STUDIECENTRUM VOOR KERNENERGIE
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RADIOLOGICAL SURVEY OF THE BELGIAN UPPER PART OF THE MEUSE RIVER

Report on the triennal low water period.
September 1992

E. Vangelder, R. Kirchmann, H. Vanmarcke,
P. Govaerts.
Radiation Protection Research Unit
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Mol - Belgium

This work was supported by
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RADIOECOLOGICAL SURVEY OF THE BELGIAN UPPER PART OF THE MEUSE RIVER DURING THE TRIENNAL LOW WATER PERIOD. SEPTEMBER 1992

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1. INTRODUCTION

A radiological surveillance programme of the sites of the nuclear power plants started in Belgium in 1965, under the joint effort of the Ministry of Public Health and the Belgian Nuclear Research Centre (SCK.CEN).

In this framework, every three years, an extensive sampling programme of the various compartments of the river Meuse was performed taking advantage of the low water level due to the removal of the dams in order to allow heavy maintenance works to the sluices. This triennal sampling programme has been performed since 1968 up to now.

A whole set of data was collected during these periods of extensive sampling related to the releases of the Chooz-A nuclear power plant (300 MWe) in the river Meuse. Directly useful informations were applied i.e. for the choice of the most relevant bio-indicators, used in the routine surveillance programme.

2. SAMPLING PROTOCOL

2.0. General

The implementation of the sampling programme needed a close collaboration between the three laboratories directly involved in the field works, namely:

-the Radiation Protection Research Unit of the SCK·CEN (MOL),
-the Radioecology Laboratory of the University of Liège,
-the Freshwater Ecology Unit of the Faculty Notre-Dame de la Paix (Namur).

After identification, the samples were labeled and transported to the laboratories of the SCK·CEN for preparation in view of the radioactivity measurements.

The sampling period extended from 21 to 25 September 1992 and covered a section of about 60 km of the river Meuse, starting at the dam of Ham-sur-Meuse, upstream of the Chooz-A nuclear power plant.
The choice of the plant and animal species was based on the previous experience gained as well as on the current state of the sampling places. That was also true for the bottom sediments.

2.1. Sampling of aquatic plants

2.1.1. Plant species:

Cinclidotus danubicus,Cinclidotus nigricans,
Fontinalis antipyretica,Platyhypnidium riparoides
Cladophora glomerata,Lemanea fluviatilis,

Phragmites australis,Phalaris arundinacea,
Acorus calamus,Scirpus lacustris,
Iris pseudocorus,Salix sp.

Nuphar lutea,Myriophyllum spicatum,
Potamogeton pectinatus.

and some other species when sufficient bio-mass was available.

2.1.2. Places of sampling:

-Ham-sur-Meuse (France,upstream NPP)
-Givet (France,downstream NPP)
-Hastière
-Waulsort
-Dinant

2.2. Sampling of aquatic animals

2.2.1. Animal species:

Dreissena polymorpha, Unio pictorum,
Anodonta anatina

Orconectes limosus, Bythinia tentaculata,

Rutilus rutilus, Leuciscus cephalus,
Alburnus alburnus, Perca fluviatilis,
Lucioperca lucioperca.

and some other species when sufficiently available

2.2.2. Places of sampling:

-Ham-sur-Meuse
-Givet
-Hastière
-Waulsort
-Houx
-Rivière/Hun

2.3. Sampling of bottom sediments and river water

2.3.1. Places of sampling:

-Ham-sur-Meuse
-Givet
-Hastière
-Waulsort
-Dinant

3. MEASUREMENT METHODS

3.1. Radiochemical analysis

-TRITIUM

Determination of organically bound tritium (OBT) from measurement of tritiated water produced by oxydation of the organic matter. The tritium in the free water tissue (TFWT) was not separated and measured as the result would not be really of significance due to the extreme mobility of water in the biosphere.

-STRONTIUM-90

For more than 30 years, Sr-89/90 have been measured, at the laboratories of the SCK/CEN, in different environmental samples. A recent review of the techniques of collection, preparation and measurements of the various types of samples has been made by C.Hurtgen (1993). Sr-90 is determined by the beta measurement of its daughter nuclide Y-90, separated from Sr-90 by radiochemical techniques (Harley,1972).

-PLUTONIUM

Pu-238, Pu-239+240 were determined by alpha spectrometry subsequent to a radiochemical separation and purification.

3.2. Gamma spectrometry

The presence and concentrations of the following gamma-emitters were looked for, using low background germanium detectors

Be-7, K-40, Mn-54, Co-58, Co-60, Ru-106, Cs-134, Cs-137, Ra-226, Th-232.

This list contains radionuclides from various origins:

- -Natural (cosmogenic or primordial),
- -Activation products,
- -Fission products.

4. RESULTS OF THE MEASUREMENTS

4.1. Aquatic plants

The results of the gamma emitters are shown in table 4.1.(a) along with the characteristics of the samples such as the sampling date, location and species. The tritium and strontium-90 results are listed in table 4.1(b) while the plutonium and americium data of the two samples of aquatic mosses are shown in table 4.1(c). It is important to mention that, for analytical reasons, the results are expressed in Bq/kg fresh matter in table 4.1(a) and in Bq/kg dry matter in the tables 4.1(b) and 4.1(c).

4.2. Aquatic animals

The radioactivity levels measured in aquatic animals are shown in the tables 4.2.(a), 4.2.(b), 4.2(c) and for fish in the tables 4.2.(d) and 4.2.(e).
As in the case of the aquatic plants, the results of the gamma emitters are expressed on the basis of fresh matter while tritium, strontium-90 and the transuranic elements are given in dry matter.

4.3. Bottom sediments

The radionuclide content of the bottom sediments are given in the tables 4.3.(a) and 4.3.(b). All the results are expressed in Bq/kg dry matter.

4.4. River water

Samples of river water were collected at the same places and time as the bottom sediments. The results of the measurements are listed in table 4.4 in Bq/l.

5. DISCUSSION

In this chapter the impact of the liquid radioactive releases from the Chooz-A NPP on the levels of contamination of the aquatic biocenosis and of the sediments of the Meuse river is discussed together with the follow-up of the impact of the Chernobyl fallout on the Meuse.

5.1 AQUATIC PLANTS

a) Tritium

The levels of OBT (organically bound tritium) in the plant material collected amounted to a few tens of Bq/kg dry matter. If one considers that one kg dry matter can produce about a half litre of combustion water, the mean activity of the water in the aquatic ecosystem was, very roughly, twice the level in the dry matter during the growth of the plant. It must be mentioned that the H-3 concentrations of the river water indicated in table 4.4. are purely indicative as it is an instantaneous sampling. As expected there is no significant difference between the plant species as far as the specific activity is concerned.

b) Sr-90

All the values given in table 4.1.(b) are below the limit of detection. This is not surprising as no measurable quantities of Sr-90 have been released in the liquid effluents and as the Sr-90 from the global fallout is presently difficult to detect in the continental waters.

c) Mn-54

All the values mentioned in table 4.1.(a) are below or around the limit of detection which is a few Bq/kg fresh matter.This is in line with the expectations as the Mn-54 activity released in 1991 from the Chooz NPP was quite low (315 MBq).

d) Radiocobalts

All the results for Co-58 and most of the results for Co-60 in table 4.1(a) are below the limit of detection which is about 1 Bq/kg fresh matter. The absence of Co-58 is quite understandable considering the fact that the ratio Co-60/Co-58 in the effluents from Chooz-A is around 35.

e) Ru-106

This radionuclide is not separately mentioned in the composition of the liquid radioactive releases from Chooz-A, in 1991. The detection limit is one order of magnitude higher than for the radiocobalts due to the low photon emission probability of the 622 keV peak (only 10%).

f) Radiocesiums

The radiocesiums are the major components of the liquid releases from Chooz-A in 1991. Indeed, Cs-137 and Cs-134 represent respectively about 66% and 11% of the activity (except H-3). The Cs-137 activity released amounted to 8460 MBq in 1991. The levels measured in the plants collected downstream of the NPP are generally above the detection limit, the values of Cs-137 being higher than those of Cs-134 which is in agreement with the discharge data.

g) Transuranics

The results of the measurements of aquatic mosses collected at Ham/Meuse and at Waulsort are shown in table 4.1.(c). The values given for Pu-239,240 are comparable. On the other hand the values of Am-241 are significant different. The value downstream the Chooz-A NPP is one order of magnitude higher than upstream.

