Jber.Biol.Stn Lunz 14: 48 - 57 (1993)

Longitudinal distribution of a microcrustacea community (first results)

Verena Anna KOWARC

Keywords: distribution, microcrustacea, meiofauna

Zusammenfassung: Längszonale Verteilung einer Microcrustaceagemeinschaft (Erste Ergebnisse) - Längszonale Verteilungsmuster bzw. Typisierungen der Fließgewässer wurden an Hand des Macro zoobenthos und zwar vorwiegend an Insekten beschrieben. Über Vorkommen und Verteilungsmuster von Fließwassercrustacea ist sehr wenig bekannt. Diese Arbeit behandelt die Microcrustaceafauna im Sensesystem (Kanton Freiburg, Schweiz), das die Zonen des Krenals und Rhithrals eines Fließwassersystems abdeckt. Faunenaufnahmen wurden im April und August mittels Boxsampler bzw. von Mai bis November mittels Freezingcore-Methode durchgeführt. Bis zum derzeitigen Stand der Arbeit konnten insgesamt 28 Arten, vorwiegend Copepoden (Harpacticiden), identifiziert werden. Der Arten- und Individuenreichtum ist im Gegensatz zu den bisher publizierten Arbeiten, die das gesamte Macrozoobenthos behandeln, in den Quellregionen bzw. im Seeausfluß (verbauter Gewässerabschnitt) am höchsten. Die Artenzusammensetzung unterscheidet sich im Bereich des unmittelbaren Seeausflusses (Warme Sense) wesentlich von den anderen Gewässerstrecken. Aufgrund der höheren Sammelfrequenz und der Möglichkeit, tiefere Sedimentschichten zu erfassen, konnten mittels Freezingcoreproben wesentlich mehr Arten nachgewiesen werden.

Introduction:

Numerous studies deal with longitudinal distribution patterns of riverain benthos and indicate faunal changes along elevational gradients (e.g. McCOY 1990, SCHAEFFER et al. 1986). Several fundamentals of ecosystem theories base on these faunal changes along river systems (ILLIES 1961, VANNOTE et al. 1980, STANFORD & WARD 1983). Comparing river zonations, the highest abundance data and diversity indices are recorded in middle or downsteam section of the streams under study. The faunal composition changes along elevational gradients, some plecopterans are restricted to headwater sections only. Some species of ephemeropterans are rather rare at those regions. Possible reasons are discussed: e.g. reduced habitat area, low primary production, and increasing unfavourable environments (see McCoy 1990 for review). Most of these theories base on the observation of macrozoobenthos and mainly on insects. Relativly little is known about longitudinal distribution patterns of meiobenthic riverain microcrustacea.

The first results of this study give species composition and longitudinal distribution of twenty-eight crustacea species along a Swiss prealpine river, ranging in altidude from 1460 to 540 m a.s.l and covering all zones within the crenal and rhithral section of a river system. Differences in species composition are described when comparing a microcrustacea community of a summercold brook with those of a lake outlet.

Study area:

Study area ist the Singine river system, situated near the western border of the canton of Fribourg, Switzerland. It belongs to the drainage area of the river Rhine (Figure 1). The confluence of the second order brook Cold Singine with its headwaters Gantrischsingine, Hengstsingine and Muscheren Singine and the Warm Singine, the lake outlet of Lac Noir, form the river Singine which enters the river Sarine. The Warm Singine, a second-order summerwarm brook (max. T: 22°C), is polluted and regulated over wide sections, in order to protect the cantonal street and farm houses. The Cold Singine (max. T.: 12°C) is nearly undisturbed with the exception of a few sills and groynes and the waste waters of a few farm houses. The geological instability (transition area between limestone and flysh) is the cause for the torrential character of the brooks: high bed load capacity during high waters, instability of river banks and the river bed. The Warm Singine is more stabilized because of the regulations described above. Downstream of the confluence of Warm and Cold Singine the river Singine flows within a 150 m broad gravel bed. Downstream of the village Plaffeien it enters a cannion section . The last section of the river Singine is canalized and the river bed is limited to a breadth of 20 to 30 m. Fourteen sample locations were chosen along the river system including Seeweidbach, the main inflow into Lac Noir and Schwarzwasser, the main affluent of the river Singine (Figure 1).

