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Chironomids of small Alpine water bodies (springs, spring brooks, pools, small lakes) of the northern Calcareous Alps

(Insecta, Diptera, Chironomidae)

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30 small Alpine water bodies (springs, spring brooks, pools, small lakes) of the northern Calcareous Alps (Berchtesgaden National Park, Germany, and adjacent regions in Austria) were surveyed for their chironomid communities in 1997 and 1998. Mainly, pupal exuviae were sampled. 94 taxa are recorded and listed. Three are new for Germany (*Diamesa wuelkeri* Serra-Tosio, *Corynoneura arctica* Kieffer, *Parakiefferiella fennica* Tuiskunen), five for Bavaria (the former, *Heterotrissocladius grimshawi* (Edwards), and *Linnophes asquamatus* Andersen), and one for Austria (*Chironomus nuditaris* Keyl). No statistically significant correlations could be found between the occurrence of any taxon and altitude (m a.s.l.). This may be due to the small data set. 71 % of all taxa recorded could be determined on species level. Taxonomic diversity ranged from 10 (a lake) to 0 (hygropetric habitats). Compared to some earlier chironomid studies from the Calcareous Alps, the present survey achieved a higher proportion of determinations to species level. It is concluded that this is an effect of sampling pupal exuviae rather than larvae.

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Introduction

This paper is dedicated to F. Reiss. Some years ago he encouraged me to collect in the Alpine region. He was convinced that, if there is still anything faunistically interesting left to discover concerning the chironomids in central Europe, it will be found in the Alps. Remembering this I was happy to join a project in 1997 and 1998 surveying the macroinvertebrate and algal communities of springs in Berchtesgaden National Park. For chironomids, only few investigations on this small ecosystem are published (e.g. Crema et al. 1996, Thienemann 1936, 1942, Weigand & Tockner 1996). Moreover, as those were based on larval material, the taxonomic resolution is not as high as possible when using pupal exuviae or adults. Therefore, the available knowledge on chironomid communities in Alpine habitats is relatively meagre. On the other hand, new species were recorded or described in all investigations. Following that, further studies are urgently needed. In the Berchtesgaden project mentioned, chironomids were collected in springs as well as in brooks, meltwater pools and small lakes. Nearly all water bodies are situated higher than 1000 m a.s.l. The paper presented follows two aims: (1) to survey the chironomid communities of the various habitats by collecting mainly pupal exuviae in order to achieve

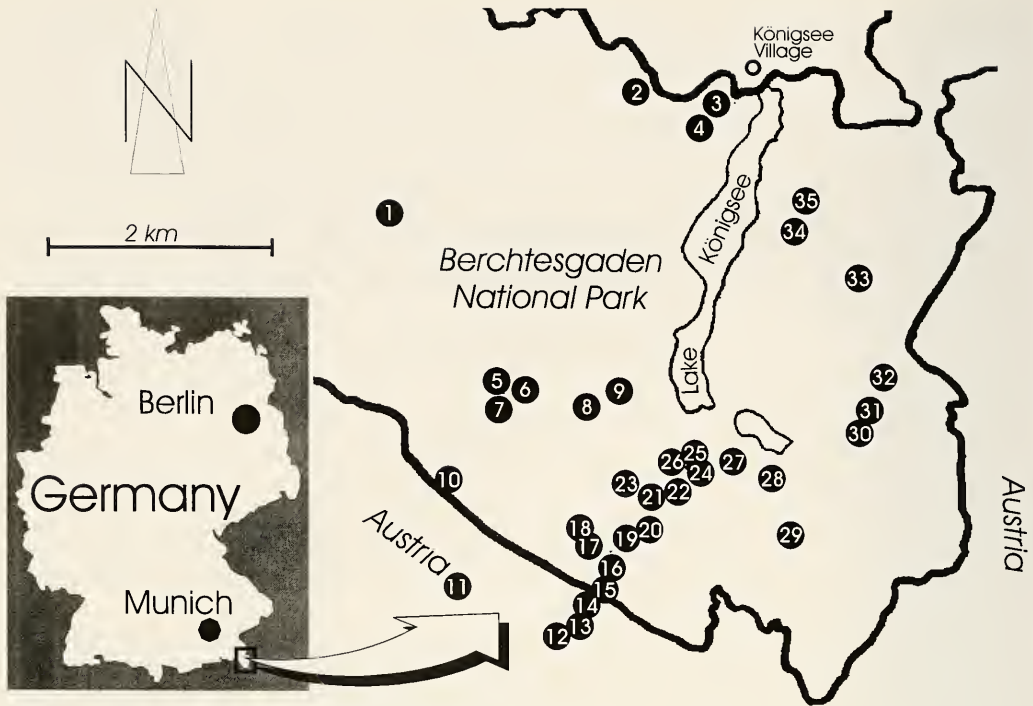


Fig. 1. Locations of sample sites (numbered as in tab. 1).

as many species-level identifications as possible, and (2) to compare the results with earlier studies sampling mainly larvae, and evaluate the methods used.