5.2 AQUATIC ANIMALS

a) Tritium

The few values of OBT determined in the soft parts of invertebrates and in the muscles of fish are given in the tables 4.2.(b) and 4.2(e). The values are within a range of 2, the mean being around 10 Bq/kg dry matter, a value already observed in the samples collected in the fall of 1989.

b) Sr-90

The results given in the tables 4.2.(b) and 4.2(e) are below the limit of detection. As already mentioned for the aquatic plants, no release of Sr-90 from the NPP occured in 1991.The data obtained in 1989 however showed, values above the limit of detection both in the case of the invertebrates and the fish.

c) Mn-54

All the values given in the tables 4.2.(a) and 4.2(d) are below the limit of detection except for one sample of *Orconectus limosus* taken at Waulsort. The invertebrates are however known as relevant bio-indicators for manganese (Kirchmann et al.,1974; IAEA,1982). The negative results are therefore due to the limited amount of Mn-54 (only 315 MBq) released in liquid effluents from Chooz-A NPP, during the period January-August 1991 according to the data provided by the plant operator.

d) Radiocobalts

All the values for both radionuclides are below the limit of detection except in five cases where the levels of Co-60 were around the threshold for some samples collected downstream of the NPP. The liquid effluents released in 1991 contained 2120 MBq Co-60 and 62 MBq Co-58. From January 1992 to August 1992 the values were respectively 473 and 12 MBq.

e) Ru -106

This radionuclide is not mentioned in the composition of the effluents released from Chooz-A. It is acumulated only to a small degree by the freshwater animals (IAEA,1982). So it is not surprising that all the results of the measurements are below the limit of detection.

f) Radiocesiums

The values reported in the tables 4.2.(a) and 4.2(d) are either below or around the limit of detection. One can consider that the content in radiocesiums of the aquatic animals is a few Bq/kg fresh matter, the levels of Cs-137 being systematically higher than for Cs-134, which is in agreement with the composition of the effluents released (Cs-137/Cs-134=6.1).

g) Transuranics

Four of the five samples listed in table 4.2.(c) show values above the detection limits. These samples are composed by the soft parts of a mollusc present in fair amounts on the bottom of the Meuse river. They were choosen because of their relatively high accumulation factor for Am and Cm (=1000) (IAEA,1982).

5.3 BOTTOM SEDIMENTS

a) Tritium

The levels of OBT (Organically Bound Tritium) in sediments shown in table 4.3.(a) are comparable to those of the living organisms collected (see above). This observation is in complete agreement with what could be expected in such situation. Nevertheless the levels observed in some samples collected at Ham/Meuse are higher that expected if only the global fallout would be involved. This remark is also valid for some aquatic plants.The reason for this is still unclear.

b) Sr-90

Except in one case (Ham/Meuse) all the values reported in table 4.3.(a) are below the detection limit. The positive value represents, most probably, the remains of the global fallout from the nuclear weapons tests conducted previously.

c) Mn-54

All the values given in table 4.3.(a) are below the limit of detection despite the high value of the Kd of manganese for sediments in a freshwater ecosystem (Kd=10,000) (IAEA,1982). But, as already mentioned the release of Mn-54 in 1991 was low (315 MBq).

d) Radiocobalts

Only two values reported in table 4.3.(a) are above the detection limit. These values refer to the levels of Co-60 measured in bottom sediments collected at Hastière and Waulsort. It must be underlined that the bottom sediments collected represent an "average" sample which is only constituted partially by recently deposed suspended matter. That means that there is only a limited impact of the recent releases on the observed levels.

e) Ru-106

As already mentioned this radionuclide is not reported as such in the composition of the effluents released by the Chooz-A NPP. Although the Kd is quite high (40.000)(IAEA,1982) no positive result is observed in table 4.3.(a) for the collected bottom sediments .

f) Radiocesiums

Considering on the one hand the level of radioactivity released and on the another hand the high Kd value (30.000) (IAEA,1982), one can expect significant values for both radiocesiums fixed by the sediments of the river. That is the case for the data reported in table 4.3.(a). Furthermore the values of the ratios of Cs-137/Cs-134 are in agreement with the value expected from the releases (Cs-137/Cs-134=6.1).

g) Transuranics

The plutonium, americium and curium concentrations in Bq/kg dry matter are listed in table 4.3(b). The level of Pu-239,240 is sometimes one order of magnitude higher than the level of Am-241 and Cm-244. No significant difference is observed between the values of the upstream and the downstream samples, which means that there is no impact from the effluents released by the Chooz-A NPP.
It interesting to know that the Kd values for the three transuranics considered here are quite high (30,000)(IAEA,1982).

6. CONCLUSION

The evolution of the radiocesium levels in the upper part of the Belgian river Meuse is shown in the tables 5(a), 5(b) and 5(c).
The comparison of the data obtained respectively in 1986, 1989 and 1992, allows to verify that the levels of contamination of the major compartments of the Meuse ecosystem reflect faithfully the modifications which appeared in the environment during this period of time.

Indeed, the impact of Chernobyl occured essentially through the deposition of radiocesiums. The bio-indicators used in the surveillance programme reflected this increase of radionuclides, as shown by the results obtained in September 1986 in the aquatic mosses, mussels and fish.

The impact of Cs-134 progressively diminished and from 1989 practically only Cs-137 was measurable in the bio-indicators and this effect continued until 1992, partly thanks to the higher contribution of Cs-137 in the releases of liquid effuents from the Chooz-A NPP.

It must also be reminded that the fallout from Chernobyl constrained a correct measurement of some of the other gamma-emitters such as Co-60 which is released in small amouts in the liquid effluents.

The Co-60 measured in the bio-indicators collected in September 1989, was no longer measurable, except in molluscs, in 1992 due to the decommissioning of the Chooz-A reactor in October 1991 and the decrease of the liquid radioactive releases.

Finally, it is interesting to underline that the Cs-137 levels measured in 1992 in the hydrophytes cryptogames and in the aquatic animals are of the same order of magnitude than those measured in 1965, before the start of Chooz-A Nuclear Power Plant, as at that time the fallout from the nuclear weapons tests was contaminating significantly the environment.

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TABLE 4.1 (a)

Radioactivity levels measured by means of high resolution gamma spectrometry in aquatic plants collected in the upper part of the Belgian Meuse river.
The table consists of two parts. In the first part the results of K-40, Mn-54, Co-58, Co-60 and Ru-106 are given
and in the second part those of Cs-134, Cs-137, Ra-226 and Th-232.
Bq/kg fresh matter

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.028	23.09.92	Waulsort	Cincl.danubicus	<70	<4	<5	<5	<30
21.029	23.09.92	Waulsort	Cladophora	≈490	<14	<19	<20	<110
21.030	23.09.92	Waulsort	Cincl.nigricans	≈680	<16	<20	<30	<130
21.031	21.09.92	Givet	Cincl.danubicus	≈45	<4	<6	<5	≈24
21.032	22.09.92	Hastière	Cincl.nigricans	≈68	<2	<3	<3	<18
21.033	21.09.92	Ham-s/Meuse	Cincl.danubicus	≈40	<4	<7	<5	<40
21.034	22.09.92	Hastière	Cincl.danubicus	≈41	<4	<8	<6	<40
21.035(a)	21.09.92	Ham-s/Meuse	Nenuphars (leaves)	≈89	<3	<4	<4	<30
21.035(b)	21.09.92	Ham-s/Meuse	Nenuphars (roots)	≈105	<4	<7	<4	<30
21.036(a)	21.09.92	Ham-s/Meuse	Iris (leaves)	190	<0.9	<1.5	<1.1	<8
21.036(b)	21.09.92	Ham-s/Meuse	Iris (roots)	270	<3	<6	<4	<30
21.037(a)	21.09.92	Ham-s/Meuse	Rumex (leaves)	≈84	<2	<3	<3	<17
21.037(b)	21.09.92	Ham-s/Meuse	Rumex roots	≈270	<4	<7	<4	<40
21.038(a)	21.09.92	Ham-s/Meuse	Carex (leaves)	89	<0.6	<0.9	<0.8	<5
21.038(b)	21.09.92	Ham-s/Meuse	Carex (roots)	≈270	≈3.7	<12	<7	<60
21.039	21.09.92	Ham-s/Meuse	Salix	153	<1.1	<1.7	<1.4	<9

