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Biological intercalibration: Invertebrates 1309

Sample processing at ICP Waters subcentre in Bergen. Photo: Tore Wiers.

International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes

Convention on Long-Range Transboundary Air Pollution

LRTAP
Long-range Transboundary Air Pollution

Norwegian Institute for Water Research
– an institute in the Environmental Research Alliance of Norway

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Abstract

The 14th intercalibration of invertebrates in the ICP Waters programme had contribution from five laboratories. The laboratories identified a high portion of the individuals in the test samples, usually > 90% of the total number of species. Shortcoming identifications below this limit were also noted. Few faults were recorded on genus level. The mean Quality assurance index was > 80 for all participating laboratories, indicating very good taxonomic work.

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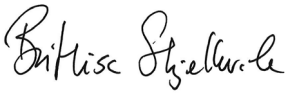
4. Overvåking	4. Monitoring



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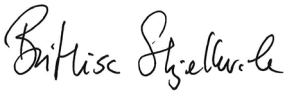

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CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING EFFECTS OF AIR POLLUTION ON RIVERS AND LAKES

Biological intercalibration:

Invertebrates 1410

ICP Waters Programme Subcentre
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Preface

The International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes (ICP Waters) was established under the Executive Body of the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) in July 1985. Since then ICP Waters has been an important contributor to document the effects of implementing the Protocols under the Convention. Numerous assessments, workshops, reports and publications covering the effects of long-range transported air pollution has been published over the years.

The ICP Waters Programme Centre is hosted by the Norwegian Institute for Water Research (NIVA), while the Norwegian Climate and Pollution Agency (Klif) leads the programme. The Programme Centre's work is supported financially by Klif.

The main aim of the ICP Waters Programme is to assess, on a regional basis, the degree and geographical extent of the impact of atmospheric pollution, in particular acidification, on surface waters. More than 20 countries in Europe and North America participate in the programme on a regular basis.

The Programme objective is to establish and maintain an international network of surface water monitoring sites and promote international harmonisation of monitoring practices. A tool in this work is the inter-laboratory quality assurance tests. The bias between analyses carried out by the individual participants of the Programme has to be identified and controlled. The tests will also be a valuable tool to improve the taxonomic skills of the participating laboratories.

We here report the results from the 14th intercalibration on invertebrate fauna

Bergen, November 2010

Arne Fjellheim

Contents

Summary

The International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes (ICP Waters) was established under the Executive Body of the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) in July 1985. The Programme objective is to establish and maintain an international network of surface water monitoring sites and promote international harmonisation of monitoring practices. A tool in this work is the inter-laboratory quality assurance tests. The bias between analyses carried out by the individual participants of the Programme has to be identified and controlled. The tests will also be a valuable tool to improve the taxonomic skills of the participating laboratories.

The 14th intercalibration of invertebrates in the ICP Waters programme had contribution from five laboratories. The laboratories identified a high portion of the individuals in the test samples, usually > 90% of the total number of species. Shortcoming identifications below this limit were also noted. Few faults were recorded on genus level. The mean Quality assurance index was > 80 for all participating laboratories, indicating very good taxonomic work.

1. Introduction

The purpose of the biological intercalibration is to evaluate the quality of the taxonomic work on the biological material delivered to the Programme centre. The quality can influence on the evaluation of the samples, which is based on the species and their tolerance (Raddum et al. 1988, Fjellheim and Raddum 1990, Raddum 1999). The control is therefore important for evaluation of the significance of trends in biotic indexes both for a specific site/watershed, as well as for comparisons of trends between different regions and countries. The material is also used for multivariate statistical analysis (Larsen et al. 1996, Skjelkvåle et al. 2000, Halvorsen et al. 2002). The results of this type of data treatment are especially sensitive to the quality of the species identification. The biological intercalibration focuses on the taxonomic skills of the participants and is a tool for improving the quality of work at the different laboratories as well as harmonisation of the biological database.

The methods for intercalibration of biological material were outlined in 1991 at the 7th ICP Waters Task Force meeting in Galway, Ireland. The different countries/laboratories have to know, first of all, their home fauna. Since the fauna in different geographical regions vary, it is necessary to prepare specific samples for each participating laboratory, based on their home fauna. It is a problem for the exercise of the intercalibration that it is not possible to use standardised samples for all participants. To solve this problem each laboratory send identified samples of invertebrates from their own monitoring sites to the Programme centre. The Programme centre will additionally add species known to be present in the region of the specific laboratory. Based on this, each laboratory receives individual test samples composed of species representing their own monitoring region.

In this report we have calculated the quality assurance index for the participants, see Raddum (2005). This index evaluates the skill of identifying the species as well as the genus. It also takes into account the effort of identifying all specimens in the sample. The highest index score is 100, while a value of 80 is set as the limit of good taxonomic work.

2. Methods

2.1 Preparation of test-samples

Samples of identified invertebrates were received from all participating laboratories. These samples were used to compose test samples, with the addition of specimens from earlier exercises and from own stocks. The geographical distribution of species is checked by the use of the Fauna Europaea Web Service (2004). This is a database of the scientific names and distribution of multicellular European land and fresh-water animals (see example in Figure 1).

