Dept. of Forensic Medicine & Toxicology,
Faculty of Vet. Med., Assiut University,
Head of Dept. Prof. Dr. A.A. Shaaban.

LEAD, COPPER, MERCURY AND CADMIUM LEVELS IN RIVER NILE WATERS AT SOME ASSIUT REGIONS, EGYPT.

(With One Table and One Figure)

By

*M. ABD EL-NASSER, A.A. SHAABAN, SEHAM, M. ALY** and *MANAL M. SAYED**

* Animal Health Research Institute, Assiut.

(Received at 8/1/1996)

مستويات الرصاص والنحاس والزنبق والكادميوم فى مياه نهر النيل فى منطقة أسيوط ، مصر

محمود عبدالناصر ، عبدالعزيز شعبان ، سهام على ، منال سيد

تعد معادن الرصاص والنحاس والزنبق والكادميوم من أهم الموثات التى نشأت وواكبت التطور الصناعى والعديد من الأنشطة الانسانية فى العقدين الأخيرين مما دفعنا فى هذه الدراسة لتحديد مستويات هذه العناصر فى مياه نهر النيل خلال شتاء وصيف ١٩٩٢/١٩٩٣ فى مناطق أسيوط (الوليدية) ومنقباد وأبوتيج وبنى قرة وديروط . أجرى هذا البحث على عدد ٥٠ عينة من المياه تم جمعها من نهر النيل فى مناطق الدراسة وتم تحديد مستويات الرصاص والنحاس والزنبق والكادميوم فى هذه العينات بعد معاملتها كيماويا . وجد أن تركيز الرصاص فى عينات المياه ٩٤٠ر١ ، ٨١٠ر٠ ، ٨١٠ر٠ ، ٣١٤ر٠ ، ٧٩٠ر٠ جزء فى المليون فى الشتاء و ٢٢٠ر٠ ، ٢٧٠ر٠ ، ٣١٣ر٠ ، ٢٢٠ر٠ ، ٢٠٠ر٠ جزء فى المليون فى الصيف فى مناطق أبوتيج ، أسيوط ، منقباد ، بنى قرة ، وديروط على الترتيب . سجلت منطقتى أبوتيج وأسيوط أعلى قيم للرصاص فى الشتاء ومنطقتى منقباد وأسيوط أعلى قيم له فى الصيف. تعدى تركيز الرصاص الحد المسموح به فى المياه المحدد من قبل منظمة الصحة العالمية وهو ٥ر٠ جزء فى المليون . أعلى تركيز للنحاس تم تعيينها فى مياه منطقتى منقباد وبنى قرة ٤٢ر٠ ، ٠٨٨ر٠ جزء فى المليون فى الشتاء و ٥٢٢ر٠ ، ٣٩ر٠ جزء فى المليون فى نفس المنطقتين فى الصيف وهذا يعتبر أقل من المسموح به من قبل منظمة الصحة العالمية والذى يبلغ ٣ جزء فى المليون . أعلى تركيز للزنبق تم قياسه فى مياه منطقتى أسيوط وبنى قرة وقدره ٧٠٠ر١٨ ، ٤٠٠ر١٢ جزء فى

البليون فى الشتاء ومنطقتى بنى قرة وديروط وقدره ٢٤٫٨٠٠ ، ١٥٫٦٠٠ جزء فى البليون فى الصيف وتعد هذه القيم أعلى من الحد المسموح به والمحدد من قبل المنظمات المعنية بالصحة العامة وقدره ٢ جزء فى البليون . أعلى تركيز للكادميوم تم تعيينه فى مياه منطقتى بنى قرة ومنقباد وبلغ ٠٫٠٠٩ ، ٠٫٠٠٧ جزء فى المليون فى الشتاء فى منطقتى ديروط ومنقباد وقدره ٠٫٠١٢ ، ٠٫٠١٥ جزء فى المليون فى الصيف . وقد وجد أن تركيز الكادميوم فى منطقتى ديروط ومنقباد فى الصيف قد تعدى الحد المسموح به عالميا وهو ٠٫٠١ جزء فى المليون . من هذا يتضح تلوث المياه فى خلال فترة البحث فى مناطق أبوتيج ، مدينة أسيوط ومنقباد ، بنى قرة وديروط بمعادن الرصاص والزئبق بينما تلوث مياه منطقتى منقباد وديروط بمعدن الكادميوم مما قد يؤدى الى انخفاض العائد السمكى فى هذه المناطق والذى يعد واحدا من أهم مصادر البروتين الحيوانى فى مصر كما أن المياه تعد مصدرا هاما لوصول هذه الملوثات الى الانسان والحيوان على حد سواء مما قد يؤدى الى آثار مهلكة لكل منهم على المدى الطويل . لهذا يوصى الباحثون بضرورة الفحص الدورى والمستمر للمياه للوقوف على مستويات هذه المعادن ووقف أى مصادر للتلوث بها .