Sample sites

Four of the waters bodies investigated are situated in Austria, but the great majority of them are in Berchtesgaden National Park in the northern Calcareous Alps, around Lake Königsee (Upper Bavaria, Germany), between the Watzmann, Steinernes Meer, and Hagen mountains (Fig. 1). The rocks are often karstic and derive almost exclusively from marine sediments, mainly from the Triassic period. The area is characterized by steep slopes, plateaus and valleys. The vegetation is dominated by woods which decrease upward of about 2000 m a.s.l. Among the 35 sites on 30 waters studied, there are springs (rheocrenes, rheohelocrenes, hygropetric zones), spring brooks, meltwater pools and small lakes, located between 960 m and 2150 m a.s.l. An overview of their characteristics is given in Tab. 1.

Material and methods

As a survey of high taxonomic resolution was one of the main goals of the study, I sampled mainly the surface drift for pupal exuviae which can be determined at species level in most cases.

Sampling was performed with a hand net ("Thienemann-Kesher", mesh size 250 μm). The net was pulled across the surface of the water for 15 to 20 min at each sample site, in running waters in a certain stretch, in pools and small lakes in the littoral zone. As far as possible without damaging the habitat, this technique was used also in springs. In very small springs or hygropetric habitats, the chironomids were picked up with tweezers. Using these methods, I obtained pupal exuviae, larvae and, in small numbers, adults.

The sampling periods were from 25 to 30 June 1997 and from 16 to 19 July 1998, chosen to find all waters free of snow cover.

Tab. 1. Sample sites and their characteristics; . = no measurement; *) refer to Fig. 1.

site nr.*)	site name	m a.s.l.	water type	date of sampling	sampled material	date of measurements	discharge [l/s]	temperature [°C]	conduct. [µS/cm]	pH	oxygen [mg/l]
1	Mittergraben (Wimbachtal)	1300	brook	19.07.98	drift	.	.	.	.	.	.
2	Schapbach-Quelle	1120	rheocene	25.06.97	surface drift	.	.	.	.	.	.
3	Sommerbichl-Weide (spring)	1170	rheocene	26.06.97	surface drift	.	.	.	.	.	.
4	Herrenpoint "F"	1280	spring brook	25-26.06.97	drift	.	.	.	.	.	.
5	Graskopf (upper spring)	1840	rheocene	18.07.98	drift	18.07.98	0,25	4,5	209	8,12	10,8
6	Rauhe Köpfe	1860	lake	18.07.98	drift	18.07.98	0,10	3,8	150	8,56	11,8
7	Graskopf (pool)	1810	meltwater pool	18.07.98	drift	18.07.98.	.	24,0	.	.	.
8	Saugasse	1200	hygropetric	16.07.98	benthos	.	.	.	.	.	.
9	Schrainbachquelle	960	rheocene	30.06.97	surface drift	15.07.98	200,00	5,5	156	8,33	11,7
10	A spring NE of Ingolstädter Haus ("Hundstodscharte")	2040	rheocene	18.07.98	drift	18.07.98	0,10	.	.	.	.
11	Steinernes Meer (Wegscheid/Weißbachscharte)	2150	hygropetric	17.07.98	benthos	17.07.98	0,01	4,9	126	8,33	10,0
12	Wunderquelle	2000	hygropetric and small spring pool	17.07.98	benthos	17.07.98	0,02	5,2	124	8,41	10,5
13	Steinernes Meer, a lake NE of Wunderquelle	2050	lake	17.07.98	drift	17.07.98	0,20	12,2	117	8,48	10,1
14	Steinernes Meer, pool SW of mark "1949"	1990	meltwater pool	17.07.98	drift	17.07.98	0,00	11,5	108	8,66	11,1
15	Stuhigraben (100 m below trail, drift along a 50 m stretch)	1700	spring brook	16.07.98	drift	16.07.98	1,00	5,3	231	7,95	9,77
15	Stuhigraben (200 m stretch below spring)	1800	spring brook	16.07.98	drift	16.07.98	0,4	3,8	270	7,885	10,36
16	Rennergraben	1660	spring brook	30.06.97	drift	16.07.98	2,50	4,9	290	7,61	9,1
17	Funtensee, near Teufelsmühle	1601	lake	16.07.98	drift	16.07.98	10,00	10,1	226	8,47	9,9
18	Funtensee, southern shore	1601	lake	30.06.97	drift	.	.	.	.	.	.
19	Feldalm (lower spring)	1760	rheocene	16.07.98	drift	.	.	.	.	.	.
20	Feldalm (upper spring)	1780	rheocene	16.07.98	drift	.	.	.	.	.	.
21	Grünsee-Alm, meltwater pool	1600	meltwater pool	29.06.97	drift	.	.	.	.	.	.
22	Grünsee-Alm, spring	1600	rheocene	29.06.97	drift	16.07.98	15,00	2,9	158	8,23	11,2
23	Grünsee, SE shore	1474	lake	29.06.97	drift	.	.	.	.	.	.
24	Schwarzensee (around the spring region)	1560	lake	29.06.97	drift	.	.	.	.	.	.
25	Schwarzensee (near outlet)	1560	lake	29.06.97	drift	.	.	.	.	.	.
26	Schwarzensee (mud in the littoral)	1560	lake	29.06.97	drift	.	.	.	.	.	.
27	Halsköpfl (moss, stone, mud)	1680	hygropetric	29.06.97	benthos	.	.	.	.	.	.
28	Hüttau	1500	meltwater pool	29.06.97	drift	.	.	.	.	.	.
29	Wasseralm	1416	spring brook	29.06.97	drift	.	.	.	.	.	.
30	Landtal (30 m downstream from spring)	1540	spring brook	27.06.97	drift	.	.	.	.	.	.
31	Landtal-Quelle	1540	spring brook	29.06.97	drift	.	.	.	.	.	.
32	Mitterhüttenalm	1630	meltwater pool	29.06.97	drift	.	.	.	.	.	.
33	Abwärtsgraben	1450	spring brook	27.06.97	drift	.	.	.	.	.	.
34	Priesberg-Alm, below a cottage	1470	rheocene	27.06.97	drift	.	.	.	.	.	.
35	Priesberger Moos (above "Brantweinbrennhütte")	1360	meltwater pool	27.06.97	drift	.	.	.	.	.	.