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.040	21.09.92	Ham-s/Meuse	Myriophyllum	≈270	<3	<5	<5	<30
21.041(a)	21.09.92	Ham-s/Meuse	Phalaris (leaves)	106	<1	<1.3	<1.2	<8
21.041(b)	21.09.92	Ham-s/Meuse	Phalaris (roots)	100	<1.6	<3	<1.9	<14
21.042	21.09.92	Givet	Scirpus lacust.	≈64	<4	<7	<5	<40
21.043(a)	21.09.92	Givet	Acorus (leaves)	59	<0.7	<1.1	<1.1	<6
21.043(b)	21.09.92	Givet	Acorus (roots)	89	<0.7	<1.3	<0.8	<7.0
21.044(a)	21.09.92	Givet	Carex (leaves)	135	<1.3	<2	<1.6	<12
21.044(b)	21.09.92	Givet	Carex (roots)	89	<0.7	<1.4	≈1.0	<6.0
21.045(a)	21.09.92	Givet	Phragmites (leaves)	195	<1.3	<2	<1.8	<11
21.045(b)	21.09.92	Givet	Phragmites (roots)	86	≈0.41	<0.7	<0.5	<4.0
21.046	21.09.92	Givet	Salix	164	<0.6	<1	<0.8	≈3.8
21.047(a)	22.09.92	Hastière	Nenuphars (leaves)	156	<0.7	<1.3	<1	<6
21.047(b)	22.09.92	Hastière	Nenuphars (roots)	105	<0.6	<1.1	<0.7	<6
21.048(a)	22.09.92	Hastière	Sparganium (leaves)	200	<1.6	<3	<1.6	<13
21.048(b)	22.09.92	Hastière	Sparganium (roots)	≈81	<1.6	<3	<1.8	<15
21.049(a)	22.09.92	Hastière	Salix (leaves)	139	<0.4	<0.7	<0.5	<4
21.049(b)	22.09.92	Hastière	Salix (roots)	≈46	<1	<1.9	<1.3	<9
21.050(a)	22.09.92	Hastière	Phragmites (leaves)	<30	<1.2	<1.7	<1.4	<10
21.050(b)	22.09.92	Hastière	Phragmites (roots)	107	<0.7	<1.1	<0.9	<8

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.051	22.09.92	Hastière	Carex	260	<1.4	<3	<3	<12
21.052(a)	22.09.92	Hastière	Iris (leaves)	210	<1.0	<1.4	<1.1	<8
21.052(b)	22.09.92	Hastière	Iris (roots)	107	<0.7	<1.1	<0.9	<8
21.053(a)	22.09.92	Hastière	Acorus (leaves)	196	<1.0	<1.8	<1.5	<9
21.053(b)	22.09.92	Hastière	Acorus (roots)	170	<0.9	<1.7	<1.1	<8
21.054(a)	23.09.92	Waulsort	Nenuphars (leaves)	145	<0.7	<1.1	<0.9	<5
21.054(b)	23.09.92	Waulsort	Nenuphars (roots)	111	<0.6	<1.0	<0.7	<5
21.055(a)	23.09.92	Waulsort	Salix (leaves)	134	<1.0	<1.8	<1.2	<9
21.055(b)	23.09.92	Waulsort	Salix (roots)	79	<1.3	<3	<1.5	<11
21.056(a)	23.09.92	Waulsort	Iris (leaves)	260	<1.2	<3	<1.5	<10
21.056(b)	23.09.92	Waulsort	Iris (roots)	130	<0.7	<1.2	<1.0	<6
21.057(a)	23.09.92	Waulsort	Acorus (leaves)	200	<0.5	<0.7	<0.6	<4
21.057(b)	23.09.92	Waulsort	Acorus (roots)	167	<0.7	<1.4	<0.9	<6
21.058(a)	23.09.92	Waulsort	Phragmites (leaves)	137	<0.8	<1.2	<1.2	<7
21.058(b)	23.09.92	Waulsort	Phragmites (roots)	52	<0.8	<1.4	<1.0	<7
21.059(a)	23.09.92	Waulsort	Carex (leaves)	280	<1.4	<2	<1.8	<11
21.059(b)	23.09.92	Waulsort	Carex (roots)	97	≈0.31	<0.8	≈0.45	<5
21.060(a)	24.09.92	Dinant	Acorus (leaves)	200	<1.0	<1.6	<1.4	<9
21.060(b)	24.09.92	Dinant	Acoris (roots)	196	<0.8	<1.5	<1	<7

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.061(a)	24.09.92	Dinant	Carex (leaves)	240	<1.3	<3	<1.5	<12
21.061(b)	24.09.92	Dinant	Carex (roots)	82	<0.7	<1.3	<0.8	<7
21.062(a)	24.09.92	Dinant	Phragmites (leaves)	240	<1.3	<3	<1.7	<12
21.062(b)	24.09.92	Dinant	Phragmites (roots)	143	<1.1	<2	<1.5	<10

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.028	23.09.92	Waulsort	Cincl.danubicus	≈2.8	≈7.1	<9	<30
21.029	23.09.92	Waulsort	Cladophora	<10	≈13	≈38	<60
21.030	23.09.92	Waulsort	Cincl.nigricans	≈8	≈13	≈38	<80
21.031	21.09.92	Givet	Cincl.danubicus	<4	≈11	<10	<14
21.032	22.09.92	Hastière	Cincl.nigricans	≈6	24	≈4.2	≈6.8
21.033	21.09.92	Ham-s/Meuse	Cincl.danubicus	<4	≈4.9	<9	≈22
21.034	22.09.92	Hastière	Cincl.danubicus	<6	≈6.7	<9	<13
21.035(a)	21.09.92	Ham-s/Meuse	Nenuphars (leaves)	<3	<2	<7	<16
21.035(b)	21.09.92	Ham-s/Meuse	Nenuphars (roots)	<4	<3	<8	<11
21.036(a)	21.09.92	Ham-s/Meuse	Iris (leaves)	<0.7	<0.8	<3	<5
21.036(b)	21.09.92	Ham-s/Meuse	Iris (roots)	<3	≈6.2	≈9.3	≈12
21.037(a)	21.09.92	Ham-s/Meuse	Rumex (leaves)	<1.9	<3	<7	≈9.0
21.037(b)	21.09.92	Ham-s/Meuse	Rumex roots	≈3	≈4.7	≈8	<26
21.038(a)	21.09.92	Ham-s/Meuse	Carex (leaves)	<0.4	≈0.5	≈0.8	≈3.4
21.038(b)	21.09.92	Ham-s/Meuse	Carex (roots)	<6	≈5.4	<14	<30
21.039	21.09.92	Ham-s/Meuse	Salix	<1.1	<1.1	<4	<7
21.040	21.09.92	Ham-s/Meuse	Myriophyllum	<3	<3	≈13	≈8.0
21.041(a)	21.09.92	Ham-s/Meuse	Phalaris (leaves)	<1	<1.1	<3	≈3.3

