranked according to conductivity preference, beginning with those having their peak abundance at ≤c. 80 µS cm^{-1} (fig. 1) through those having their peak abundance at >250 µS (Fig. 4). Planktic species are marked with an asterisk.

180, *Cephalodella v. ventripes* 190, *Synchaeta pectinata* 190, *Lecane inermis* 199, *Ascomorpha saltans* 204, *Lecane l. lunaris* 216, *Keratella i. irregularis* 225, *Colurella o. obtusa* 234, *Keratella i. wartmanni* 240, *Lepadella p. patella* 240, *Cephalodella gracilis* 241, *Trichocerca birostris* 252, *Euchlanis d. dilatata* 253, *Keratella cochlearis tecta* 261, *Cephalodella gibba* 267, *Rotaria rotatoria* 269, *Pompholyx sulcata* 275, *Brachionus a. angularis* 278, *Lecane closterocerca* 279, *Keratella q. quadrata* 289, *Filinia longiseta* 294.

As far as the planktic species are concerned, the results mentioned are more or less in accordance with previous experience (see especially Bērziņš, 1949; Pejler, 1957, 1965 & 1983; Hakkari, 1972; Radwan, 1976; Gannon & Stemberger, 1978; Karabin, 1983 and 1985a and b, Walz *et al.*, 1987), the oligotrophic species being found in the beginning of the series, the eutrophic ones at the end. The indicators of oligotrophy are partly intermingled with euryecious species which dominate the rotifer plankton in oligotrophic lakes, although they may also be found in relatively eutrophic lakes (e.g., *Conochilus unicornis* and *Kellicottia longispina*). Some of the indicators were not included in the diagram concerning