In selected water bodies, temperature, conductivity, oxygen, and pH were measured with field instruments of WTW. The measurements were performed by Harald Haseke and Elmar Pröll of Calcareous Alps National Park in Upper Austria, who joined the excursions in 1998.

Results

a. General

A total of 94 chironomid taxa were recorded (see Tab. 2): 7 Tanypodinae, 9 Diamesinae, 1 Prodiamesinae, 56 Orthocladiinae, 21 Chironominae (9 Chironomini, 12 Tanytarsini). Taxonomic diversity ranged from 10 (Lake Grünsee, site nr. 23) to 0 (hygropetric springs, sites nr. 8 and 11).

Compared to the lists of Samietz (1996, 1999), three species are documented from Germany for the first time (*Diamesa wuelkeri* Serra-Tosio, *Corynoneura arctica* Kieffer, and *Parakiefferiella fennica* Tuiskunen). Samietz (1996) listed *D. wuelkeri* as “possible or likely” in Germany, and regarded the record of *C. arctica* by Dettinger-Klemm (1994) as doubtful. The present investigation has now proved the presence of *C. arctica* in Germany. *P. fennica* Tuiskunen had been recorded only from northern Palaearctic lakes (Langton 1991) and the Iberian Peninsula (Soriano et al. 1997). In Bavaria, compared to Reiss & Reiff (1995), five species were recorded for the first time: the former three plus *Heterotrisocladus grimshawi* (Edwards) and *Limnophes asquamatus* Andersen. For Austria, comparing to Janecek & Contreras (1995), *Chironomus nuditaris* Keyl is recorded for the first time.

A mathematical evaluation of the faunistic data did not lead to significant results. Taxonomic diversity did not correlate with altitude (m a.s.l.). A definite pattern of the distribution of species in the various waters could not be shown, as the numbers and abundances of the taxa were too low for statistical analysis.

However, some typical communities can be demonstrated with the species found.

- In the two **hygropetric habitats** investigated, only taxa from other dipteran families were found (*Thaumalea* spec., *Oxycera* spec., *Tipula* spec.), but no chironomids.
- In both **springs** (represented here by rheocrenes) and **spring brooks**, forms not strictly limited to spring areas (crenobiotic) were recorded. The communities were formed from cold-stenothermic, crenophilic (e.g. *Heleniella serratosioi*, *Diamesa wuelkeri*, *Metriocnemus eurynotus*, *Parakiefferiella fennica*), and epirhithral taxa. Additionally, members of *Limnophyes*, *Thienemanniella*, *Corynoneura* and *Eukiefferiella* were recorded regularly.
- In **small lakes**, species known from littoral zones of cold lakes were characteristic (e.g. *Tanytarsus sinuatus*, *Paratanytarsus* spp., *Corynoneura arctica*, *Cricotopus albiforceps*, *C. reversus*).
- In **meltwater pools** with moderate to heavy organic pollution, *Chironomus nuditaris* and *C. cingulatus* were found regularly.