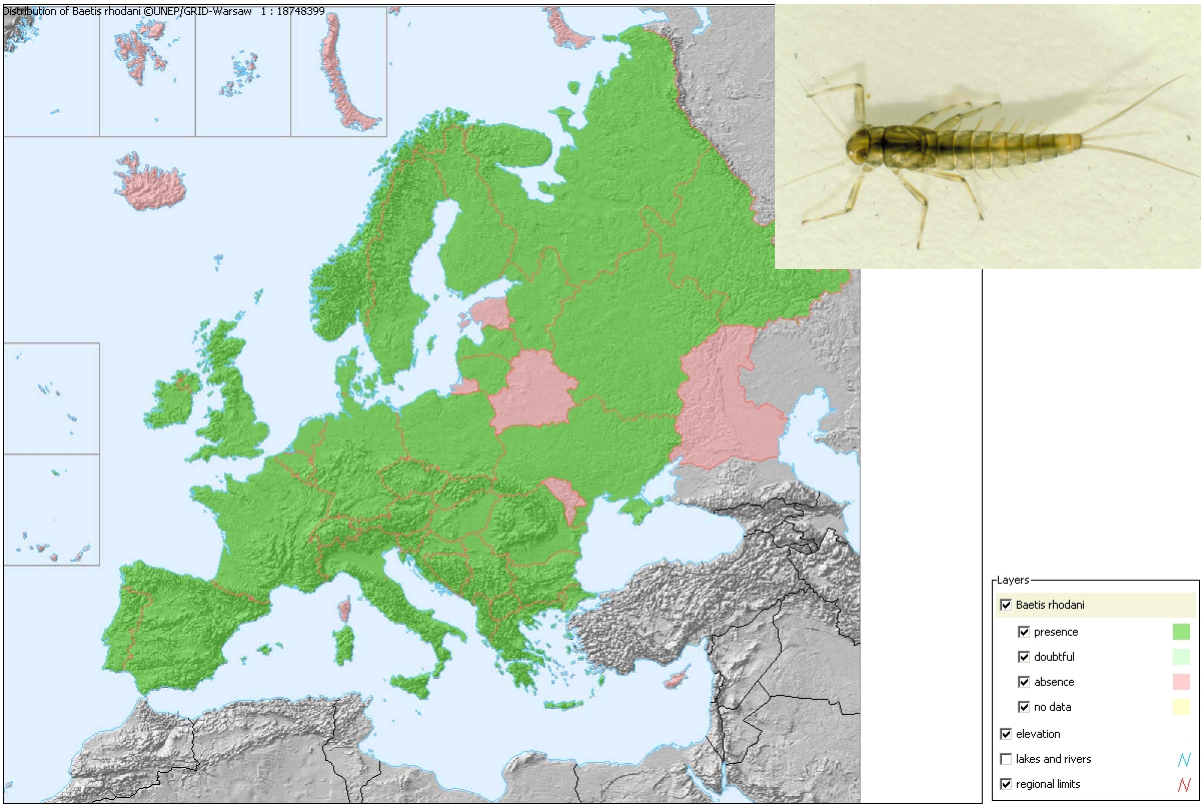

Figure 1. *Geographical distribution of the mayfly* Baetis rhodani *in Europe. This is an example of a widely distributed freshwater species. The species is recorded in all countries participating in the ICP Waters intercalibration with the exception of Estonia. Map after Fauna Europaea version 1.1, http://www.faunaeur.org, Photo: Arne Fjellheim*

2.2 Identification

To minimise possible faults the following procedure have been used in preparing the test samples:

- The participating country has first identified the source material for the test samples. Two of us have verified the identification of the species/taxa as far as possible without damaging the individuals.

- The content of the two test samples for each laboratory, with respect to species and numbers, is listed in a table. Two persons control that the correct number and species is placed in the test samples according to the list.

2.3 Damages of the material

The quality of the test material may be reduced during handling and shipping. Taxonomically important parts of the body, as gills, legs, cerci, mouthparts etc., can be lost or destroyed in actions connected with identification, sample composition and transportation. Contamination of larvae can also occur during these processes as well as during the identification work at the participating laboratories. All mentioned possibilities for faults could influence on the results of the identifications and disturb the results in a negative way.

2.4 Evaluation

The results of the tests are sent to the laboratories for eventual comments before publishing the report. In this way we can remove taxonomical biases, for example misidentified or destroyed test material. In cases of disagreement material may be sent back to the Programme subcentre for control. This procedure may act educational for both parts.

For calculation of faults (in percent), we must take into account possible destructions of the material as mentioned above. Further, a wrong identification of a species is one fault even if the sample contains many individuals of the species. We encourage the participants to give comments on matters that may impede the identification. For example, misidentification of species may in cases where important taxonomic characters have been destroyed, be neglected if this is pointed out by the participant.

We have discriminated between "short coming" identification, probably due to damaged material, and virtual fault (wrong species - or genus name). Due to this, some subjective evaluations of the results have to be made. The percent of faults is therefore not always the exact calculated percent of faults, but can be a modified value where some “expert judgement” is taken into account.

It is also of interest to know how many individuals that have been identified of the total number in the sample. This is named *% identified*. A low percent means that many individuals are not identified and will consequently reduce the value of the taxonomic work.

Available material for making test samples varies. The number of individuals and number of species delivered will therefore differ. Normally each laboratory gets between 50 and 80 individual species in the two samples. Samples with low diversity will be easier to handle than samples with high diversity, see Appendix tables. This should also be kept in mind when the results are evaluated. On the other hand, small samples should be avoided as only a few misidentifications could result in a low score.