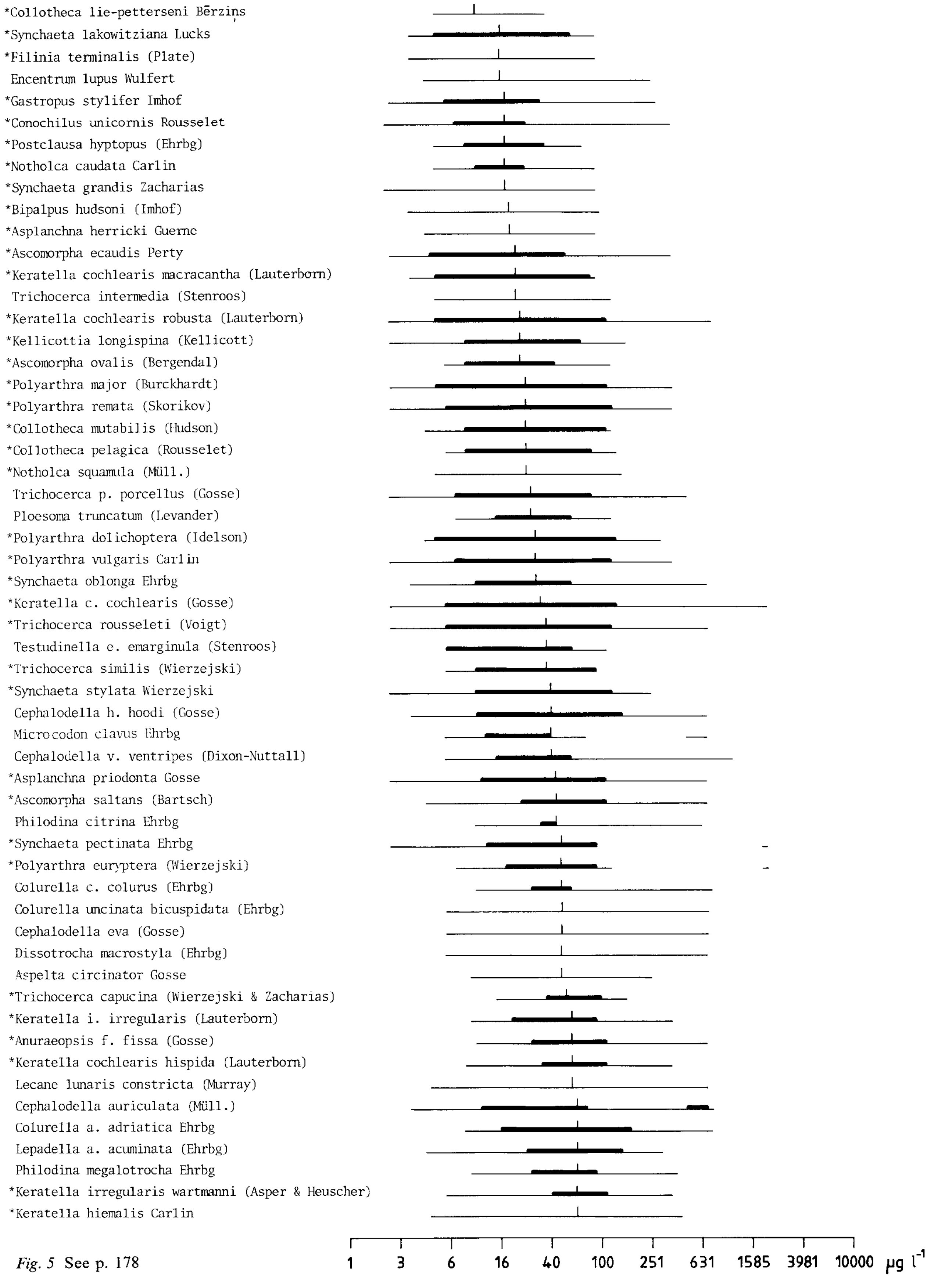

Fig. 5 See p. 178

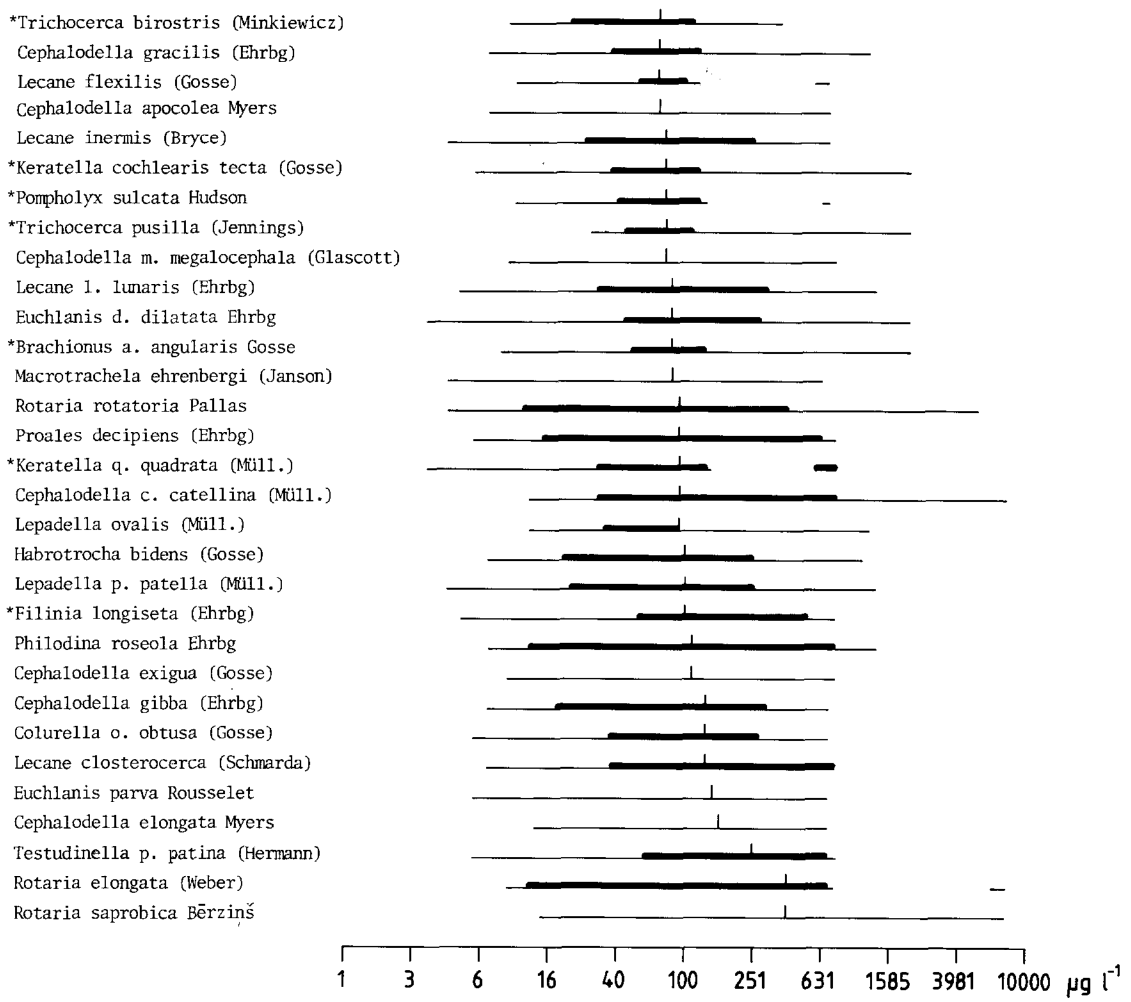

Fig. 5–6. Occurrence of rotifers in relation to tot-P content of the water. The species are ranked in a series, beginning with those showing their maximum abundance at relatively low tot-P values (Fig. 5). For other explanations, see the text of Figs. 1–4.

dry matter, because of too few observations in connection with these analyses, but their oligotrophic character is still quite apparent when studying the correlations with μS and tot-P. *Synchaeta grandis*, for instance, regarded as an indicator of oligotrophy, is ranked as number 9 for tot-P and as number 33 for μS. The corresponding figures for the eutrophy indicators *Anuraeopsis fissa* and *Trichocerca pusilla* are 48 and 130, and 64 and 150, respectively.

Keratella quadrata, next to last in the ranking list above, was included among the indicators of eutrophy in Pejler (1957) but not by the same author in 1965 because it is also found in deep oligotrophic lakes like L. Vättern and L. Torneträsk. Possibly different races are adapted to different environmental conditions, which is also indicated by the large morphological variation in this species (cf. Pejler, 1981).