SUMMARY

The increased use of heavy metals like lead, copper, mercury and cadmium in industry and agriculture, and thier subsequent intrusion in indeterminate amounts into the environment has caused ecological and biological changes. In our study 50 water samples were collected from Abu-Tig, Assiut Manquabad, Bany-Qurra and Dairut, at winter and summer 1992/1993. Water samples were subjected to analysis for the presence of lead, copper, mercury and cadmium. Our results revealed that lead concentrations in water of the different examined areas were 1.940, 0.810, 0.810, 0.314 and 0.790 ppm in winter and 0.220, 0.270, 0.313, 0.222 and 0.200 ppm in summer at Abu-Tig, Assiut, Manqabad, Bany-Qurra and Dairut respectively. Abu-Tig and Assiut areas registered the highest concentration in winter and Manqabad and Assiut in summer. The examined water samples were above the permissible limit of WHO (0.10 ppm) or United States Environmental Protection Agency (US EPA) which is 0.05 ppm. The highest concentration of copper in water samples collected from Manqabad and Bany-Qurra were 0.42 and 0.088 ppm in winter and 0.522 and 0.39 ppm in summer. The examined water samples showed values less than the permissible limits adopted by US EAP (1.0 ppm). A concentration of 18.700 and 12.400 ppb were the highest concentrations of mercury in water samples collected from Assiut and Bany-Qurra in winter and 24.800 and 15.600 ppb in Bany-Qurra and Dairut in summer. The examined water samples showed values more than the permissible limits adopted by US EPA (2 ppb). The highest concentration of cadmium in water at Bany-Qurra and Manqabad (0.009 and 0.007 ppm) in winter and Dairut and Manqabad (0.012 and 0.015 ppm) in summer. Water samples showed cadmium values less than the permissible limit (0.01 ppm) except water samples collected from Manqabad and Dairut in summer which reached to 0.015 and 0.012 ppm respectively.

Keyword: *Lead, Copper, Mercury and Cadmium levels in River Nile*

INTRODUCTION

The control of water pollution is important not only for amenity and public health reasons but also because clean water for domestic, industrial and agricultural use is in short supply. There is considerable evidence that some heavy metals may be harmful to health at levels recorded in the environment. They are conservative pollutants in that they are not broken down, or are broken down over such a long time scale, that they effectively become permanent additions to the aquatic environment. The heavy metals of most wide spread concern to human health are lead, copper, mercury and cadmium, *Nriagu (1988)* has suggested that over 1 billion (10^9) human beings are currently exposed to elevated concentrations of toxic metals and metalloids in the environment and several million people may be suffering from subclinical metal poisoning.

The heavy metals in freshwater are a matter of concern because of their toxic potential ability to be accumulated in food chains, therefore (Cd^{2+} and Hg^{2+} are on first list and Pb on second list percent of dangerous substances, *(Gardiner and Mance, 1984 and Ellis, 1989)*. The River Nile is the most important aquatic system of Egypt. It provides the freshwater supply for the whole country. In addition it considered the major source of fish which is the main source of animal proteins in Egypt nowaday. The aim of this work was to assess the levels of lead, copper, mercury and cadmium in water samples collected from the River Nile at Abu-Tig, Assiut (El-Wilidiya), Manquabad, Bany-Qurra and Dairut areas during winter and summer 1992/1993.