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.041(b)	21.09.92	Ham-s/Meuse	Phalaris (roots)	<1.7	≃2	≃5.1	≃4.9
21.042	21.09.92	Givet	Scirpus lacust.	<4	<4	≃7.8	
21.043(a)	21.09.92	Givet	Acorus (leaves)	<0.6	≃0.64	<1.7	
21.043(b)	21.09.92	Givet	Acorus (roots)	≃1.0	4.3	≃1.1	≃3.0
21.044(a)	21.09.92	Givet	Carex (leaves)	<0.8	<1.7	<4	
21.044(b)	21.09.92	Givet	Carex (roots)	≃2.2	13.0	≃4.9	≃7.9
21.045(a)	21.09.92	Givet	Phragmites (leaves)	≃0.64	≃3.9	<3	
21.045(b)	21.09.92	Givet	Phragmites (roots)	≃1.3	7.1	≃4.6	≃6.0
21.046	21.09.92	Givet	Salix	<0.6	2.3	<1.6	
21.047(a)	22.09.92	Hastière	Nenuphars (leaves)	≃1.2	3	<1.6	
21.047(b)	22.09.92	Hastière	Nenuphars (roots)	<0.6	<0.6	<1.3	<3
21.048(a)	22.09.92	Hastière	Sparganium (leaves)	≃1.6	≃2.9	<4	
21.048(b)	22.09.92	Hastière	Sparganium (roots)	<1.5	≃3	<4	<5
21.049(a)	22.09.92	Hastière	Salix (leaves)	<0.4	≃1.4	<0.9	
21.049(b)	22.09.92	Hastière	Salix (roots)	≃3.3	9.4	≃2.8	≃3.9
21.050(a)	22.09.92	Hastière	Phragmites (leaves)	≃0.88	≃3.7	<3	
21.050(b)	22.09.92	Hastière	Phragmites (roots)	≃0.75	3.1	<1.5	≃2.9

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.051	22.09.92	Hastière	Carex	<1.4	≈1.7	<4	
21.052(a)	22.09.92	Hastière	Iris (leaves)	≈1.1	≈2.7	<3	
21.052(b)	22.09.92	Hastière	Iris (roots)	≈0.75	3.1	<1.5	≈2.9
21.053(a)	22.09.92	Hastière	Acorus (leaves)	≈0.85	≈3.4	<3	
21.053(b)	22.09.92	Hastière	Acorus (roots)	≈1.1	4	≈1.3	<4
21.054(a)	23.09.92	Waulsort	Nenuphars (leaves)	<0.6	≈1.0	≈1.4	
21.054(b)	23.09.92	Waulsort	Nenuphars (roots)	<0.4	≈0.64	<1.2	≈1.8
21.055(a)	23.09.92	Waulsort	Salix (leaves)	≈0.72	≈2.9	<3	
21.055(b)	23.09.92	Waulsort	Salix (roots)	≈3.4	10.9	≈2.8	≈4.4
21.056(a)	23.09.92	Waulsort	Iris (leaves)	<1.9	≈2.3	<3	
21.056(b)	23.09.92	Waulsort	Iris (roots)	≈0.90	3.3	<1.6	≈3.1
21.057(a)	23.09.92	Waulsort	Acorus (leaves)	≈0.54	2.2	<1	
21.057(b)	23.09.92	Waulsort	Acorus (roots)	≈0.70	≈1.8	<1.7	<5
21.058(a)	23.09.92	Waulsort	Phragmites (leaves)	3.6	13	≈3.9	
21.058(b)	23.09.92	Waulsort	Phragmites (roots)	≈1.8	6.2	<1.9	≈3.0
21.059(a)	23.09.92	Waulsort	Carex (leaves)	≈1.7	6.5	<4	
21.059(b)	23.09.92	Waulsort	Carex (roots)	2.4	12.3	≈4.1	≈5.6
21.060(a)	24.09.92	Dinant	Acorus (leaves)	≈0.72	≈2.4	<3	
21.060(b)	24.09.92	Dinant	Acoris (roots)	≈0.48	≈2.9	<1.9	≈3.9

TABLE 4.1 (a) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.061(a)	24.09.92	Dinant	Carex (leaves)	≃1.2	≃1.0	<4	
21.061(b)	24.09.92	Dinant	Carex (roots)	≃1.3	10.2	≃4.4	≃7.4
21.062(a)	24.09.92	Dinant	Phragmites (leaves)	<1.2	<1.6	≃4.1	
21.062(b)	24.09.92	Dinant	Phragmites (roots)	≃1.2	≃1.2	<3	≃6.7

TABLE 4.1 (b)

Tritium and Strontium-90 levels measured in aquatic plants collected in the upper part of the Belgian Meuse river.
Bq/kg dry matter

N° Sample	Date	Location	Species	H-3	Sr-90
21.028	23.09.92	Waulsort	Cincl.danubicus	17.2±4.9	≤1.7
21.031	21.09.92	Givet	Cincl.danubicus	5.7±1.4	≤1.0
21.033	21.09.92	Ham-s/Meuse	Cincl.danubicus	16.0±5.5	≤1.9
21.034	22.09.92	Hastière	Cincl.danubicus	20.6±3.6	≤1.2
21.038(a)	21.09.92	Ham-s/Meuse	Carex (leaves)	7.9±2.1	≤1.3
21.038(b)	21.09.92	Ham-s/Meuse	Carex (roots)	19.7±2.1	≤1.5
21.044(a)	21.09.92	Givet	Carex (leaves)	10.5±2.0	≤1.4
21.044(b)	21.09.92	Givet	Carex (roots)	21.5±2.2	≤1.5
21.051	22.09.92	Hastière	Carex	7.7±2.2	
21.059(a)	23.09.92	Waulsort	Carex (leaves)	7.6±2.0	≤1.3
21.059(b)	23.09.92	Waulsort	Carex (roots)	71.8±3.4	≤1.4
21.061(a)	24.09.92	Dinant	Carex (leaves)	8.6±2.1	≤1.3
21.061(b)	24.09.92	Dinant	Carex (roots)	17.2±2.0	≤1.2

TABLE 4.1 (c)

Plutonium and americium levels measured in aquatic plants collected in the upper part of the Belgian Meuse river.
Bq/kg dry matter

N° Sample	Date	Location	Species	Pu-238	Pu-239,240	Plutonium	Am-241
21.028	23.09.92	Waulsort	Cincl.danubicus	1.3	1.3	1.6	2.3
21.033	21.09.92	Ham-s/Meuse	Cincl.danubicus	1.5	1.62	1.62	20

TABLE 4.2 (a)

Radioactivity levels measured by means of high resolution gamma spectrometry in aquatic animals collected in the upper part or the Belgian Meuse river.
The table consists of two parts. In the first part the results of K-40, Mn-54, Co-58, Co-60 and Ru-106 are given and in the second part those of Cs-134, Cs-137, Ra-226 and Th-232.
Bq/kg fresh matter

N° Sample	Date	Location	Species/organs	K-40	Mn-54	Co-58	Co-60	Ru-106
21.000	24.09.92	Rivière	Anodonta	≈8	<0.17	<0.19	<0.3	<1.5
21.000(a)	24.09.92	Rivière	soft part	<30	<1.2	<1	<1.6	<10
21.000(b)	24.09.92	Rivière	internal liquid	<30	<1.1	<1.4	<1.5	<10
21.000(c)	24.09.92	Rivière	shell	<40	<2	<3	<3	<20
21001	24.09.92	Rivière	Unio	≈6.8	<0.3	<0.4	<0.4	<3
21001(a)	24.09.92	Rivière	soft part	≈21	<2	<8	<2	<20
21.002	22.09.92	Hastière	Unio	3.0	<0.3	<0.4	<0.4	<1.2
21.002(a)	22.09.92	Hastière	soft part	≈36	<1.8	<6	<2	<15
21.003	22.09.92	Hastière	Anodonta	≈8.2	<0.4	<0.6	<0.5	<3
21.003(a)	22.09.92	Hastière	soft part	≈13	<1.0	<4	≈1.0	<9
21.004	25.09.92	Champalle	Unio	≈8.8	<0.3	<0.4	<0.4	<3
21.004(a)	25.09.92	Champalle	soft part	≈17	<1.9	<8	<1.6	<16
21.005	25.09.92	Champalle	Anodonta	≈12.0	<0.5	<0.6	<0.7	<4
21.005(a)	25.09.92	Champalle	soft part	≈16	<1.8	<7	<1.5	<16