We have calculated the quality assurance index, Qi, for important groups of invertebrates as well as the mean index for each participant. The Qi integrates the separate levels of the identifications as follows:

Qi = % correct species/10 * % correct genus/10 * % identified individuals/100

Qi will be a number between 0 and 100. 100 are the highest score that can be obtained. A score ≥80 is regarded as good taxonomical work.

2.5 Test of the subcentre

The ICP waters subcentre in Bergen is tested with the help from Sweden. The Swedish University of Agricultural Sciences in Uppsala prepares and evaluates the test of the subcentre. Methodology and implementation is otherwise identical to the other tests.

3. Results and discussion

Five laboratories participated in the intercalibration of invertebrates in 2010 (Appendix A). The content of species in the test samples delivered - and the results of the identification by the different laboratories are shown in Appendix Tables 1 - 5.

3.1 Mayflies

The identification of mayflies (Ephemeroptera) was generally good (Figure 12, Appendix Table 1-5). Laboratory 5 identified the mayflies without faults. The results from the other laboratories were acceptable, with only minor faults. The Qi was calculated to 94, 92, 95, 88 and 100 for laboratories 1, 2, 3, 4 and 5, respectively. This indicates high quality of work for all laboratories.

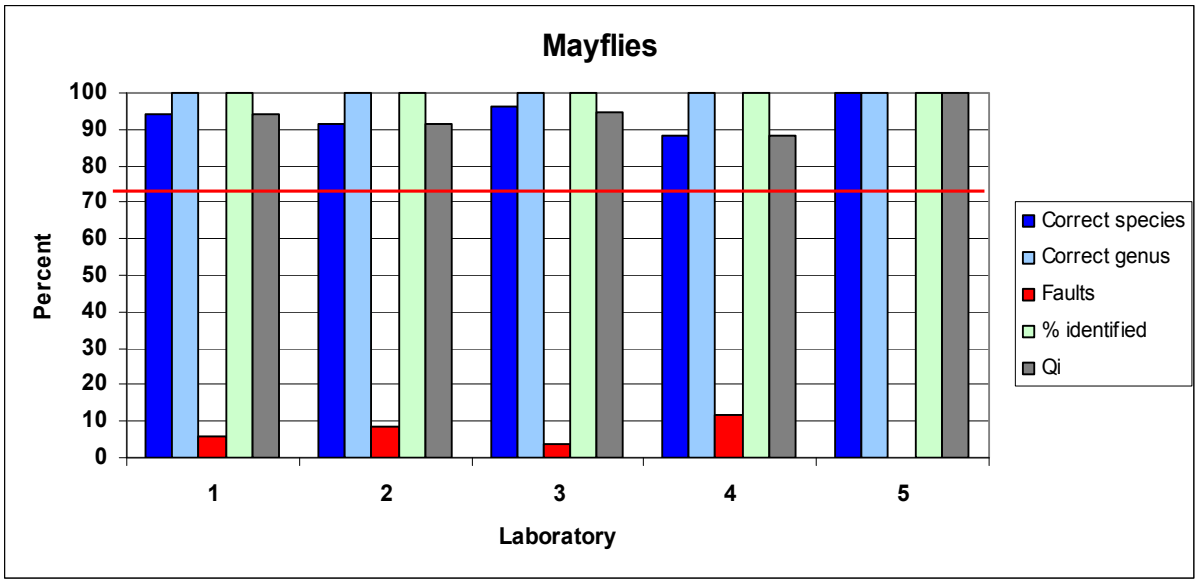

Figure 2. *Results of the identification of mayflies.*

3.2 Stoneflies

Laboratory 3 and 5 identified the stoneflies (Plecoptera) without faults, while the results from the rest of the participants were acceptable (Figure 3, Appendix tables 1 - 5). The Qi was calculated to 90, 94, 100, 82 and 100 for laboratories 1, 2, 3, 4 and 5, respectively.