Sample site	code	altidude (m a.s.l)
Gantrischsingine	GS	1460
Hengstsingine	HS	1300
Muscheren Singine	MS	1300
Cold Singine	CS	919
Seeweidbach	1	1080
Warm Singine (lake outflow)	2	1040
Warm Singine (natural part)	3	931
Warm Singine (regulated part)	4	900
Singine near the village Plaffeien	5	850
Singine upstream of Sodbachbridge	6	658
Singine downsteam of the inflow of Schwarzwasser	7	577
Singine near the village Thörishaus	8	569
Singine near the village Neuenegg	9	536
Schwarzwasser	SW	592

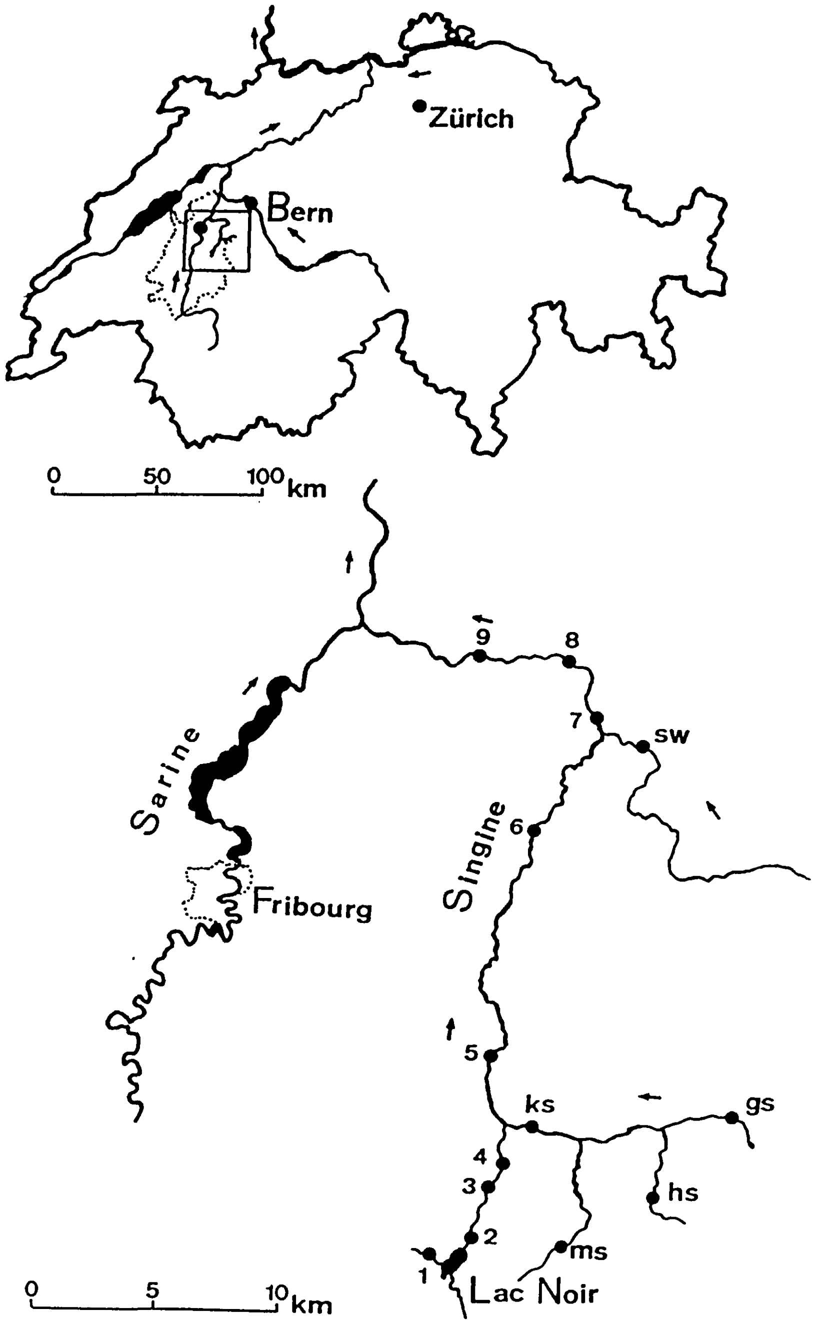

Figure 1: Location of the river system and the fourteen sample sites.

