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Development of regional models of groundwater fauna in South Korea

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1. Introduction

Sustainable use of landscapes and resources requires special techniques for assessment and evaluation that are adapted to the different biotopes considered(Hahn, 2002). Water management, in dealing with one of the most important resources, has to uphold some general principles. A very significant one is the principle of regionality.

Until now, in Europe considerable work is being undertaken to formulate regional models of macrobenthic communities of springs and streams. In contrast, knowledge of regional patterns fauna in groundwater is scant. However groundwater is one of the most important resources and also one of the biggest living spaces on earth, populated by a species rich fauna, the so-called stygofauna. These long-living animals are highly adapted to their biotope and they are blind and colourless and their body shape is stretched. Also they have a reduced metabolism and low rates of reproduction.

As a result of their high adaptation and their long life span, stygofauna are probably well suited as bioindicators(Hahn and Friedrich, 1999). A presupposition using stygofauna as bioindicators is the knowledge of characteristical regional groundwater communities. Hence, developing regional models of stygofaunal communities is important for the assessment of groundwater conditions. In order to clarify applied questions (e.g. biomonitoring, sustainable use of groundwater, protection of species and biotopes), it is necessary to describe reference communities, which serve as a basis for the development of regional models. Informations on the distribution of stygofauna as well as knowledge on their ecological demands and biogeography are rare, because of the world-wide insufficient data.

Freshwater ecological systems are strongly influenced by the abiotic and biotic parameters of their catchment area. In particular groundwater biotopes are highly diverse. There may be alluvial, porous and fractured rock aquifers ordered in several layers within the same landscape. On the catchment scale, these aquifers often interact with each other and also with surface water. On the small scale, hydrochemical and substrate conditions may change within a few meters, or even centimeters (Hahn, 2002). Distribution of stygofauna seems to be strongly influenced by these factors. In order to explore large scale distribution of stygofauna and to be able to describe the typical stygofaunal communities of a country or catchment, a representative set of sampling sites has to be selected. In each

landscape, stygofaunal samples must be taken in each type of aquifer and in several depths. Due to patchy distribution of fauna repeated sampling must be carried out at each site. As a consequence, a high number of sampling sites and probes are required in accompany with a challenge that can only be addressed with a cheap and fast sampling technique.

While this concept was often used to characterize superficial aquatic fauna, very few studies were done on stygofauna with this background (Steenken 1998; Ronneberger, 1975; Wegelin, 1966; Humphreys, 2001). But no study has yet been carried out on the groundwater fauna of a whole state. The significance of investigations regarding administrative borders is the possibility of developing state-wide concepts for the sustainable management of groundwater and for the conservation of stygofauna.

2. Aims and Issues

This is the first study in Korea to investigate groundwater fauna representatively and to relate their distribution to special aspects of landscape, geological and physico-chemical factors, considering land use. The study shall develop regional models of stygofauna communities for assessment of groundwater conditions besides an overview of the stygofauna and the groundwater landscapes of Korea. With these results it is possible to determine regionalized quality targets for groundwater. Groundwater management, protection and conservation can be specified by appointment of regional models. And water management plans for sustainable usage of groundwater can be compiled. Also the study is a presupposition to develop a stygofaunal bioindicator system. A bioindicator system can help to clarify the hydrological situation in the groundwater fast and cost-efficient. In addition, it is able to make statements about the pollution degree.

In this study, the questions about the differences concerning groundwater fauna within different naturraum's and groundwater landscapes in Korea shall be settled. Which role can be attributed to the geological and biogeographical factors, the hydrochemical factors and the type of land use? And to what extent are these differences influenced and determined by abiotic factors? To answer these questions following goals of this study have to be accomplished:

- Survey and description of the stygofauna in Korea and particularly in Nakdong catchment.
- Development of regional models for the groundwater fauna of Korea and the Nakdong catchment.
- Attempt of an assessment of the environment factors influencing stygofauna.
- Selection of suitable sampling sites for a medium-term to long-term biomonitoring

3. Methods

Approximately 200 ground water wells distributed over whole Korea are examined. These sampling sites cover large parts of the landscape areas of Korea. The sampling of the measuring points is carried out exclusively with plankton nets, so-called net samplers, developed for this kind of sampling especially. Several authors, inter alias Hahn(2001), Dumas and Fontanini(2001) and Malard et

al.(1997) describe net collectors as an adequate method for the extraction of groundwater fauna. Earlier examinations of Steenken (1998) prove that the species composition in the measuring pipes largely corresponds to the one of the surrounding groundwater. The population density, however, is much higher than in the surrounding medium. For the withdrawal of the faunistic sample the net sampler with a mesh size of 74 µm is used that is invented by Fuchs and Hahn. The animals can be taken with this special net sampler fast and economically. The net sampler can be used for sampling the stygofauna from boreholes with a diameter over 5 cm. The parameters such as oxygen content, oxygen saturation, water temperature, conductivity and pH value, nitrate and manganese are examined.