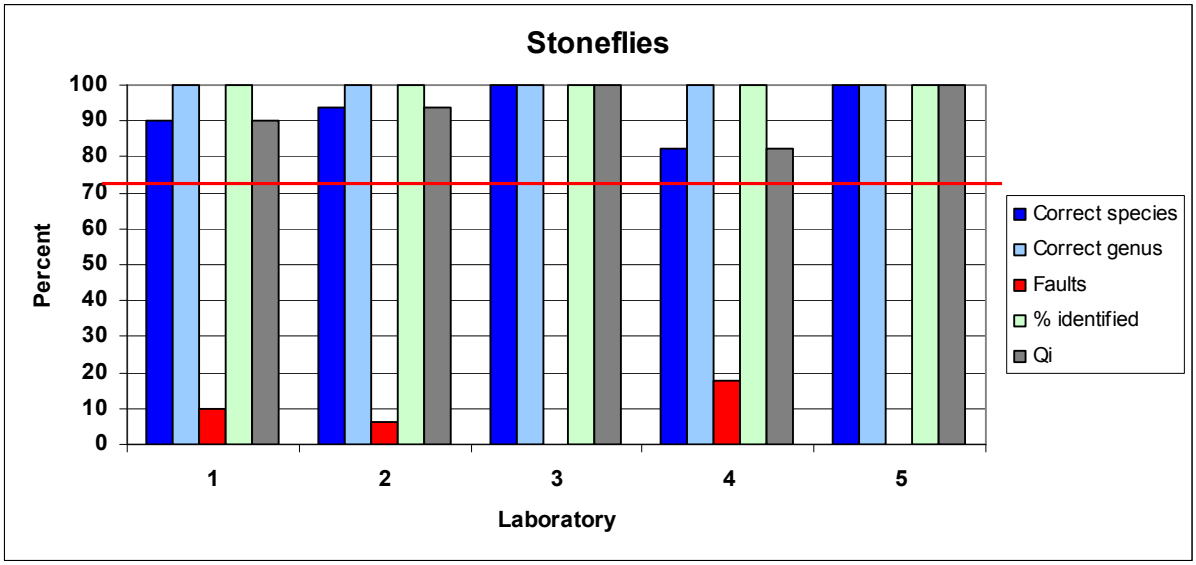

Figure 3. *Results of the identification of stoneflies.*

3.3 Caddisflies

The identification of caddisflies (Trichoptera) is presented in Figure 4. Laboratory 2, and 4 identified all specimens correctly. The *% identified* was 100% for all participants. The taxonomic work on caddisflies was overall regarded as very good with Qi values of 94, 100, 97, 100 and 90, for participants 1, 2, 3, 4 and 5, respectively.

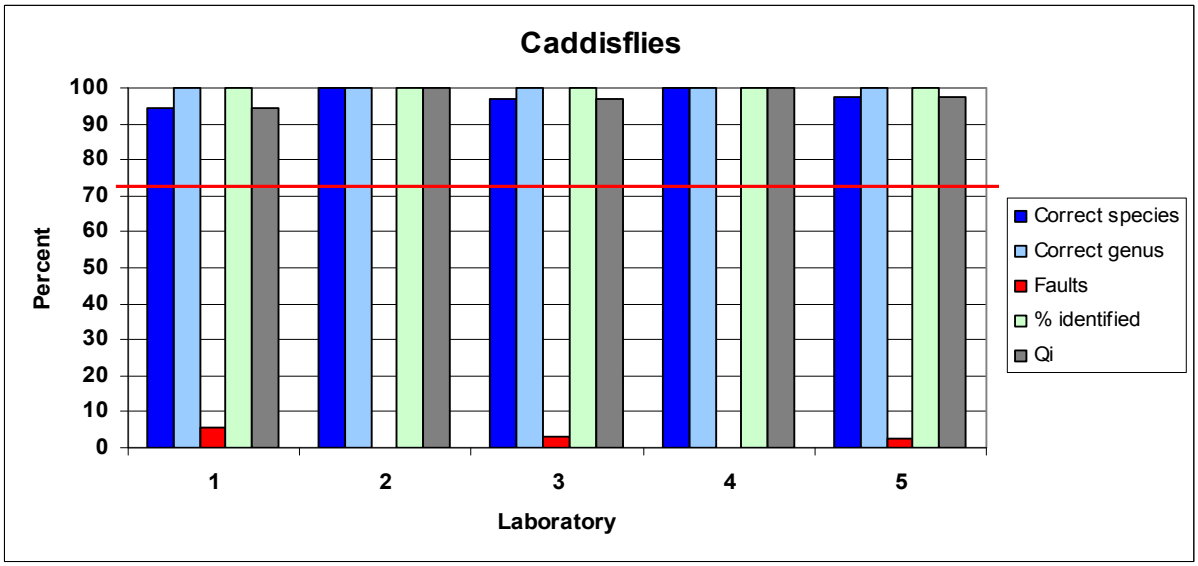

Figure 4. *Results of the identification of caddisflies.*

3.4 Other groups

In this intercalibration we have included water beetles (Coleoptera), larger crustaceans (Malacostraca), leeches (Hirudinea), molluscs (Gastropoda), alder-flies (Megaloptera), Diptera etc. Both larvae and imagines have been included for some of the groups. Leeches, molluscs and larger crustaceans are sensitive to acid water and important for the evaluation of acidification. The tolerance of the invertebrates among Coleoptera, Megaloptera, Diptera etc. is little known, but generally they are regarded as tolerant to acidic water and consequently have low importance for evaluation of acidity indices. However, all species will be important for invertebrate community analysis. Figure 5 shows the results of the identification of these groups. The identifications made by laboratory 1, 3 and 5 were perfect with no faults. The quality of laboratory 2 was also very good. Laboratory 4 got a Qi score slightly below the level of acceptance. The reason for this was partly misidentifications and partly the fact that not all animals were identified. The Qi score was 100, 97, 100, 77, and 100, for participants 1, 2, 3, 4 and 5, respectively.