Boulders, cobbles, pebbles, and gravel form the matrix of the bedsediments. The interstitial space is filled with fine sand. The surface of the bedsediments of Muscheren Singine is highly incrusted. The richness of gipsum, limestone, and the pollution cause high conductivity. A description of some basic physical and chemical parameters is summarized in table 1.

location	ph	µs/cm	O_2 mg/l	O_2 %
GS	8.01	239	8.30	96
HS	8.13	408	9.50	100
MS	8.04	852	11.50	115
CS	8.18	474	30.00	103
1	8.33	308	9.50	115
2	8.29	396	7.40	100
3	8.36	454	8.70	98
4	8.37	450	8.50	95
5	8.23	446	8.40	96
6	7.75	587	9.60	101
8	8.26	423	8.30	101
SW	8.28	395	8.30	100

location	NH_4 mg/l	NO_3 mg/l	SO_4 mg/l	BSB_5 mg/l
GS	0.020	0.64	33.3	0.50
HS	0.020	0.37	109.0	0.60
MS	0.020	0.48	137.0	0.50
CS	0.020	0.44	114.0	0.50
1	0.010	0.33	21.3	0.60
2	0.020	0.63	91.8	0.80
3	0.045	0.38	98.0	1.10
4	0.030	0.35	98.7	0.80
5	0.080	0.39	98.5	0.50
6	0.020	5.14	18.8	0.60
8	0.030	1.67	9.3	0.60
SW	0.021	2.27	22.3	0.90

Table 1: Physical and chemical parameters of the surface water at each sample site (code as above).

Method:

The fauna was collected in April and May 1991 using a box type surber sampler (⌀ – 34 cm, mesh size – 100 µm, (BRETSCHKO & KLEMENS 1986)). At each sample site three sample units were taken to give a rough esimation of the abundance of the fauna. At station 3 and 4 (Warm Singine), CS (Cold Singine) and 5 (Singine near Plaffeien village) freezing core samples were taken three times from April to November 1991. The freezing core samples allow to calculate abundances and to describe the vertical distribution patterns of the fauna (BRESCHKO & KLEMENS 1986, modified after EGLIN 1990). The samples have been fixed using isopropanol. The fauna was counted under a dissection microscope and identified using an Olympus Ch-3 microscope. Copepoda, Chydoridae and Cladocera were identified to species level, following the taxonomy after DUSSART (1967 and 1969), KIEFER (1973), and AMOROS (1984). Ostracoda are not identified yet and are therefore excluded in this study. Thus, sample processing is not finished, statistical treatment and the discussion about diversity is not provided yet.