MATERIAL and METHODS

50 water samples were collected from the River Nile at Abu-Tig, Manquabad, Assiut (El-Wilidiya), Bany-Qurra and Dairut during the years 1992/1993, 25 samples in winter and the same number in summer. Samples were collected from the River Nile at various distances and depths, five samples from each area as shown in the location map of studied areas fig. 1. Water samples were digested by the use of a mixture of equal volumes of nitric and perchloric acids according to *Chau et al. (1974)*. Lead levels of the prepared water samples were estimated according to the method of *Campiglio (1979)* using lead electrode model 94-82 attached to expandable ion analyzer (EA 920), Orion Research, Orion American Company. Copper levels were determined according to the method of *Smith and Manahan (1973)* in the same manner. Estimation of mercury levels in water samples

was according to *Overman (1971).* Cadmium levels were estimated according to *Gardiner (1974)* in the same way.

RESULTS

The analysis of lead in water in winter season revealed an increase in the concentration of lead at Assiut and Manqabad areas (0.810 ppm for both) more than other areas of Dairut, Abu-Tig and Bany Qurra which reached 0.79, 0.72 and 0.31 ppm as shown in table 1. The highest concentration of water in summer registered at Manqabad and Assiut areas (0.313 and 0.270 ppm) in comparison with the areas of Bany Qurra, Abu-Tig and Dairut (0.222, 0.220 and 0.200 ppm). Analytical findings of copper concentration of the water supply at the various areas of study showed in the same table. The highest concentration registered in water samples collected from Manqabad and Bany Qurra in winter and in summer seasons were 0.42, 0.088 and 0.522, 0.39 ppm respectively, while Assiut, Dairut and Abu-Tig areas showed the lowest concentrations (0.041, 0.061 and 0.077 ppm) in winter and (0.144, 0.210 and 0.128 ppm) in summer.

Analysis of water samples for mercury in studied areas proved that highest concentration was at Assiut and Bany Qurra areas in winter (18.700 and 12.400 ppb). and at Bany-Qurra and Dairut areas in summer (24.800 and 15.600 ppb). Cadmium concentrations in water samples showed its highest level in Bany-Qurra and Manqabad (0.009 and 0.007 ppm) in winter and Manqabad and Dairut (0.015 and 0.012 ppm) in summer.

DISCUSSION

Table 1 shows the levels of tested heavy metal concentrations in water samples collected during winter and summer 1992/1993 from the River Nile. Indeed, it is well known that metal concentrations in river waters may vary over wide ranges *(Lietz and Galling, 1989).* Our study revealed an elevation of lead concentration in water samples collected from Assiut and Manqabad in winter as well as in summer. These results could be attributed to the presence of industrial discharge from superphosphate factory and petrolleum factory, in addition to pollution of the River Nile which lies near the high way and motor cars effluents,the effects of many industrial and anthropogenic activities in the areas of sample collection. Since this area is the most densely populated and there are many industrial activities, several domestic and industrial effluents and wastes are discharged to the river's water.It is well known that the main sources of environmental pollution in Assiut province return to the presence of various factories like

superphosphate and cement factories at Manqabad, soap and oil factory at Bany-Qurra, in addition to the petroleum factory located beside Assiut City.

Van Hassel et al. (1980) stated that high way or motor boat traffic are the main source of lead pollution. Also *El-Nabawi et al. (1987)* reported that industrial and agriculture discharge are primary source of lead pollution in Egypt.*Mason (1991)* cited that tetra-ethyl lead is used as petrol additive which has been widely dispersed in environment.Our results revealed that the highest level of lead recorded in water samples collected from Manqabad and Assiut areas was 0.810 ppm. WHO (1972) stated that the international standards for drinking water must not exceed 0.1 mg lead/liter. In the presence of nitrate, ammonium salt or dissolved carbon dioxide the water become plumosolvent, level of lead as high as 25 mg/liter have been reported.