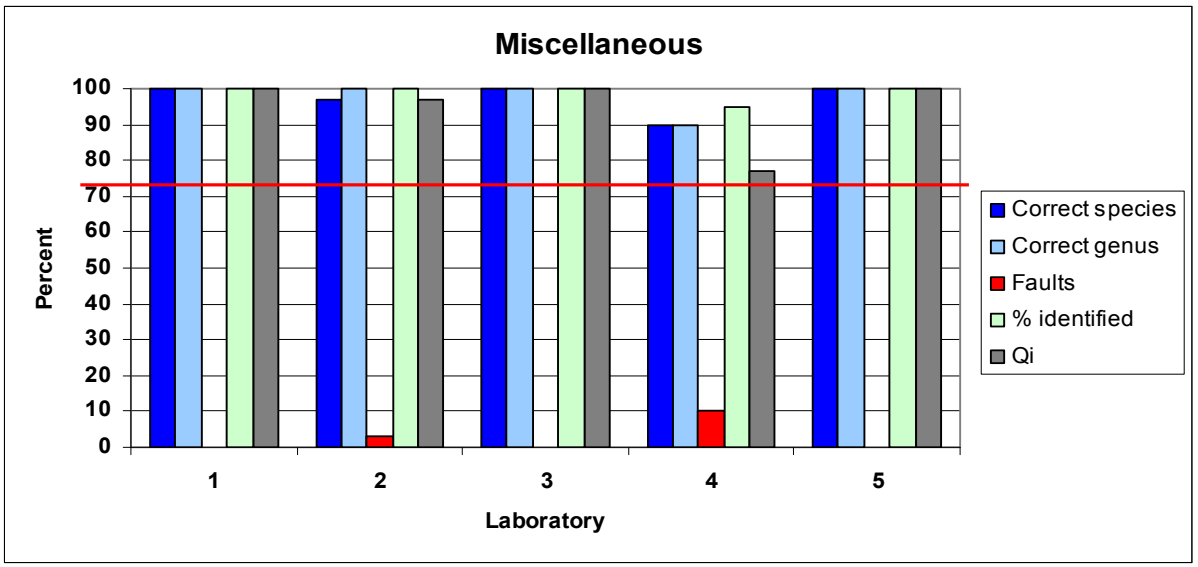

Figure 5. *Results of the identification of miscellaneous groups*

3.5 Total number of species in the sample

There were generally low discrepancy between the number of individuals put into the samples and the reported number of larvae. A total of 429 individual specimens were sent to the different laboratories. Of these 99 percent were reported back to the Programme subcentre.

4. Evaluation/conclusion

The laboratories generally identified a high portion of the total number of species in the test samples. Shortcoming identification was low and indicated a good taxonomic skill by the participants. The mean skill of identifying species and genus and Qi score per laboratory is shown in Figure 6. Laboratory 1 to 5 got a mean Qi score of 95, 96, 98, 87 and 99, respectively. All tests were characterized as very good taxonomic work. The biological intercalibration is important for harmonising biological material/databases and will be of high value in programmes where community analyses is in focus or where the ecological status should be stated, like EU Water Framework Directive.

None of the participants did misidentifications that could result in a wrong acidity index, based on the Raddum score (Raddum et al., 1988).

The biological intercalibration under the ICP Waters Programme is a unique test, as it operates on a species level. A similar test is run by the Natural History museum, London, aiming to test skills in identifying British freshwater macroinvertebrates to major groups, mostly to family level (Identification Qualifications – IdQ test). The invertebrate groups covered in this test are those used in the BMWP water quality score system (Armitage et al., 1983) and include groups used for monitoring freshwater environments under the EU Water Framework Directive (Schartau et al. 2008).

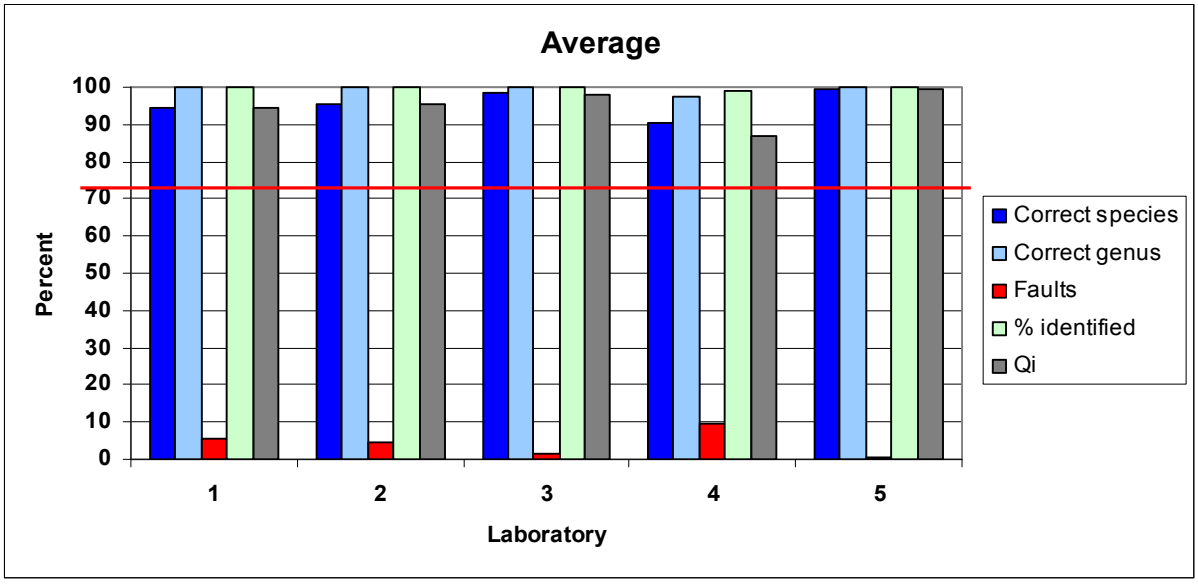

Figure 6. *Mean skill in percent of identifying species and genus and mean Qi for each laboratory.*

5. Acknowledgements

We wish to thank Lars Eriksson at the Swedish University of Agricultural Sciences, Uppsala for performing the intercalibration test of benthic invertebrate laboratory the ICP Waters subcentre, Uni Research, Bergen.