species/location	GS	HS	MS	CS	1	2	3	4	5	6	7	8	9	SW
CYCLOPOIDA														
Macrocyclops albidus (Jurine)	-	-	-	-	-	-	-	r	-	-	-	-	-	-
Eucyclops serrulatus (Fischer)	r	-	-	-	-	-	r	r	-	-	-	-	r	-
Paracyclops fimbriatus (Fischer)	-	r	-	-	-	-	-	r	r	-	-	-	-	-
Megacyclops viridis (Jurine)	-	-	-	-	-	-	-	r	r	-	-	-	-	-
Cyclops vicinus (Uljanin)	r	-	-	-	-	e	r	-	-	-	-	-	-	-
C. insignis (Claus)	-	-	-	-	-	r	-	-	-	-	-	-	-	-
Acanthocyclops vernalis (Fischer)	-	-	-	r	-	-	-	-	r	-	r	-	r	-
A. robustus (G.O. Sars)	r	r	-	r	r	c	c	c	d	r	c	c	c	-
Diacyclops bicuspidatus (Claus)	-	-	-	-	-	-	-	r	-	-	-	-	r	-
HARPACTICOIDA														
Canthocamptus staphylinus (Jurine)	-	-	-	-	-	e	-	-	-	-	-	-	-	-
Attheyella crassa (G.O. Sars)	-	r	r	c	-	e	e	e	e	-	-	r	r	-
Bryocamptus zschokkei (Schmeil)	e	e	c	c	c	-	c	e	c	-	r	r	r	-
B. pygmaeus (G.O. Sars)	-	-	r	r	-	-	r	r	r	-	-	r	-	-
B. minutus (Claus)	-	r	-	-	-	-	c	c	r	-	-	-	-	-
B. typhlops (Mrázek)	r	-	-	r	-	-	c	c	c	-	-	-	-	-
B. (Limnocamptus) echinatus (Mrázek)	c	r	c	r	-	-	e	e	c	-	-	-	r	r
Moraria poppei (Mrázek)	r	c	-	r	-	r	r	r	-	-	-	-	-	-
M. mrázeki (Th. Scott)	-	-	-	r	r	c	-	r	-	-	-	-	-	-
M. brevipes (Sars)	-	-	-	r	-	-	r	r	r	-	-	-	-	-
Paracamptus schmeili (Mrázek)	-	r	-	r	-	-	r	r	-	-	-	-	-	-
Hypocamptus brehmi (van Dauwe)	-	-	-	-	r	-	r	r	r	-	-	-	-	-
CHYDORIDAE														
Alona quadrangularis O.F. Müller	-	-	-	-	-	r	-	-	-	-	-	-	-	-
A. rustica Scott	-	-	-	-	-	r	-	-	-	-	-	-	-	-
A. guttata G.O. Sars	-	-	-	-	-	-	-	r	-	-	-	-	-	-
Leydigia leydigi Schoedler	-	-	-	-	-	r	-	-	-	-	-	-	-	r
Chydorus ovalis Kurz	-	-	-	-	-	r	-	-	-	-	-	-	-	-
CLADOCERA														
Bosmina coregoni (Braid)	r	-	-	r	-	-	-	r	r	-	-	-	-	-
Daphnia cucullata G.O. Sars	-	-	-	-	-	c	r	-	r	-	-	-	-	-

GS - Gantrischsingine
HS - Hengstsingine
MS - Muscheren Singine
CS - Cold Singine
1 - Seeweidbach
2 - Warm Singine (lake outflow)
3 - Warm Singine (natural part)
4 - Warm Singine (regulated part)
5 - Singine near village Plaffeien
6 - Singine upstream Sodbachbridge
7 - Singine downstream the inflow of Schwarzwasser
8 - Singine near village Thörishaus
9 - Singine near village Neuenegg

Table 2: List and dominance of species at each sample site (r - rare, c - common, e - eudominant, - not occuring).

First results and discussion:

Dipterans, mainly chironomidae and simuliidae, dominate the invertbrate fauna of the Singine river system. The two families together form about 90 % of the whole river fauna. Crustacea occur in higher abundances at only three sampling sites: Hengstsinine, Muscheren Singine and Warm Singine – lake outlet (Figure 2). Copepods dominate the microcrustacea community at station 2, while ostracods occur in high abundances at Hengst- and Muscheren Singine. At downstream regions crustacea are rather rare in comparison to other groups.