As regards the non-planktic species, their relation to the trophic degree as such has not been dealt with previously, as far as we are aware. However, Sládeček (1973) discusses the connection to saprobity at length, a factor which ought to be strongly correlated to the trophic degree. The close connection between saprobity and trophic degree is also exhaustively dealt with by Donner (1978, pp. 127–130). Sládeček

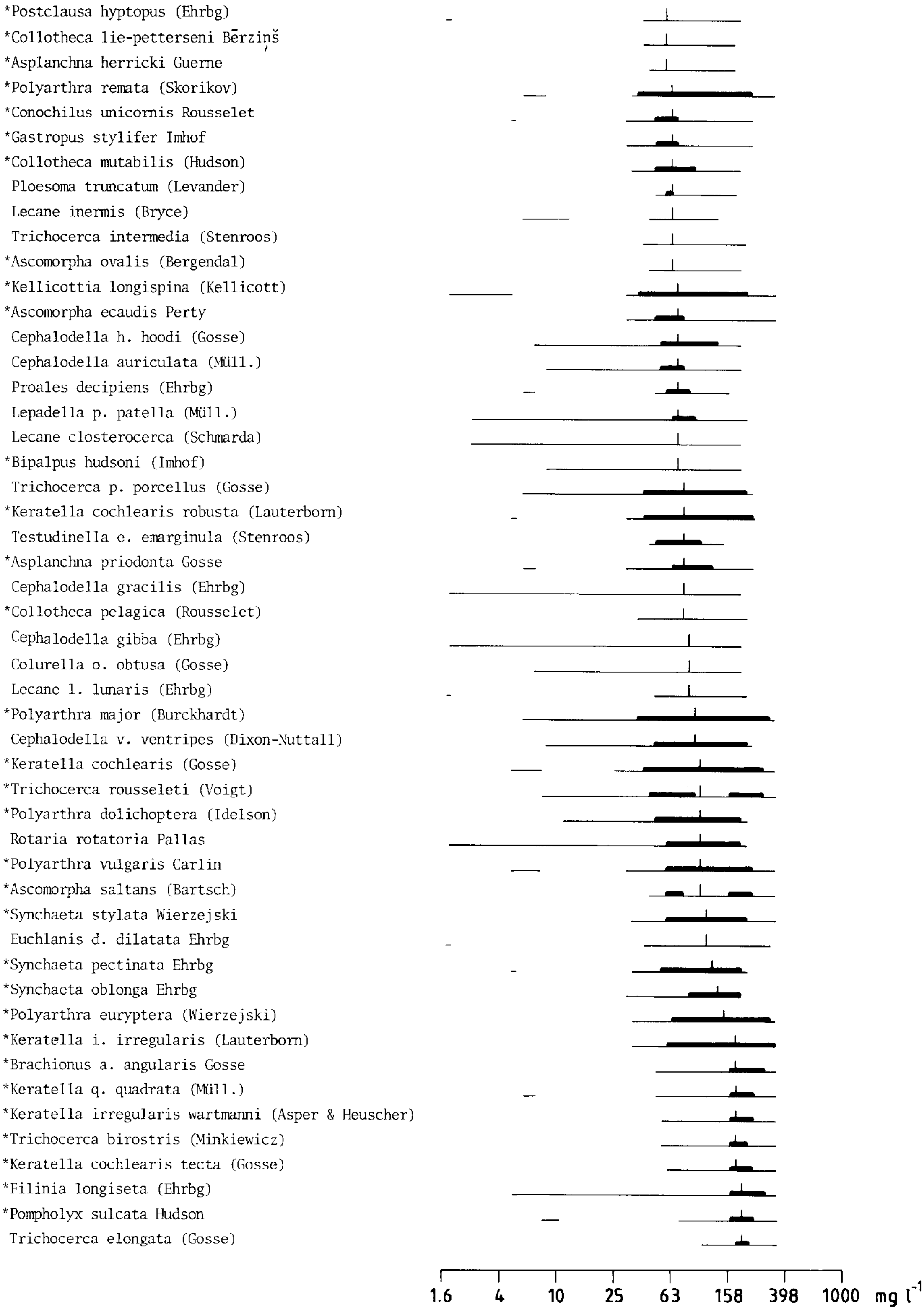

Fig. 7. Occurrence of rotifers in relation to content of dry matter in the water. The species are ranked in a series beginning with those having their maximum abundance at relatively low values of dry matter. For other explanations, see the text of Figs. 1–4.

(op. cit.) includes both planktic and non-planktic species in his book. Almost all species in our ranking list above are designated in op. cit. as oligosaprobic or, in a few cases, as oligosaprobic-β-mesosaprobic. However, *Pompholyx sulcata* and *Filinia longiseta* are regarded as β-saprobic, *Brachionus a. angularis* as β-α-saprobic, *Rotaria rotatoria* as α-saprobic. It is apparent that all the last-named species are to be found in the latter part of our list. For the habitat choice in non-planktic rotifers the nature of the substrate ought to be of great importance, a matter to which we want to return in future papers.

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