6. References

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Appendix A. Identified species/genus

Each participating laboratory is identified by a number, which is identical with table number. Laboratories participating in the intercalibration of invertebrates in 2010 and their code numbers are:

1. Latvian Environment, Geology and Meteorology centre, Maskavas Street 165, Riga, LV-1019, **Latvia**
2. Swedish University of Agricultural Sciences, Dept. of Environmental Assessment, P.O. Box 7050, S-75007 Uppsala, **Sweden**
3. Uni Research, Thormøhlensgt. 49, N-5006 **Norway**
4. Institute for Environmental Studies, Faculty of Science, Charles University, Prague, **Czech Republic**
5. Finnish Environment Institute, Monitoring and Assessment Unit, Survontie 9, FIN-40500 Jyväskylä, **Finland**

Appendix table 1. Identified species/genus in sample 1 and 2 by Laboratory 1

Table 1	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Caenis macrura	1		1	
Caenis luctuosa		1		1
Caenis horaria	1	1	1	1
Brachycerus harrisella	1	1	1	1
Cloeon dipterum	1	1	1	1
Kageronia fuscogrisea	1	1	1	1
Heptagenia sulphurea			1	1
Ephemera danica	1	1	1	1
Ephemerella aurivilli	1	1		
Seratella ignita			1	1
Potamanthus luteus	1	1	1	1
Plecoptera				
Amphinemura borealis	1	1	1	
Amphinemura sulcicollis				1
Nemoura avicularis	1	1	1	1
Nemoura cinerea	1	1	1	1
Taeniopteryx nebulosa	1	1	1	1
Isoperla grammatica	1	1	1	1
Trichoptera				
Mystacides longicornis	1	1	1	1
Brachycentrus subnubilus	1	1	1	1
Molanna angustata	1	1	1	1
Ecnomus tenellus	1	1	1	1
Lepidostoma hirtum	1	1	1	1
Lasiocephala basalis	1	1	1	1
Cheumatopsyche lepida	1	1		
Hydropsyche angustipennis	1	1		
Hydropsyche siltalai	1	1	1	1
Hydropsyche pellucidula			1	1
Ironoquia dubia	1	1	1	1
Notidobia ciliaris	1	1	1	1
Athripsodes aterimus	1	1		
Athripsodes cinereus			1	1
Neureclipsis bimaculata	1	1	1	1
Cyrnus trimaculatus	1	1		
Cyrnus flavidus			1	1
Polycentropus irroratus	1		1	
Polycentropus flavomaculatus		1		1
Leptocerus tineiformis	1	1	1	1
Plectrocnemia conspersa	1	1	1	1
Hydropsyche contubernalis	1	1	1	1
Gastropoda				
Viviparius viviparius	1	1		
Viviparius contectus			1	1
Bithynia leachi	1	1		
Bithynia tentaculata			1	1
Theodoxus fluviatilis	1	1	1	1
Bathyomphalus contortus	1	1	1	1
Physa fontinalis	1	1	1	1
Acroloxus lacustris	1	1	1	1
Bivalvia:				
Dreissena polymorpha	1	1	1	1
Hirudinea				
Erpobdella octoculata	1	1	1	1
Glossophonia heteroclita	1	1	1	1
Crustacea:				
Gammarus lacustris	1	1	1	1
Diptera:				
Atrichops crassipes	1	1	1	1
Coleoptera:				
Elmis aenea	1	1	1	1
Brychius elevatus	1	1	1	1
Limnius volckmari	1	1	1	1
Heteroptera:				
Apheloceirus aestivalis	1	1	1	1

Appendix table 2. Identified species/genus in sample 1 and 2 by Laboratory 2

Table 2	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Baetis rhodani	1	1	1	1
Nigrobaetis digitatus	1	1	1	1
Kageronia fuscogrisea	1	1		
Heptagenia sulphurea			1	1
Ephemerella aurivilli			1	1
Seratella ignita	1	1		
Caenis horaria			1	1
Caenis luctuosa	1	1		
Leptophlebia vespertina			1	
Leptophlebia marginata	1	1		1
Plecoptera				
Amphinemura borealis	2	1		
Amphinemura sulcicollis	1	1	1	1
Capnopsis shilleri	1	1	1	1
Protonemura meyeri	1	1	1	1
Leuctra fusca	1	1	1	1
Leuctra hippopus	1	1	1	1
Nemoura cinerea	1	1	1	
Nemoura flexuosa				1
Nemurella pictetii	1	1	1	1
Trichoptera				
Hydropsyche siltalai	1	1	1	1
Hydropsyche pellucidula	1	1	1	1
Rhyacophila fasciata	1	1	1	1
Rhyacophila nubila	1	1	1	1
Sericostoma personatum	1	1	1	1
Micrasema gelidum	1	1	1	1
Lepidostoma hirtum	1	1	1	1
Philopotamus montanus	1	1	1	1
Brachycentrus subnubilus	1	1	1	1
Tinodes waeneri	1	1	1	1
Oligochaeta				
Stylaria lacustris	1	1	1	1
Gastropoda:				
Valvata cristata	1	1	1	1
Anisus vortex	1	1	1	1
Bithynia tentaculata	1	1	1	1
Physa fontinalis	1	1	1	1
Hirudinea				
Helobdella stagnalis	1	1	1	1
Erpobdella octoculata	1	1	1	1
Crustacea				
Gammarus pulex	1	1	1	
Gammarus lacustris				1
Asellus aquaticus	1	1	1	1
Odonata				
Erythromma najas	1	1	1	1
Cordulegaster boltoni	1	1	1	1
Diptera:				
Chaoborus flavicans	1	1	1	1
Coleoptera:				
Orectochilus villosus	1	1	1	1
Limnius volcmari	1	1	1	1
Platambus maculatus	1	1	1	1
Hydraena gracilis	1	1	1	1