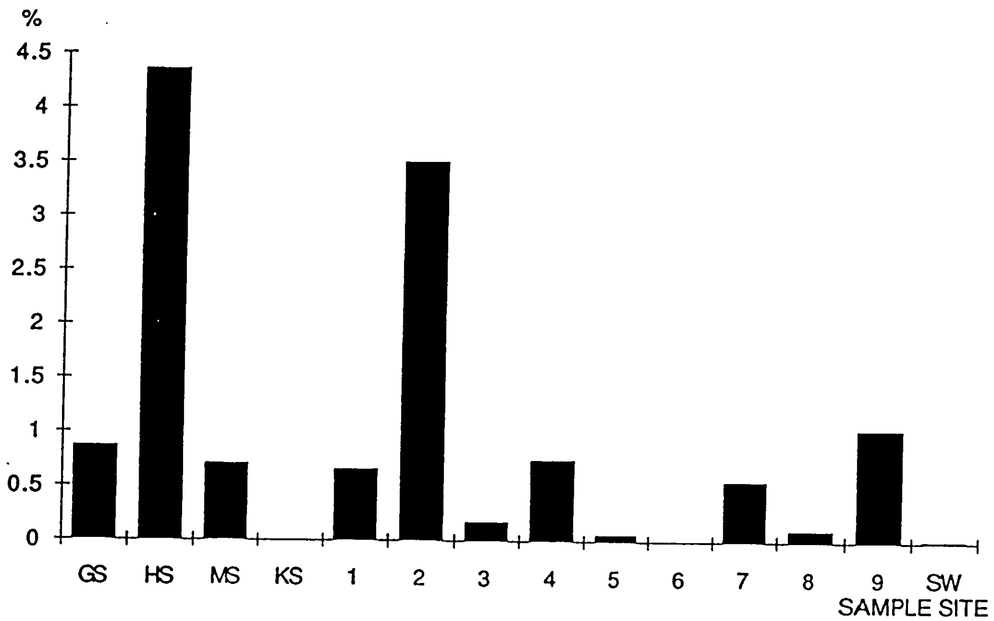

Figure 2: Distribution in percent of microcrustacea at each sample site. 100 % are the number of individuals recorded at each sample site.

Altogether 28 species have been identified so far and 5 to 10 species of ostracods have to be expected. Most of the recorded species belong to the copepods, whereas chydorids and cladocera are rather rare. Among the copepods harpacticoids are dominant based on the number of species and abundance. A species list and relative abundance data are given in table 2.

Species richness is much higer in upstream sections of the river system, including sample site 5 (Singine near Plaffeien village) and with the exception of sample site 1 – Seeweidbach (Figure 3). Most of the harpacticoid species found in the river system are restricted to the headwaters only, while cyclopoids dominate the downstream sections. Thus, the distribution of the harpacticoid community causes species richness along the river. Only few species like *Acanthocyclops robustus*, *Attheyella crassa*, and *Bryocamptus zschokkei* seem to colonize the whole Singine river system, while species of the genus Moraria, and Hypocamptus are restricted to the headwaters only. The genus Cyclops and Canthocamptus occur only at the lake outflow. Both are typical inhabitants of the benthic community of standing waters. The species of the genera Macrocyclops, Paracyclops and of the Chydoridae are rather rare and the distribution pattern seems to be incomplete yet. The higher species richness and most probably higher diversity in upstream regions of the microcrustacea community give contradictory results to the described distribution patterns of macroinvertebrates and insects.

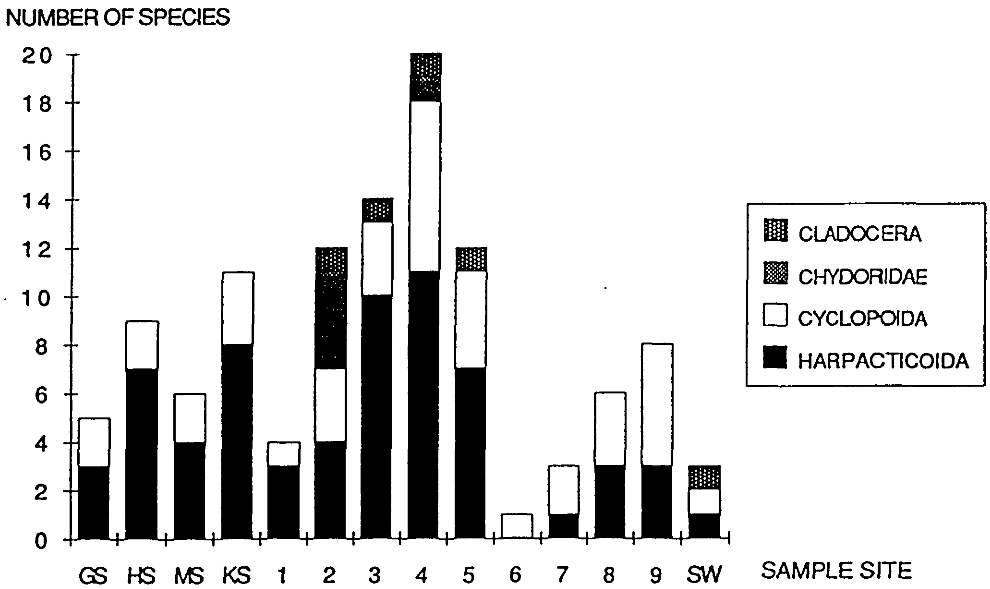

Figure 3: Number of species at each sample site.