Twort et al. (1974) reported that the WHO "international standards" (1971) a tentative limit of 0.1 mg lead/liter in water, the WHO "European standards" (1970), suggested that a maximum lead concentration in water is 0.3 mg/liter and under normal running condition the concentration of lead in water should be less than 0.05 mg/liter. *Wardrope and Graham (1982)* stated that the WHO and European communities recommended lead level for water 0.1 ppm. *WHO (1984)* stated that the natural lead content of lake and river water world wide has been estimated to be 1-10 µg/liter. The comparison between our results and the previous recommended international standards, indicated a higher lead concentration recorded in all water samples in winter as well as in summer.

The analytical study of water samples revealed an elevation in copper concentration at Manqabad and Bany-Qurra areas in winter and in summer seasons. This elevation may be attributed to industrial effluents discharged from factories at Manqabad and Bany-Qurra. Ibrahim *(1980 and 1983)* recorded that copper was significantly elevated at the main source of superphosphate effluent on River Nile as a result of rock phosphate usage during the processes of superphosphate fertilizer at Manqabad. *Omaya (1982)* stated that level of copper increased in recent years in marine and lake sediments near industrial region.*Singh et al. (1990)* stated that subermarkha river at Ghatsila is polluted by effluents discharge from Hinduston copper limited and uranium corporation of India limited.Our results revealed that the level is less than the permissible limit 1.0 ppm recommended by *US EPA (1986).*

Analysis of water samples revealed an elevation of mercury at areas of Assiut and Bany-Qurra in winter and Bany-Qurra and Dairut in summer. Elevation of mercury at Assiut may attributed to the use of mercuric

compounds as fungicides in agriculture and horticulture and at Bany-Qurra due to industrial discharge from soap and oil factory. Elevation of mercury at Dairut may attributed to the direction of water stream from south to north (Fig. 1). WHO working group (1989) recorded that the chlora-alkali industry, the wood pulping industry also released significant amounts of mercury. High concentrations of metal are still present in sediments, associated with the industrial application of mercury. *Mason (1991)* stated that some industry release mercury into the environment, chloro-alkali industry which produces chlorine and sodium hydroxide electrolytically, using mercury as cathode is responsible for much contamination of lakes and rivers. Our result proved that mercury concentrations higher than the permissible limit (2.00 ppb) recommended by the international standards of *US EPA (1986).*

The analytical study of water revealed an elevation of cadmium levels at areas of Bany-Qurra and Manqabad in winter and at Manqabad and Dairut in summer, which showed cadmium levels higher than that recommended in the international standards (0.01 ppm) of *US EPA (1986). Davis (1984)* stated that the main sources of cadmium pollution are the combustion of gasoline. The utilization of cadmium containing pesticides, phosphate fertilizers and industrial wastes may be the main sources of contamination. On the other hand *Oronsaye and Brafield (1984)* stated that heavy metals including cadmium are released into the aquatic environment by industrial concerns such as mining and plating processes.

It should be stated that the water of the River Nile which is the source of life of Egypt is polluted with lead and mercury in some areas along its course in Assiut region. These pollutant metals may be derived from anthropogenic activities, industrial as well as agricultural wastes and several major drains. Regular analysis and monitoring programms should be applied in an attempt to control these environmental pollution by heavy metals.

REFERENCES

Campiglio, A. (1979): Potentiometric microdetermination of lead electrode and its application of organic lead compound. Mikrochim. Acta, 1: 267.

Chau, Y.K. and Chan, K. (1974): Determination of labile and strongly bound metals in lake water. Water Research, 8: 383-388.

Davis, R.D. (1984): Cadmium; a complex environmental problem. Experientia, 40: 117-126.

El-Nabawi, A.; Heinzow, B. and Kruse, H. (1987): As, Cd, Cu, Pb, Hg, and Zn in fish from Alexandria region, Egypt. Bull. Environ. Contam. Toxicol. 39: 889-897.

Ellis, K.V. (1989): Surface water pollution and its control. Macmillon, London.

Gardiner, J. (1974): The chemistry of cadmium in natural water. I. A study of cadmium complex formation using the cadmium specific ion electrode. Water Res., 8: 23.

Gardiner, J. and Mance, G. (1984): Water quality standards arising from European community directives. Water Research Center Tech. Res. 204.