In Tab. 2, the occurrences and abundances of the taxa are given, sorted according to water body type.

b. Taxonomic resolution

The distribution of identifications among taxonomic precision levels was as follows:

taxonomic level	number	% of all taxa
defined species	57	} 71
“cf.”	4	
between two species*	6	
sp. 1, spec. A, Pe 2a, b	8	} 26
species group	2	
genus (“spec.”)	14	
lower than “sp.”**	3	3

* e.g. *Eukiefferiella minor/fittkai*; ** e.g. Orthocladiinae gen. spec.

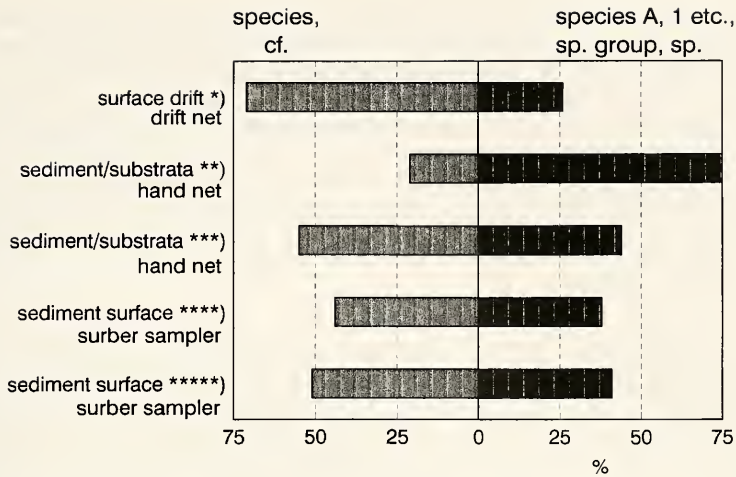


Fig. 2. Comparison of taxonomic determination levels achieved (in % of N = total number of taxa recorded) from different substrates, collecting methods, and studies. *) present study (N=94); **) Crema et al. (1996) (N=53 and 55, resp.); ***) Weigand & Tockner (1996) (N=63); ****) Janecek et al. (1991) (N=70); *****) Moog & Heinisch (1991) (N=150).

The different developmental stages were identified as follows:

taxonomic level	adults	pupal exuviae	larvae
defined species	7	46	25
"cf."			
between two species*)	2	6	17
sp. 1, spec. A, Pe 2a, b			
species group			
genus ("spec.")	-	-	3
lower than "spec." **)			

In summary, more than 2/3 of the taxa recorded could be determined to a level at least close to a defined species name. Most of these were based on pupal exuviae.

Comparing this distribution of taxonomic levels to earlier studies from Berchtesgaden National Park (Crema et al. 1996) and from the Austrian Calcareous Alps (Weigand & Tockner 1996, Janecek et al. 1991, Moog & Heinisch 1991), the present survey achieved the highest proportion of taxa determined to defined species (Fig. 2).

Discussion

The numbers of new records for Bavaria and Germany indicate the need for further study to gain a comprehensive overview of communities in Alpine habitats. Among the pupal exuviae collected there are forms of *Micropsectra* and *Smittia* that are probably new. F. Reiss had the opinion that it is very near to *M. seguyi* (*attenuata* group) from the Sierra Nevada. Sadly, his much too early death has made a description impossible at this time. From other invertebrate groups, new records and descriptions from Alpine spring ecosystems have also been reported recently (e.g. Hydracarina: Crema et al. 1996, Mollusca: Weigand & Tockner 1996). Thus, further new discoveries can be expected.

Most of the taxa recorded in this study can be found at lower altitudes as well. However, it is important to know up to what altitudes a species can occur (e.g. 2050 m for *Procladius choreus*, *Dicrotendipes modestus*, and *Tanytarsus sinuatus*, see tab. 2).

The lack of strictly crenobiontic species in the family Chironomidae has been noted by Lindegaard (1995) and can be confirmed from lowland springs (Orendt, in press). It seems also to be true for the

mined as “spec.,” “spec. group”, “agg.,” “spec. A, B ...” or “spec. 1, 2 ...” is higher in all the studies mentioned. In the work of Crema et al. (1996), this type of taxa is dominating. The present relative improvement is, of course, not a result of a better sampling strategy than was used by my esteemed colleagues, but rather a consequence of including pupal exuviae.

18 out of 38 taxa (47 %) determined from larval material could be identified to species level. This means that 20 % of all chironomid taxa recorded could be based on larvae. This proportion is too low to get a comprehensive overview of the communities. The situation can be improved by collecting pupal exuviae, which provides us with both a sufficient number of specimens and a higher taxonomic determination level, because identification of species from pupal exuviae is further developed than for larvae. Consequently, for further investigations I recommend to include the collection of pupal exuviae.

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