Obviously, highest species richness is recorded at sample site 4 (Warm Singine, regulated part), when comparing all sample sites. Most of the harpacticoid species and rather rare cyclopoid and chydorid species occur at this location of the Warm Singine. Some of these species are mainly found in standing waters. Thus, artificial pools, that occur at this location, provide lentic habitats and give those species a chance to survive.

Species composition at sample site 2 (Warm Singine, lake outflow) differs extremely in comparison to the other sample locations. *Cyclops vicinus* and *Canthocamptus staphylinus* dominate the microcrustacea community at this location. Both species are known to occur in the plankton and benthic community in lakes. They have not been recorded in downstream regions whereas two other mainly planctonic species *Bosmina longirostris* and *Daphnia cucculata* have been found several kilometers downstream of the lake outflow (Table 3). Most probably those four species originally occur in Lake Noir and have been washed into the river during high water periods. The survival of these species in the river is not clear. Bosmina and Daphnia have been found several times at 30 to 50 cm sediment depth. More investigations are necesarry to answer this question.

The occurance of *Hypocamptus brehmi* at Warm Singine and Singine near Plaffeien has to be emphasized, because this species has only been recorded twice before. VAN DAUWE (1922) found this species in subterranean waters in the Wendelstein region (Germany) for the first time. TILZER (1968) discribed this species in hyphoreic waters at the Arlbergregion in Austria. Thus, it is the first record of *Hypocamptus brehmi* in Switzerland.

The number of species recorded from box samples and freezing core samples are rather different when compared with each other (Table 3). Possible reasons are the higher number of freezing core samples taken and the compactness of the sediment, wich restricts boxsampling to the topmost layers only. The processing of freezing core samples shows that most of the crustacea species occur at sediment layers deeper than 10 to 20 cm depth. The box sampler seems to be a suitable sample technique at the first order rivers, because the bedsediments are not so developed there. At these locations the sediments reaches a depth of 10 to 15 cm. Thus, it is probable that species richness becomes much higher in downstream sections, if freezing core samples are taken.

location	CS	3	4	5
Boxt sampler	1	3	6	2
FCE	11	13	18	11

CS - Cold Singine
3 - Warm singine (natural part)
4 - Warm Singine (regulated part)
5 - Singine near the village Plaffeien

Table 3: Number of species caught with the box sampler or freezingcore method.

The microcrustacea community of the Singine river system is rather common on genus level, when compared with data from the literature. The genera Acanthocyclops, Paracylops, Bryocamptus, Attheyella, Moraria, Alona, and Lydigiia seem to occur rather frequently in running waters (O'DOHERTY 1986, KOWARC 1991, PENNAK & WARD 1986, ROUCH 1988, RUNDLE & HILDREW 1991, SHIOZAWA 1991). The species composition and dominance differ depending on the region and the habitat. The copepod community of the Singine river system is rather similar to that of a second order, summer cold prealpin Austrian mountain brook (Oberer Seebach - RITRODAT Lunz study area - KOWARC 1991). Several species (*Limnocamptus echinatus*, *Bryocamptus zschokkei*, *B. cuspidatus*, *B. pygmaeus*, *B. typhlops*, *Attheyella crassa*, *Moraria poppei*, *Canthocamptus staphylinus*, *Acanthocyclops robustus*, *A. vernalis*, and *Megacyclops viridis*) occur in both rivers. Whereas *Limnocamptus echinatus* clearly dominates the copepod community in Oberer Seebach, no such dominant species could be found in the Swiss alpine brook. *Attheyella crassa*, *Bryocamptus zschokkei*, *Limnocamptus echinatus*, and *Bryocamptus minutus* are the most abundant species in the Singine. *Attheyella wierzejskii*, a rather frequent species of Oberer Seebach, does not occur in the Singine although another species of the genera Attheyella (*A. crassa*) occurs in both rivers. Abundances of microcrustacea are low in the Singine when compared to the other studies. Especially chydorids are rather rare and only found in single specimen, whereas they are the most dominant species in some Minnesota streams (SHIZOAWA 1991).

References:

AMOROS, C. 1984: Crustacés Cladocères.- Bull.Soc.Linnéenne de Lyon 53: 1-143.