TABLE 4.2 (a) continued

N° Sample	Date	Location	Species/organs	K-40	Mn-54	Co-58	Co-60	Ru-106
21.006	23.09.92	Waulsort	Anodonta	<7	<0.4	<0.4	<0.5	<3
21.006(a)	23.09.92	Waulsort	soft part	≈17	<3	<8	<3	<18
21.007	24.09.92	Dinant	Unio	≈6.5	<0.3	<0.4	<0.4	<3
21.007(a)	24.09.92	Dinant	soft part	≈25	<1.7	<7	≈1.5	<15
21.008	24.09.92	Dinant	Anodonta	≈11	<0.5	<0.6	<0.6	<3
21.008(a)	24.09.92	Dinant	soft part	<30	<1.9	<7	<1.6	<16
21.009	22.09.92	Hastière	Dreissena	≈34	<1.8	<4	<3	<17
21.010	23.09.92	Waulsort	Dreissena	<50	<3	<3	<3	<17
21.011	24.09.92	Dinant	Dreissena	<50	<3	<3	<4	≈36
21.012	24.09.92	Rivière	Dreissena	≈35	<1.6	<1.7	<1.9	<15
21.013	25.09.92	Champalle	Dreissena	<60	<3	<4	<4	<30
21.014	24.09.92	Dinant	Bythinia	<40	<3	<3	<3	<19
21.015	24.09.92	Rivière	Bythinia	<40	<1.8	<3	<3	<17
21.015(a)	24.09.92	Rivière	soft part	<16	<1	<1.1	<1	<7
21.016	25.09.92	Champalle	Bythinia	230	<3	<4	≈4.3	<30
21.017	21.09.92	Ham-s/Meuse	Anodonta	<60	<3	<5	<4	<30
21.017(a)	21.09.92	Ham-s/Meuse	soft part	≈13	<1.1	<5	<0.8	<10
21.018	21.09.92	Givet	Anodonta	≈9.6	<0.2	<0.5	<0.5	<3

TABLE 4.2 (a) continued

N° Sample	Date	Location	Species/organs	K-40	Mn-54	Co-58	Co-60	Ru-106
21.019	22.09.92	Hastière	Orcon.limosus	≈840[1]	<30	<90	≈26	<170
21.020	23.09.92	Waulsort	Orcon.limosus	≈32	≈3.1	<4	<4	<30
21.022	25.09.92	Houx	Orcon.limosus	<70	<3	<4	<4	<30

[1]: contribution of K-40 of the measurement glass vial

TABLE 4.2 (a) continued

N° Sample	Date	Location	Species/organs	Cs-134	Cs-137	Ra-226	Th-232
21.000	24.09.92	Rivière	Anodonta	≈0.18	≈0.75	≈1.2	≈1.3
21.000(a)	24.09.92	Rivière	soft part	<1.2	<1.6	<4	<6
21.000(b)	24.09.92	Rivière	internal liquid	<1.1	<1.1	<4	<7
21.000(c)	24.09.92	Rivière	shell	<2.5	<4	<6	<13
21.001	24.09.92	Rivière	Unio	<0.4	≈0.55	<0.9	<2
21.001(a)	24.09.92	Rivière	soft part	≈1.1	≈2.1	<4	<10
21.002	22.09.92	Hastière	Unio	≈0.44	≈0.91	<1.2	≈0.86
21.002(a)	22.09.92	Hastière	soft part	<1.5	≈1.8	<4	<7
21.003	22.09.92	Hastière	Anodonta	≈0.26	≈0.48	≈0.63	≈1.9
21.003(a)	22.09.92	Hastière	soft part	≈0.82	≈2.3	≈1.3	<4
21.004	25.09.92	Champalle	Unio	≈0.15	≈0.79	<1.1	<2
21.004(a)	25.09.92	Champalle	soft part	<1.5	≈1.4	≈2.9	<6
21.005	25.09.92	Champalle	Anodonta	<0.5	≈1.7	≈1.0	≈39
21.005(a)	25.09.92	Champalle	soft part	<1.6	<1.5	≈4.6	<6
21.006	23.09.92	Waulsort	Anodonta	≈0.5	≈0.9	≈0.56	≈1.5
21.006(a)	23.09.92	Waulsort	soft part	<1.9	≈1.9	<4	<8
21.007	24.09.92	Dinant	Unio	≈0.4	≈0.8	<0.8	≈1.7
21.007(a)	24.09.92	Dinant	soft part	<1.7	≈2.1	≈2.2	<6

TABLE 4.2 (a) continued

N° Sample	Date	Location	Species/organs	Cs-134	Cs-137	Ra-226	Th-232
21.008	24.09.92	Dinant	Anodonta	0.4	1.2	0.7	≈1.9
21.008(a)	24.09.92	Dinant	soft part	<1.5	1.2	3.0	<6
21.009	22.09.92	Hastière	Dreissena	1.8	4.2	<8	≈14
21.010	23.09.92	Waulsort	Dreissena	1.8	3.5	<7	<11
21.011	24.09.92	Dinant	Dreissena	2.7	3.9	7.1	≈11
21.012	24.09.92	Rivière	Dreissena	1.7	6.3	4	≈6.8
21.013	25.09.92	Champalle	Dreissena	<4	9.6	4.5	<19
21.014	24.09.92	Dinant	Bythinia	1.3	2.2	<6	<11
21.015	24.09.92	Rivière	Bythinia	1.2	<3	3.8	≈11
21.015(a)	24.09.92	Rivière	soft part	<1	<1	<1.8	<3
21.016	25.09.92	Champalle	Bythinia	41	580	7.7	≈11
21.017	21.09.92	Ham-s/Meuse	Anodonta	<4	<3	<8	<20
21.017(a)	21.09.92	Ham-s/Meuse	soft part	<1.0	<0.9	<3	<4
21.018	21.09.92	Givet	Anodonta	<0.9	3.5	1.4	≈1.9
21.019	22.09.92	Hastière	Orcon.limosus	<15	20	<30	<80
21.020	23.09.92	Waulsort	Orcon.limosus	<3	3.5	<10	<13
21.022	25.09.92	Houx	Orcon.limosus	<3	2.1	6.4	≈6.7

TABLE 4.2 (b)

Tritium and Strontium-90 levels measured in aquatic animals collected in the upper part of the Belgian Meuse river.
Bq/kg dry matter

N° Sample	Date	Location	Species/organs	3-H	Sr-90
21.001(a)	24.09.92	Rivière	Unio soft part	13.0±2.6	≤1.3
21.002(a)	22.09.92	Hastière	Unio soft part	8.3±2.6	≤1.3
21.004(a)	25.09.92	Champalle	Unio soft part	6.1±2.4	≤1.3
21.007(a)	24.09.92	Dinant	Unio soft part	7.8±2.4	

TABLE 4.2 (c)

Plutonium, americium and curium levels measured in aquatic animals collected in the upper part of the Belgian Meuse river.
Bq/kg dry matter

N° Sample	Date	Location	Species	Pu-238	Pu-239,240	Plutonium	Am-241	Cm-244
21.000	24.09.92	Rivière	Anodonta	2.3	11.9	11.9	11.0	2.6
21.003	22.09.92	Hastière	Anodonta	3.0	12.2	15.23	8.2	1.5
21.005	25.09.92	Champalle	Anodonta	1.3	1.3	1.6	5.3	4.8
21.006	23.09.92	Waulsort	Anodonta	1.5	1.31	1.31	1.1	0.8
21.008	24.09.92	Dinant	Anodonta	1.9	2.0	2.4	4.3	1.7
21.017	21.09.92	Ham-s/Meuse	Anodonta	<0.030	<0.025		<0.030	

TABLE 4.2 (d)

Radioactivity levels measured by means of high resolution gamma spectrometry in fish collected in the upper part of the Belgian Meuse river. The table consists of two parts. In the first part the results of K-40, Mn-54, Co-58, Co-60 and Ru-106 are given and in the second part those of Cs-134, Cs-137, Ra-226 and Th-232
Bq/kg fresh matter