Ibrahim, Th.A. (1980): Effect of some waste products of chemical factories in Assiut province on Animal health.Thesis for M.V.Sc. Faculty of Veterinary Medicine, Assiut University, Egypt.

Ibrahim, Th.A. (1983): Toxicological effects of the products of the super phosphate plant on Egyptian buffaloes in Assiut province. Ph.D. Thesis presented to the Faculty of Veterinary Medicine, Assiut University, Egypt.

Lietz, W. and Galling, G. (1989): Metals from sediments wat. Res. 23: 247-252. Biology of freshwater pollution. 2nd edition. Longman group UK. limited PP. 168-178.

Mriagu, J.O. (1988): A silent epidemic of environmental metal poisoning ? Environ. Pollut, 50: 189-161.

Omaya, S.T. (1982): Heavy metals, nutrient interaction. Food technology, 36 (10): 96-103.

Oronsaye, T.A.O. and Brafield, A.E. (1984): The effect of dissolved cadmium on the chloride cells of the stickleback, Gasterosteus aculeatus. J. Fish Biol. 25: 253-258.

Overman, R.F. (1971): Potentiometric Titration of mercury using the iodide selective electrode as indicator. Anal. Chem. 43 (4): 616.

Singh, N.K.; Varma, M.C. and Datta, M.J.S. (1990): accumulation of copper, zinc, lead, iron and cadmium in certain fresh water fishes of River subernarekha. J. Article original research, 2 (3): 189-193.

Smith, M.J. and Manahan, S.E. (1973): Copper determination in water by standard addition potentiometry. Anal. Chem., 45 (6): 836.

Twort, A.C.; Hoather, R.C. and Law, F.M. (1974): Water supply. 2nd ed. Edward Arnold Ltd., London, PP. 190: 199, 408.

US EPA (1986): Quility criteria for water (Cited in metal poisoning in fish. forward by sorensen, E.M.B. (1991). by CRC Press, Inc. PP. 359.

Van Hassel, J.H.; Ney, J.J. and Garling, J.R. (1980): Heavy metals in a stream ecosystem at sites near highways. Trans. Amer. Fish Soc., 109: 636.

Wardrope, D.D. and Graham, J. (1982): Lead mine waste hazards to livestock. Vet. Record, 111: 457-459.

WHO (1972): Health hazards of the human Environment. WHO report, Geneva, PP. 61.

WHO (1984): Guidelines for drinking water quility, volume 2, health criteria and other supporting information, PP. 111-119.

WHO International Standard (1971): Cited after Twort *et al.* (1974).

WHO working group (1989): Mercury, environmental health criteria 86. WHO report, Geneva, PP. 9.

Table 1. Heavy metal concentrations (mean ± S.E.) in water samples

Area	Winter				Summer			
	Lead (ppm)	Copper (ppm)	Mercury (ppb)	Cadmium (ppm)	Lead (ppm)	Copper (ppm)	Mercury (ppb)	Cadmium (ppm)
Abu-Tig	0.720±0.140 0.420-1.200	0.077±0.025 0.030-0.19	8.800±1.030 3.000-9.000	0.005±0.006 0.003-0.008	0.220±0.018 0.180-0.300	0.128±.0357 0.05-0.24	7.000±0.370 6.000-8.000	0.006±0.001 0.003-0.011
Assiut	0.810±0.096 0.500-1.100	0.041±0.015 0.021-0.11	18.700±1.490 15.000-24.000	0.006±0.0001 0.001-0.008	0.270±0.030 0.188-0.350	0.144±.0448 0.06-0.125	5.900±0.330 5.000-7.000	0.007±0.0004 0.005-0.008
Manqabad	0.810±0.140 0.400-1.200	0.42±0.005 0.029-0.065	10.900±0.780 8.000-13.000	0.007±0.002 0.002-0.016	0.313±0.018 0.250-0.375	0.522±0.036 0.15-0.37	4.000±0.580 1.500-5.000	0.015±0.001 0.006-0.018
Bany- Qurra	0.314±0.071 0.110-0.470	0.088±0.019 0.055-0.175	12.400±0.380 4.500-16.000	0.009±0.0001 0.005-0.016	0.222±0.026 0.188-0.340	0.39±0.084 0.065-0.6	24.800±6.280 19.000-60.000	0.009±0.0008 0.007-0.012
Dairut	0.790±0.150 0.450-1.200	0.061±0.001 0.055-0.065	9.900±0.160 9.500-10.500	0.003±0.0006 0.002-0.0065	0.200±0.014 0.160-0.250	0.210±.0214 0.155-0.285	15.600±3.580 7.000-28.000	0.012±0.0004 0.010-0.013