Appendix table 3. Identified species/genus in sample 1 and 2 by Laboratory 3

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Caenis horaria	2	2		
Caenis luctuosa			2	2
Kageronia fuscogrisea	2	2		
Heptagenia sulphurea	1	1		
Heptagenia dalecarlica			2	2
Ameletus inopinatus	1	1	1	1
Nigrobaetis digitatus	1	1		
Nigrobaetis niger			1	1
Baetis rhodani	1	1	2	2
Alainites muticus	1	1	1	1
Ephemerella aurivilli	1	1	1	1
Ephemerella mucronata			1	1
Seratella ignita	1	1		
Ephemera danica	1	1		
Leptophlebia marginata	1	1	1	1
Siphlonurus aestivalis	1			
Siphlonurus lacustris		1		
Plecoptera				
Siphonoperla burmeisteri	1	1		
Brachyptera risi			1	1
Taeniopteryx nebulosa	1	1	1	1
Isoperla grammatica	1	1	1	1
Leuctra nigra	1	1		
Protonemura meyeri	1	1		
Amphinemura borealis	1	1	1	1
Amphinemura sulcicollis			1	1
Nemoura cinerea	1	1		
Nemoura avicularis			1	1
Nemurella pictetii			1	1
Diura nanseni			1	1
Trichoptera				
Neureclipsis bimaculata	1	1	1	1
Plectrocnemia conspersa			1	1
Polycentropus flavomaculatus			1	1
Polycentropus irroratus	1	1		
Cyrnus flavidus	1	1	1	1
Cyrnus trimaculatus			1	1
Hydropsyche siltalai	1	1		
Hydropsyche pellucidula	1	1	1	1
Hydropsyche angustipennis			1	1
Rhyacophila nubila	1	1	1	1
Rhyacophila fasciata			1	1
Tinodes waeneri	1	1	1	1
Agapetus ochripes	2	1	1	1
Agapetus sp.		1		
Athripsodes cinereus			1	
Athripsodes sp.cf.*albifrons*				1
Lepidostoma hirtum	1	1		
Mystacides azurea			1	1
Goera pilosa			1	1
Ceraclea annulicornis			1	
Ceraclea sp.				1
Sericostoma personatum	1	1		
Chimarra marginata	1	1		
Oecetis testacea	1	1	1	1
Micrasema sp.	1	1		
Philopotamus montanus			1	1
Brachycentrus subnubilus	1	1		
Gastropoda:				
Bathyomphalus contortus	1	1		
Hippeutis complanatus			1	1
Physa fontinalis			1	1
Valvata cristata	1	1		
Hirudinea				
Erpobdella octoculata	1	1	1	1
Helobdella stagnalis			1	1
Crustacea:				
Asellus aquaticus	1	1	1	1
Gammarus lacustris	1	1	1	1
Gammarus pulex	1	1		
Monoporeia affinis			1	1
Odonata				

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Somatochlora metallica	1	1		
Coleoptera:				
Elmis aenea	2	2	1	1
Hydraena gracilis	1	1	1	1
Limnius volkmari	1	1	1	1
Megaloptera:				
Sialis fuliginosa			1	1
Sialis lutaria	1	1		
Diptera:				
Chaoborus flavicans	1	1	1	1

Appendix table 4. Identified species/genus in sample 1 and 2 by Laboratory 4

Table 4	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Caenis robusta	1	1		
Caenis moesta			1	1
Ephemera danica	1	1		
Rhitrogena semicolorata	1	1		
Ecdyonurus torrensis			1	1
Epeorus sylvicola	1	1		
Ephemerella ignita			1	1
Ephemerella mucronata	1	1	1	1
Leptophlebia vespertina	1	1	1	
Leptophlebia marginata				1
Siphlonurus armatus	1	1	1	1
Cloeon dipterum	1		1	
Baetidae indet.		1		1
Baetis fuscatus	1		1	
Baetis sp.		1		1
Plecoptera				
Siphonoperla torrentium	1		1	
Siphonoperla neglecta		1		
Siphonoperla taurica				1
Amphinemura sulcicollis	1	1		
Nemoura cinerea	1	1	1	1
Nemoura avicularis	1	1	1	1
Protonemura auberti			1	1
Protonemura cf. nitida		1		
Protonemura montana	1		1	
Leuctra rauscheri/teriolensis	1	1	1	1
Leuctra handlirschi/pusilla	1			
Leuctra major	1	1	1	1
Perla marginata		1	1	
Diura bicaudata	1	1		
Trichoptera				
Ptilocolepus granulatus	1	1	1	1
Mystacides azurea	1	1	1	1
Agrypnia varia			1	1
Phryganea bipunctata	1	1		
Oligotricha stritata			1	1
Limnephilus rhombicus	1	1		
Molanna nigra	1	1	1	1
Molannodes tinctus	1	1		
Cyrnus flavidus	1	1		
Plectrocnemia geniculata			1	1
Holocentropus dubius	1	1	1	1
Turbellaria:				
Crenobia alpina			1	1
Bivalvia:				
Pisidium casertanum	1	1	1	1
Diptera:				
Wiedemannia sp.	1	2		
Euphylidorea (meigeni cf.*)*			1	
Chaoborus (obscuripes cf.*)*	1		1	1
Chaoborus flavicans		1		
Chelifera sp.	1			
Coleoptera:				
Hydroporus palustris			1	1
Deronectes latus	1	1		
Nebrioporus assimilis	1	1	1	1
Heteroptera:				
Callicorixa praeusta	1	1		
Glaeonocorisa propinqua			1	1
Sigara lateralis	1	1		
Sigara fossarum			1	1
Sigara nigrolineata	1	1		
Plea minutissima			1	
Notonecta glauca				1
Megaloptera:				
Sialis fuliginosa	1	1		
Sialis lutaria			1	1