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.069	05.10.92	Houx	Chub	130	<0.5	<1.7	<0.5	<4
21.070	05.10.92	Houx	Roach	126	<0.5	<1.6	<0.5	<4
21.071	05.10.92	Houx	Perch	≈92	<3	<10	<3	<23
21.072	05.10.92	Houx	Carp	117	<1.9	<7	<3	<15
21.073	05.10.92	Houx	Pike perch	117	<2	<7	<3	<17
21.074	24.09.92	Rivière	Bleak	≈110	<3	<9	<3	<18
21.075	24.09.92	Rivière	Roach	≈110	<3	<10	<3	<30
21.076	24.09.92	Rivière	Perch	121	<0.3	<0.9	<0.3	<2
21.077	24.09.92	Rivière	Chub	110	<0.4	<1.4	<0.4	<3
21.078	21.09.92	Givet	Pike perch	116	<2	<9	<3	<17
21.079	21.09.92	Ham-s/Meuse	Chub	86	<1.1	<5	<0.9	<10
21.080	22.09.92	Hastière	Roach	106	<1.1	<5	<1.0	<10
21.081	22.09.92	Hastière	Chub	1270*	<19	<90	<18	<150

TABLE 4.2 (d) continued

N° Sample	Date	Location	Species	K-40	Mn-54	Co-58	Co-60	Ru-106
21.082	22.09.92	Hastière	Perch	1360*	<13	<60	<16	<110
21.083	22.09.92	Hastière	Bleak	1080*	<8	<40	<6	<70
21.084	21.09.92	Waulsort	Pike perch	1060*	<14	<60	≈11	<110
21.085	21.09.92	Waulsort	Perch	≈120	<4	<13	<3	<30
21.086	21.09.92	Waulsort	Roach	120	<0.5	<3	<0.6	<4
21.087	23.09.92	Waulsort	Chub	115	<0.4	<1.6	<0.5	<4
21.088	23.09.92	Waulsort	Roach	129	<0.5	<3	<0.5	<4
21.089	23.09.92	Waulsort	Perch	129	<0.5	<1.8	<0.5	<4
21.090	23.09.92	Waulsort	Bleak	99	<1.2	<5	<1.0	<11
21.091	23.09.92	Waulsort	Eel	68	<0.4	<1.4	<0.4	<3
21.092	21.09.92	Givet	Perch	≈96	<3	<9	<1.9	<18

* : contribution of K-40 of the measurement glass vial.

TABLE 4.2 (d) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.069	05.10.92	Houx	Chub	<0.5	≈1.5	0.9	<1.7
21.070	05.10.92	Houx	Roach	≈0.6	≈1.6	≈1.0	<1.6
21.071	05.10.92	Houx	Perch	<3	≈2.4	<6	≈9.5
21.072	05.10.92	Houx	Carp	<1.5	<1.5	<4	<7
21.073	05.10.92	Houx	Pike perch	<2	≈3.2	<4	<8
21.074	24.09.92	Rivière	Bleak	<1.9	≈1.6	<4	<10
21.075	24.09.92	Rivière	Roach	<1.9	<1.9	<8	<7
21.076	24.09.92	Rivière	Perch	≈0.37	2.9	<0.5	<0.7
21.077	24.09.92	Rivière	Chub	≈0.32	1.11	≈0.9	≈0.66
21.078	21.09.92	Givet	Pike perch	≈1.6	≈4.4	≈3.1	<7
21.079	21.09.92	Ham-s/Meuse	Chub	<0.9	<0.9	<2	<3
21.080	22.09.92	Hastière	Roach	≈1.2	4.1	<3	<4
21.081	22.09.92	Hastière	Chub	<17	≈15	<40	<9
21.082	22.09.92	Hastière	Perch	<11	≈21	<24	≈61
21.083	22.09.92	Hastière	Bleak	<7	<10	<14	<30
21.084	21.09.92	Waulsort	Pike perch	<10	<10	<30	<40
21.085	21.09.92	Waulsort	Perch	<3	≈5.1	<6	≈11

TABLE 4.2 (d) continued

N° Sample	Date	Location	Species	Cs-134	Cs-137	Ra-226	Th-232
21.086	21.09.92	Waulsort	Roach	<0.5	≈1.1	<0.9	<1.7
21.087	23.09.92	Waulsort	Chub	≈0.7	2.3	<0.8	<1.2
21.088	23.09.92	Waulsort	Roach	≈0.84	3.9	<1	≈1.2
21.089	23.09.92	Waulsort	Perch	≈0.92	4.9	<0.9	<3
21.090	23.09.92	Waulsort	Bleak	<1.0	≈3.3	<3	<4
21.091	23.09.92	Waulsort	Eel	≈0.33	1.68	≈0.8	≈1.6
21.092	21.09.92	Givet	Perch	<1.8	7.2	≈5.0	≈11

TABLE 4.2 (e)

Tritium and strontium-90 levels measured in fish collected in the upper part of the Belgian Meuse river.
Bq/kg dry matter

N° Sample	Date	Location	Species	3-H	Sr-90
21.070	05.10.92	Houx	Roach	6.4±2.4	≤1.3
21.075	24.09.92	Rivière	Roach	17.6±2.7	≤1.2
21.088	23.09.92	Waulsort	Roach	8.8±2.5	≤1.2

TABLE 4.3.(a)

Gamma emitters, tritium and strontium-90 in sediments
Bq/kg dry matter

N° Sample	Date	Locations	K-40	Mn-54	Co-58	Co-60	Ru-106	Cs-134	Cs-137	Ra-226	Th-232
21.063	21.09.92	Ham	360	<3	<7	<2	<17	<3	<1.5	33	39
21.064	21.09.92	Ham	250	<3	<8	<2	<18	<3	≈3.5	26	≈28
21.065	21.09.92	Givet	470	<3	<8	<3	<19	8.4	45	36	42
21.066	22.09.92	Hastière	280	<1.3	<5	≈1.6	<12	18	84	25	32
21.067	23.09.92	Waulsort	330	<1.5	<5	≈2.5	<14	26	105	34	38
21.068	24.09.92	Dinant	360	<3	<1	<4	<23	16.9	77	33	27

N° Sample	Date	Locations	3-H	Sr-90
21.063	21.09.92	Ham	13.9±1.2	4.0±1.6
21.064	21.09.92	Ham	3.2±0.3	≤1.3
21.065	21.09.92	Givet	5.9±0.6	≤1.3
21.066	22.09.92	Hastière	7.0±0.7	≤1.3
21.067	23.09.92	Waulsort	8.7±0.7	≤1.2
21.068	24.09.92	Dinant	11.0±0.7	≤1.3

TABLE 4.3 (b)

Plutonium, americium and curium in sediments.
Bq/kg dry matter

N° Sample	Date	Locations	Pu-238	Pu-239,240	Plutonium	Am-241	Cm-244
21.063	21.09.92	Ham	1.9	2.0	2.4	2.9	2.1
21.064	21.09.92	Ham	8.0	28	36	2.7	1.49
21.065	21.09.92	Givet	0.9	1.0	1.2	1.4	1.1
21.066	22.09.92	Hastière	3.9	16.4	20	4.8	2.1
21.067	23.09.92	Waulsort	1.7	2.8	2.8	3.3	2.5
21.068	24.09.92	Dinant	7.0	8.0	15.1	2.1	1.8

TABLE 4.4

Radioactivity levels measured in water of the Meuse river.
Bq/l

N° Sample	Date	Location	K-40	Mn-54	Co-58	Co-60	Ru-106	Cs-134	Cs-137	Ra-226	Th-232
21.023	21.09.92	Ham	<1.7	<0.08	<0.14	<0.1	<0.7	<0.08	<0.09	<0.19	<0.3
21.024	21.09.92	Givet	<4.0	<0.2	<0.3	<0.3	<1.7	<0.2	<0.2	0.3	0.5
21.025	22.09.92	Hastière	<4.0	<0.2	<0.3	<0.3	<1.8	<0.2	<0.2	<0.7	<1.0
21.026	23.09.92	Waulsort	<4.0	<0.2	<0.3	<0.3	<1.9	<0.2	<0.2	<1.0	<1.5
21.027	24.09.92	Dinant	<4.0	<0.2	<0.3	<0.3	<1.9	<0.2	<0.2	<1.0	<1.2

N° Sample	Date	Location	Pu	U	Am	Po
21.023	21.09.92	Ham	<3	6.5±1.0	<3	<3
21.024	21.09.92	Givet	<3	7.8±1.2	<3	3±0.8
21.025	22.09.92	Hastière	<3	11.0±1.4	<3	<3
21.026	23.09.92	Waulsort	<3	8.0±1.2	<3	3.1±0.8
21.027	24.09.92	Dinant	<3	10.3±1.4	<3	<3

TABLE 5 (a)

Radiocesium levels (Bq/kg fresh matter) in aquatic mosses (*Cinclidotus sp)* collected in September 1986, 1989 and 1992 in the upper part of the Belgian Meuse River.