BRETSCHKO, G., KLEMENS, W.E. 1986: Quantitative methods and aspects in the study of the interstitial fauna of running waters.- Stygologia 2: 297-316.

DAUWE VAN, C. 1922: Maraenobiotus brehmi, ein neuer moosbewohnender Süsswasser - Harpacticide. Arch.Hydrobiol. 13: 561-564.

DUSSART, B. 1967: Le Copépodes des eaux continentales. Tome I: Calanoïdes et Harpacticoïdes.- Edition N. Boubee & Cie, Paris 500 pp.

DUSSART, B. 1969: Le Copépodes des eaux continentales. Tome II: Cyclopoïdes et Biologie.- Edition N. Boubee & Cie, Paris 292 pp.

EGLIN, S.W.T. 1990: Die Zusammensetzung und kleinräumige Verteilung der Makroinvertebratenzönose eines natürlichen, voralpinen Fließgewässers (Thur) in Abhängigkeit vom Nahrungsangebot und der Sedimentstruktur.- Dissertation, Eidgenössischen Technischen Hochschule Zürich, 145 pp.

ILLIES, J. 1961: Versuch einer allgemeinen Gliederung der Fließgewässer.- Int.Revue ges.Hydrobiol. 46: 205-213.

KIEFER, F. 1973: Ruderfußkrebse (Copepoda). - Kosmos-Verlag Stuttgart. 96pp.

KOWARC, V.A. 1991: Distribution of harpacticoids in a second order mountain stream (RITRODAT-Lunz study area, Austria).- Verh.Int.Verein.Limnol. 24: 1930-1933.

McCOY, E. 1990: The distribution of insects along elevational gradients.- Oikos 58: 313-22.

O'DOHERTY, E.C. 1985: Stream-dwelling copepods: Their life history and ecological significance.- Limnol.Oceanogr. 30: 554-564.

PENNAK, R.W., WARD,4 J.V. 1986: Interstitial faunal communities of the hyporheic and adjacent groundwater biotopes of a Colorado mountain stream.- Arch.Hydrobiol.Suppl. 74: 356-396.

ROUCH, R. 1988: Sur la répartition spatiale des Crustacés dans le sous-écoulement d'un ruisseau des Pyrénées.- Annls Limnol. 24: 213-234.

RUNDLE, S.D., HILDREW, A.G. 1990: The distribution of micro-arthropods in some southern English streams: the influence of physicochemistry.- Freshwat.Biol. 23: 411-431.

SCHAEFFER, D.J., PERRY, J.A. 1986: Gradients in the distribution of riverine benthos.- Freshwat.Biol. 16: 745-757.

SHIOZAWA, D.K. 1991: Microcrustacea from the benthos of nine Minnesota streams.- J.N.Am.Benthol.Soc. 10: 286-299.

STANFORD, J.A., WARD, J.V. 1983: The intermediate disturbance hypothesis: an explanation for biotic diversity pattern in lotic ecosystems. Dynamics of lotic ecosystems. Fontaine, T.E., Bartell, S.M. (Eds.).- Ann. Arbor Science, Michigan, 347-356.

TILZER, M. 1968: Zur Ökologie und Besiedlung des hochalpinen hyporheischen Interstitials im Arlberggebiet (Österreich).- Arch.Hydrobiol. 65: 253-308.

VANNOTE, R.L., CUMMINS, K.W., SEDELL, J.R., MINSHALL, G.W., CUSHING, C.E. 1980: The river continuum concept.- Can.J.Fish. Aquat.Sci.17: 130-137.

Acknowlegments:

The present study is a part of the project "Einfluss von technischen Eingriffen an natürlichen Fliessgewässern auf die Fauna und Flora", supported by the Swiss National Fonds, the "Bundesamt für Umwelt, Wald und Landschaft (BUWAL)", the Department of "Strassenbau", and SANDOZ AG, Rhein Fonds. Coordination: I. Tomka and A. Zurwerra I have to thank all my colleagues for help during field work.

Autor's address: Dr. Verena Anna Kowarc
Fließwasserprojekt "Sense"
Universität Freiburg
Institut für Zoologie
Rohrmoos PF. 335
CH-1711 Schwarzsee