4. Preliminary results and discussion

The examination of the stygofauna in Korea has just started, so that still no secured results are present. In the near future samplings of the boreholes will be continued.

Up to now animals could be locked in 58 % of all samples and 260 individuals were determined and assigned to the higher taxa. These results are similar to them in german studies. In Figure 1 is shown evidently that 52.1 % of caught individuals are cyclopids. Considers one the nauplii is it even 55 %. The next frequent groups are the Nematoda and Ostracoda with 6.9 % and 6.2 %.

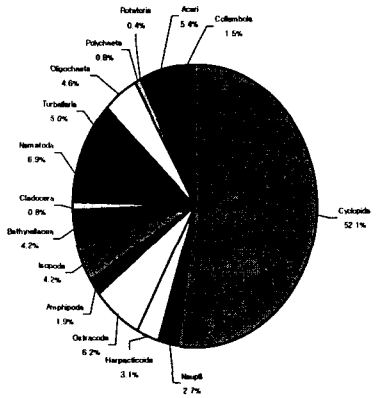

Figure 1 Percentage of the different taxa in the samples until now.

So far 30 animal samples became from the alluvial aquifers and 48 samples from the deeper aquifers are evaluated. Clear differences show up. While 73.3 % of samples of alluvial aquifers are colonized, animals could be found in only 47.9 % of the deeper aquifers. Also the individual number is higher despite fewer samples in the alluvial aquifers with 147 individuals than in the deeper aquifers (113 individuals).

The next figure (Figure 2) shows the differences in the distribution of the Taxa between the alluvial aquifer and the deep aquifer (mostly rock fracture aquifer).

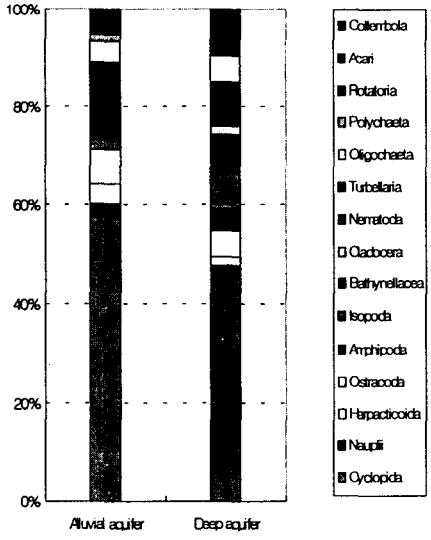

Figure 2 Additive Percentage of the Taxa in the Alluvial and Deeper Aquifer

The number of taxa in both aquifer types is equal, it could however more individuals at smaller number of samples be determined. In addition more boreholes of alluvial aquifer are populated than boreholes of deeper aquifers. But keep in mind, due to the small database the occurrence of one taxon with several individuals in only one borehole can cause clear differences. Thus the differences explain themselves,

for example regarding the nematods or amphipods.

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5. References

Dumas, P. & G. Fontanini (2001): Sampling fauna in aquifers: a comparison of net-sampling and pumping - Arch. Hydrobiol. 4, 661-676

Hahn, H. J. (2001): Methods and difficulties of sampling stygofauna - "Field screening Europe 2001"; Second International Conference and Industrial Exhibition, Karlsruhe 14.-16. May 2001

Hahn, H. J. (2002): Developing regional models of stygofaunal communities at a landscape scale for the assessment of groundwater conditions - the Naturraum concept.

Hahn, H. J. & E. Friedrich (1999): Brauchen wir ein faunistisch begrundetes Grundwassermonitoring und was kann es leisten? - Grundwasser 4: 147-154.

Humphreys, W. F. (2001): Groundwater calcrete aqufiers in the Australian arid zone: the context to an unfolding plethora of stygal biodiversity. - Rec. West. Aust. Mus. Suppl. 64.

Malard, F., Reygrobellet, J. L., Laurent, R. & J. Mathieu (1997): Developments in sampling the fauna of deep water-table aquifers - Arch. Hydrobiol. 138: 401-432

Ronneberger, D. (1975): Zur Kenntnis der Grundwasserfauna des Saale-Einzugsgebietes (Thueringen). - Limnologica 9: 323-391.

Steenken, B. (1998): Die Grundwasserfauna. Ein Vergleich zweier Grundwasserlanfschaften in Baden-Wuerttemberg; Landsberg.

Wegelin, R. (1966): Beitrag zur Kenntnis der Grundwasserfauna des Saale-Elbe-Einzugsgebietes. - Zool. Jb. Syst. 93: 1-117.