Appendix table 5. Identified species/genus in sample 1 and 2 by Laboratory 5

Table 5	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Ephemerella aurivilli	1	1	1	1
Ephemerella mucronata	1	1	1	1
Ephemerella ignita	1	1	1	1
Nigrobaetis digitatus	1	1	1	1
Baetis rhodani	1	1	1	1
Nigrobaetis niger	1	1	1	1
Alainites muticus	1	1	1	1
Ameletus inopinatus	1	1	1	1
Heptagenia dalecarlica	1	1		
Kageronia fuscogrisea	1	1	1	1
Heptagenia sulphurea			1	1
Caenis luctuosa	1	1	1	1
Plecoptera				
Protonemura intricata	1	1	1	1
Taeniopteryx nebulosa	1	1	1	1
Siphonoperla burmeisteri	1	1	1	1
Diura nanseni	1	1	1	1
Trichoptera				
Ceratopsyche silfvenii	1	1	1	1
Ceratopsyche nevae	1	1	1	1
Hydropsyche siltalai	1	1	1	1
Hydropsyche pellucidula	1	1	1	1
Hydropsyche saxonica	1	1	1	1
Cheumatopsyche lepida	1	1	1	1
Arctopsyche ladogensis	1	1	1	1
Silo pallipes	1	1	1	1
Philopotamus montanus	1	1	1	1
Chimarra marginata	1	1	1	1
Polycentropus flavomaculatus	1	1	1	1
Plectrocnemia conspersa	1	1	1	1
Neureclipsis bimaculata	1	1	1	1
Wormaldia subnigra	1	1	1	1
Rhyacophila nubila	1	1	1	1
Lepidostoma hirtum	1	1	1	1
Agapetus ochripes	1	1	1	1
Micrasema gelidum	1	1	1	1
Micrasema setiferum	1		1	1
Sericostoma personatum	1	1	1	1
Phryganea bipunctata	1	1	1	1
Malacostraca:				
Asellus aquaticus	1	1	1	1
Gammarus lacustris	1	1	1	1
Coleopteraa:				
Olimnius tuberculatus	1	1		
Limnius volckmari			1	1
Stenelmis caniculata	1	1	1	1
Elmis aenea	1	1	1	1
Odonata:				
Platycnemsis pennipes	1	1	1	1
Cordulegaster boltoni	1	1		
Onychgompus forcipatus			1	1
Ophiogomphus cecilia	1	1	1	1
Diptera:				
Atherix ibis	1	1	1	1

Appendix B. Reports and publications from the ICP Waters Programme

All reports from the ICP Waters Programme from 1987 up to present are listed below. All reports are available from the Programme Centre. Reports and recent publications are also accessible through the ICP Waters website; http://www.icp-waters.no/

Manual for Chemical and Biological Monitoring. Programme Manual. Prepared by the Programme Centre, Norwegian Institute for Water Research. NIVA, Oslo 1987.

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Norwegian Institute for Water Research, 1988. Intercalibration 8802. pH, K_{25}, HCO_3, NO_3, SO, Cl, Ca, Mg, Na, K. Programme Centre, NIVA, Oslo.

Proceedings of the Workshop on Assessment and Monitoring of Acidification in Rivers and Lakes, Espoo, Finland, 3rd to 5th October 1988. Prepared by the Finnish Acidification Research Project, HAPRO, Ministry of Environment, October 1988.

Norwegian Institute for Water Research, 1989. Intercalibration 8903: Dissolved organic carbon and aluminium fractions. Programme Centre, NIVA, Oslo. **NIVA-Report SNO 2238-89**.

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Johannessen, M. 1990. Intercalibration in the framework of an international monitoring programme. Proceedings of the third annual Ecological Quality Assurance Workshop, Canada Centre for Inland Waters, Burlington Ontario. Programme Centre, NIVA, Oslo.

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Norwegian Institute for Water Research, 1990. Data Report 1989. Programme Centre, NIVA, Oslo.

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Hovind, H. 1992. Intercalibration 9206: pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, Al and DOC. Programme Centre, NIVA, Oslo. **NIVA-Report 2784-92**.

Norwegian Institute for Water Research, 1992. Data Report 1990. Programme Centre, NIVA, Oslo.

Norwegian Institute for Water Research, 1992. Evaluation of the International Co-operative Programme on Assessment and Monitoring of Acidification in Rivers and Lakes. Programme Centre, NIVA, Oslo.

Hovind, H. 1993. Intercalibration 9307: pH, k_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, reactive and non-labile aluminium, TOC and COD-Mn. Programme Centre, NIVA,Oslo. NIVA-Report 2948-93.

Raddum, G.G. 1993. Intercalibration of Invertebrate Fauna 9301. Programme Centre, NIVA, Oslo. **NIVA-Report SNO 2952-93.**

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