Location	Species	1986			1989			1992		
		Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134
Ham	Cinclidotus nigricans	11	30	2.73	≤4.87	2.76	≥0.57			
	Cinclidotus danubicus	14	30	2.14	≤3.64	1.62	≥0.44	<4	≈4.9	≥1.22
Givet	Cinclidotus nigricans	24	60	2.50	≤9.42	11.44	≥1.21			
	Cinclidotus danubicus	<12	47	>3.92	≤6.33	≤7.08		<4	≈11	≥2.75
Hastière	Cinclidotus nigricans	82	164	2.00	2.38	9.07	3.81	≈6	24	≈4.00
	Cinclidotus danubicus	9.8	22	2.24	≤12.2	16.20	≥1.33	<6	≈6.7	≥1.11
Waulsort	Cinclidotus danubicus	31.6	83.6	2.65	1.81	4.35	2.40	≈2.8	≈7.1	≈2.54
	Cinclidotus nigricans	~53.8	~78.9	~1.47	1.93	4.32	2.24	≈8	≈13	≈1.62
Anseremme	Cinclidotus nigricans	130	270	2.07	-	-	-	-	-	-

Table 5 (b)

Radiocesium level (Bq/kg fresh flesh) in roach (*Rutilus rutilus*) caught in september 1986, 1989 and 1992 in the upper part of the Belgian Meuse River

Location of Catch	1986			1989			1992		
	Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134
Hastière	-	-		1.07	≤7.52	≤7.03	≈1.2	4.1	≈3.42
Waulsort	<2.9	5.1	1.76	0.50	1.71	3.42	<0.5	≈1.1	≥2.2
				1.85	4.59	2.48	≈0.84	3.9	≈4.64
				0.88	3.66	4.16			
Colebi	<7.4	~8.6	≥1.16						
Hun	~1.3	3.3	>2.54						
Houx	-	-		-	-		≈0.6	≈1.6	≈2.67
Rivière	-	-		-	-		<1.9	<1.9	-
Tailfer	-	-		≤1.75	≤6.87	-	-	-	
				≤1.86	5.62	≥3.2			
Namèche	1.1	2.2	2.00	-	-		-	-	

Table 5 (c)

Radiocesium level (Bq/kg fresh flesh) in pike (*Perca fluviatilis*) caught in september 1986, 1989 and 1992 in the upper part of the Belgian Meuse River

Location of Catch	1986			1989			1992		
	Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134	Cs-134	Cs-137	Cs-137/Cs-134
Givet	-	-		-	-		<18	7.2	>4.00
Hastière	-	-		-	-		<11	≈21	≥1.91
Waulsort	-	-		1.34	4.07	3.04	<3	≈5.1	≥1.91
				0.84	2.80	3.33	≈0.92	4.9	≈5.32
				≤1.91	1.70	≥1.94			
Rivière	3.1	6.6	2.13	-	-		≈0.37	2.9	≈7.84
Houx	-	-		-	-		<3	≈2.4	≥0.80
Namèche	<1.7	~2.7	≥1.59	-	-		-	-	