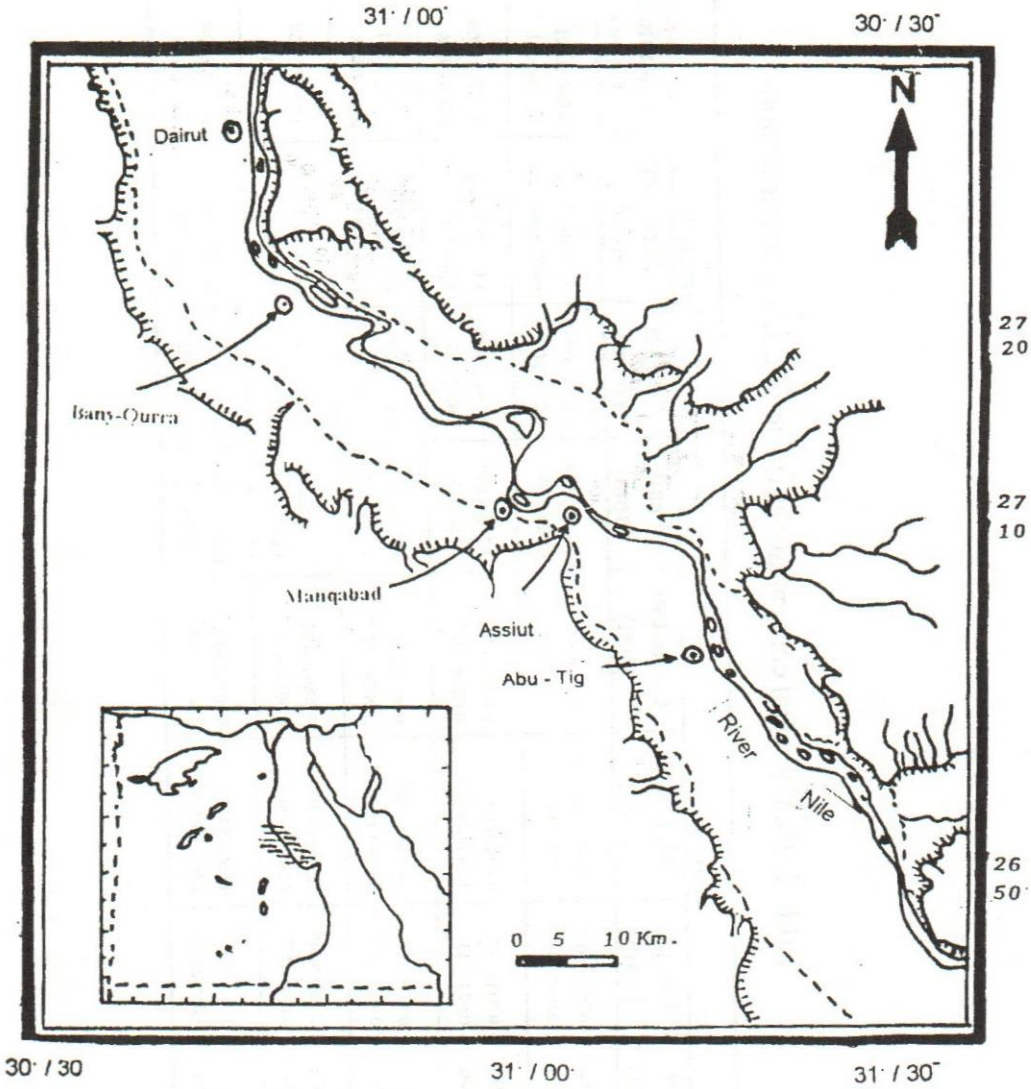

Fig. 1. location map of studied areas