ANNEX

Photo 1.: *Acorus calamus*

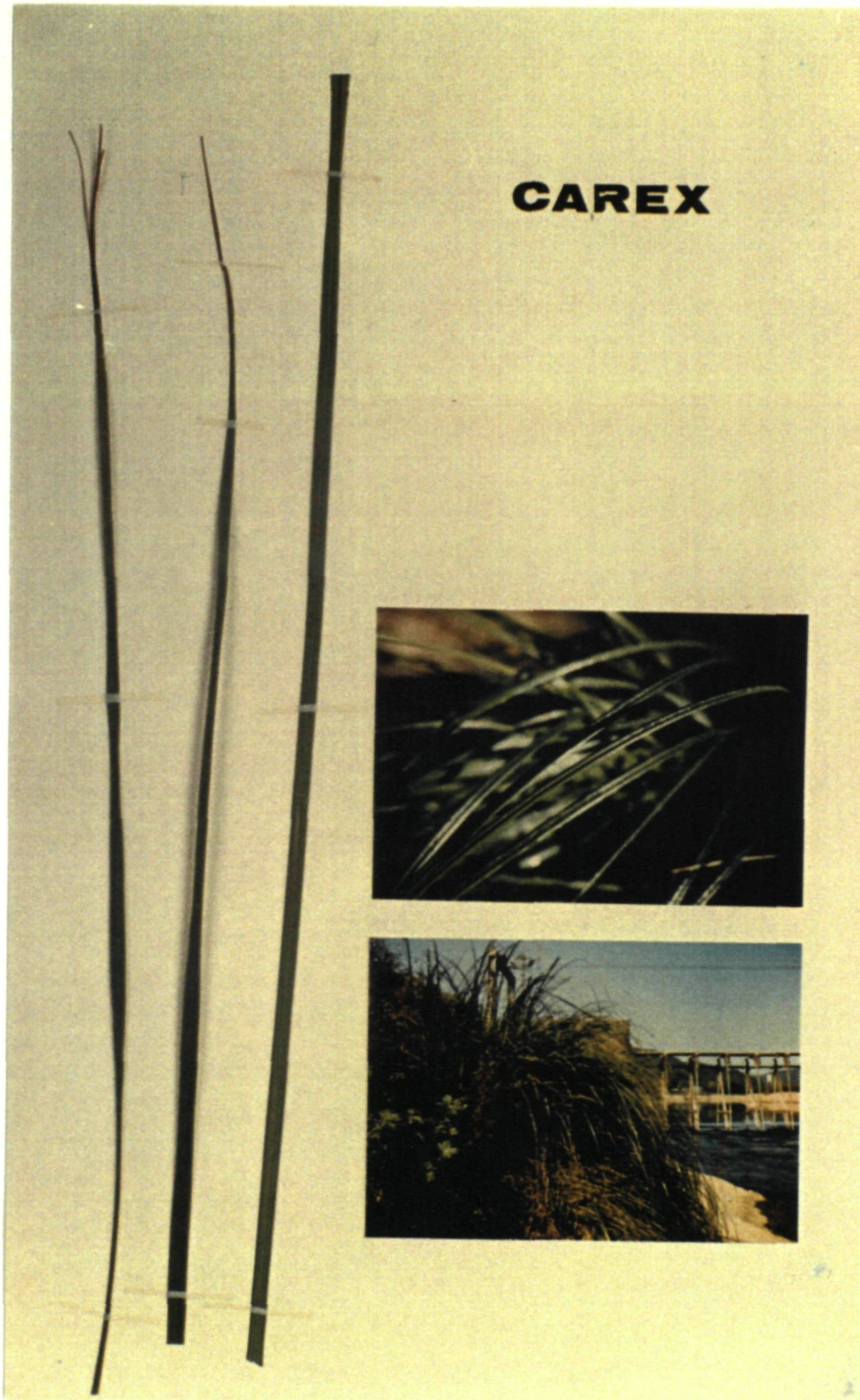


Photo 2.: *Carex*

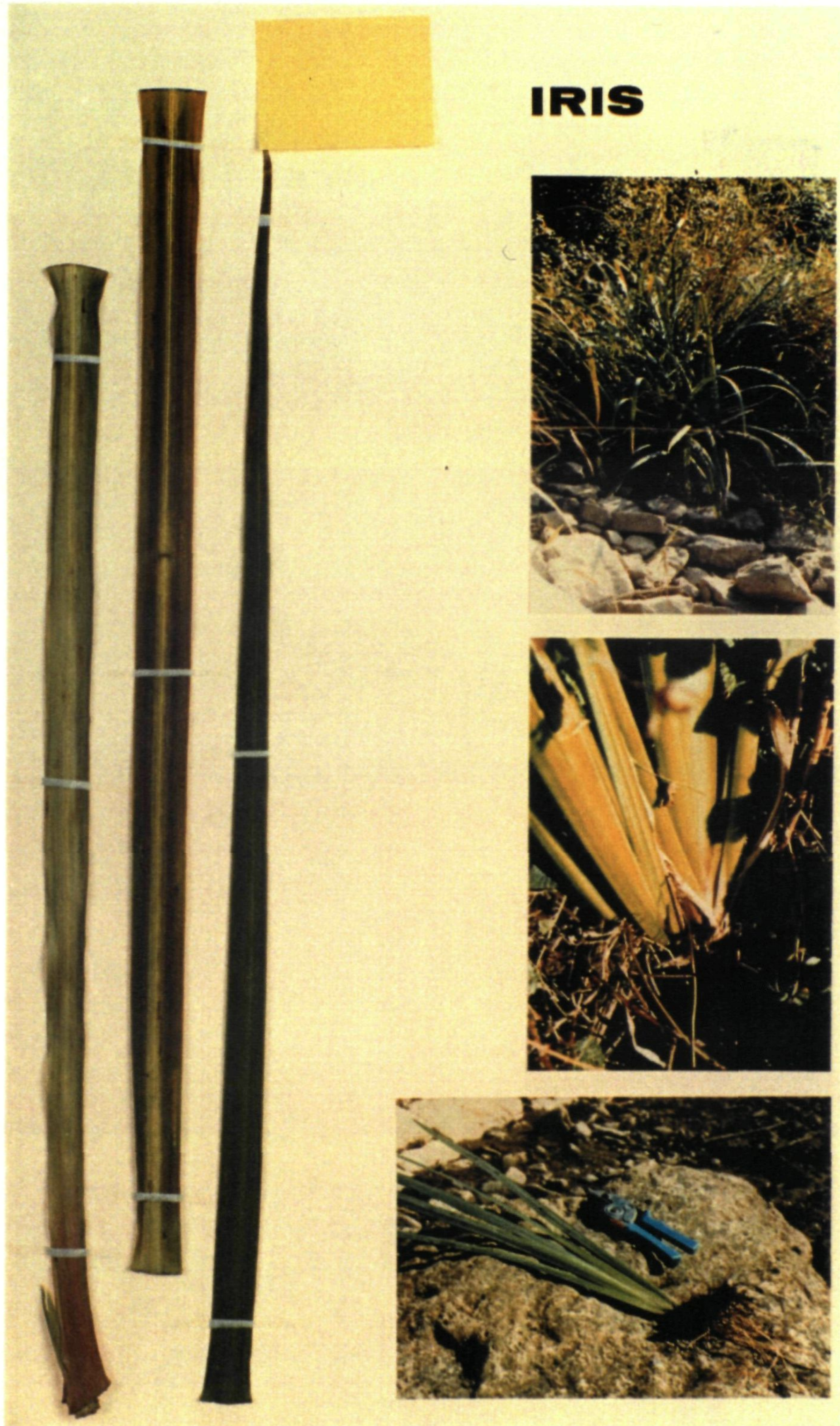


Photo 3.: *Iris pseudocorus*

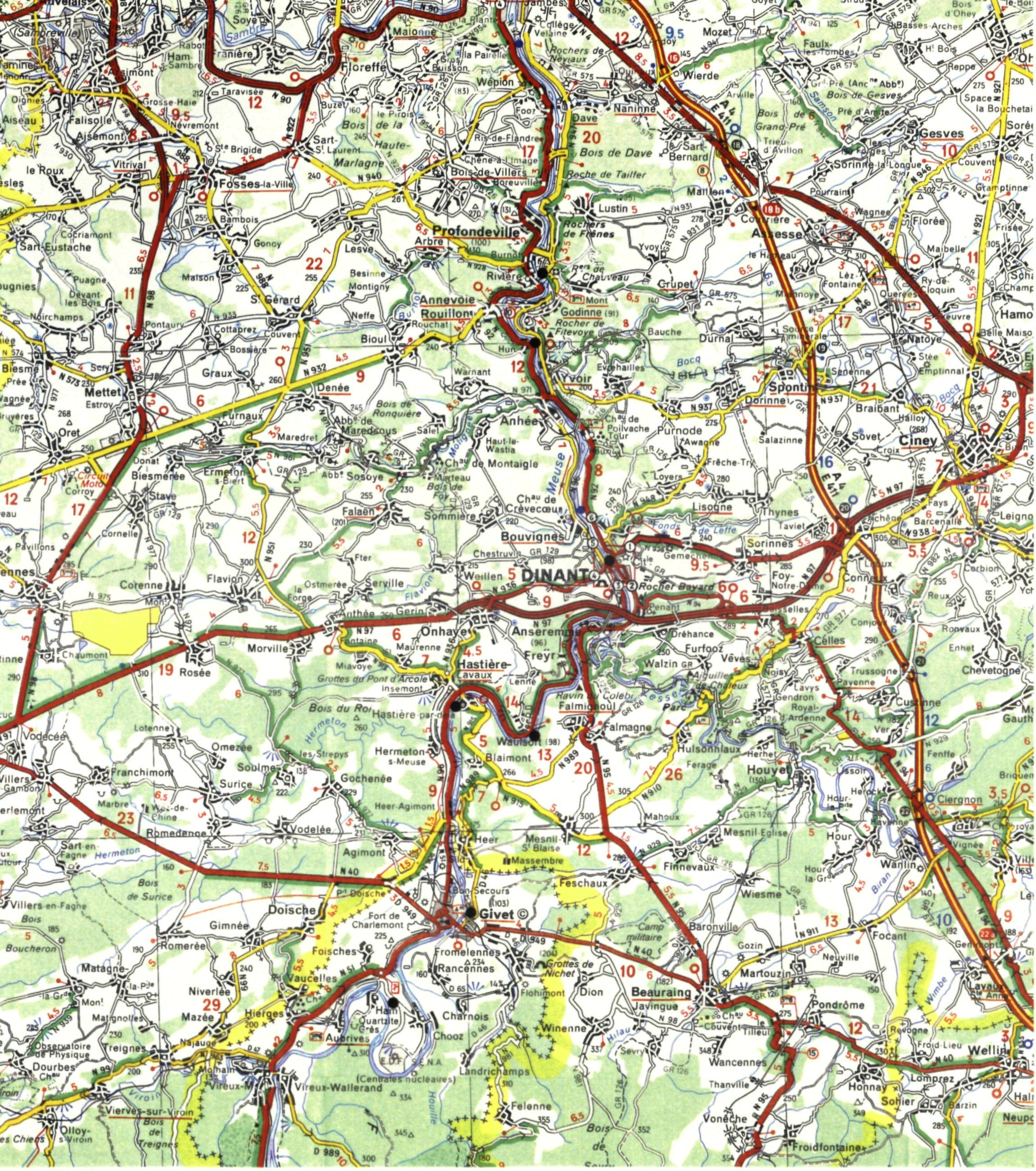
Photo 4.: *Phalaris arundinacea*

Photo 5.: *Phragmites autralis*

Photo 6.: *Saule*

Photo 7.: *Scirpus lacustris*

Photo 8.: *Sparganium*



The sampling locations are indicated with black dots

- aquatic plants
- aquatic animals
- sediments
- river water