Bibliography on Mercury

ENVIS Centre on
Occupational and Environmental Health

Website : envisnioh.org

NATIONAL INSTITUTE OF OCCUPATIONAL HEALTH
(Indian Council of Medical Research)
Ahmedabad

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Working Team

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Introduction

Some of the metals are essential for the normal growth, development, reproduction and various other physiological functions. However, their excess or deficiency in the body might lead to adverse biological effects. Human being can be exposed to certain metals through environment and with higher doses during their occupation. There are three species of mercury: 1) organic 2) inorganic and 3) elemental mercury, elemental mercury used in the production of batteries, thermometers, etc. Elemental mercury is absorbed mainly through inhalation. The inorganic salts are absorbed through ingestion and highly irritating causing mucosal damage. Organic mercury compounds are readily absorbed through all routes (Frazier and Hage, Reproductive Hazards of the Workplace 146, 1998)). Mercury is encountered in the workplace in two major forms: inorganic mercury, which includes both elemental and inorganic salt; and as organic mercury compounds, also known as alkyl mercury compounds. Occupational exposure to inorganic mercury compounds is much more common than to organic mercury compounds. Occupational uses of mercury include manufacture of amalgams, lab equipments, valves, switches and rectifiers; as catalyst and pigments; and as medicines, biocides and antifouling agents (Frazier and Hage, 1998). The mercury from dental amalgam may contribute from 0 to 75% of total daily mercury exposure depending upon the number of amalgam fillings, the amount of fish consumed and other less common sources such as mercury spills, religious practices, or herbal remedies that contain mercury (ATSDR, Toxicological Profile for Mercury, 1994).

Exposure to toxic mercury is a growing health hazard throughout the world today. Recent studies show that mercury exposure may occur in the environment, and increasingly in occupational and domestic settings. Children are particularly vulnerable to Hg intoxication, which may lead to impairment of the developing central nervous system, as well as pulmonary and nephrotic damage (Counter and Buchanan, Toxicol Appl. Pharmacol 198: 209, 2004). In addition, some of the metals including mercury reported to have endocrine

disruptive potential affecting normal reproductive and endocrine function and might have potential adverse effect even at a very low level not only for the exposed individual but also to the offspring.

The present bibliography covers the data available on environmental and occupational exposure and health impairments including biological and environmental monitoring from India. The data were collected through searching various databases such as Pub Med, Medline, Toxline and other websites such as Goggle and consulting various journals. We have arranged the data year wise from recent one to older one. In addition, information on tolerance guidelines, concentration of mercury in biota and pollution source and control technology measures provided. We are thankful to Dr. SP Sharma Project Director (EI), Ministry of Environment & Forest, New Delhi, India for encouragement and suggestion.

Dr. P. K. Nag
Officer-In-Charge

Dr. Sunil Kumar
Coordinator- ENVIS-NIOH

Tolerance Guidelines*

Title	Details
Max. Permissible limit in water	1 μg/l
Max. Concentration in compost	0.15 mg/kg dry basis
Max. Concentration in treated leacheate	10 μg/l in land, surface water and public sewers
Max. Allowed / recommended levels of mercury in fish	0.5 ppm total mercury
National data on consumption	NA

Ministry of Commerce, Govt. of India. 1995
Ministry of Environment and Forest, Govt. of India. 2000
Adopted from
Dr. R. C. Srivastava, ITRC, Lucknow, INDIA
Global Mercury Assessment (Comments and inputs on Draft Assessment Report 2002)

Reported Concentration of total mercury in biota from different coastal parts of peninsular India

Location	Hg Concentration	Organisms
Sagar Island, east coast	0.06-2,24 μg/gm dry	Bivalves
Madras, southeast coast	BDL-100 ng/gm	Fishes
Madras, southeast coast	0.08-0,14 ppm/wet wt	Fishes
Karwar, west coast	0.03-0.003 μg/gm wet wt	Fishes
Bombay, west coast	0.13-10.82 μg/gm dry wt	Bivalves
Bombay, west coast	0.03-0.82 μg/gm dry wt	Fishes
Bombay, west coast	1.05-3.60 μg/gm dry wt	Gastropods
Bombay, west coast	1.42-4.94 μg/gm dry wt	Crabs
Arabian Sea and Bay Of Bengal	Below Detection -0.210 ppm	Fishes
Indian Ocean	0.02-0.065 ppm wet wt	Bivalves
	<0.004-0.021 ppm wet wt	Crabs
	<0.004-0.36 ppm wet wt	Fishes

Bhattacharya B; Sarkar S. K. Chemosphere, Vol. 33, 147-158, 1996
Adopted from
Dr. R. C. Srivastava, ITRC, Lucknow, INDIA
Global Mercury Assessment (Comments and inputs on Draft Assessment Report 2002)

Mercury Pollution sources and control techniques

Air pollution sources	Control measures	Water pollution Sources	Control measures	Soil pollution Sources	Control measures
Hg mining and smelting	Conditioning of Hg vapour in refrigeration unit followed by EP	Chlor-alkali industry	Process-change/ Properly designed tailings disposal sys.	Use as herbicide and insecticide	Restriction in use in agriculture
Mercury battery cell	EP/bag house	Mining and smelting / battery	Ion exchange/ neutralization And sedimentation with / without ppt	Airborne Hg particulate deposition	Air pollution control
Chlor-alkali industry	Process – change/use of ventury scrubber	Pulp and paper	Process – change / restriction in use of Hg	Solid waste dumping	Restriction without pretreatment like recycling/ sanitary – land fill, etc.

R. S. Tiwaree and D. S. Bhargava. Trace Metals (Cd, Pb and Hg) in the Environment. Indian Journal of Environmental Protection, 12 : 241-250, 1992.

Adopted from

Dr. R. C. Srivastava, ITRC, Lucknow, INDIA

Global Mercury Assessment (Comments and inputs on Draft Assessment Report 2002)

1. **Agarwal R, Kumar R, Behari JR.**
   Mercury and lead content in fish species from the river Gomti, Lucknow, India, as biomarkers of contamination.
   Bull Environ Contam Toxicol. 78(2):118-22, 2007
   Toxicokinetics Section, Industrial Toxicology Research Centre, PO Box 80, M. G. Marg, Lucknow, (Uttar Pradesh), India.

2. **Kannan SK**, **Krishnamoorthy R**.
   Isolation of mercury resistant bacteria and influence of abiotic factors on bioavailability of mercury - A case study in Pulicat Lake North of Chennai, South East India
   Sci Total Environ. 2006
   Department of Applied Geology, University of Madras, Chennai - 600025, India.

Pulicat Lake sediments are often severely polluted with mercury compounds and other toxic heavy metals. Several mercury-resistant bacteria were isolated and identified from the sediments and all the isolates exhibited broad spectrum resistance (both organic and inorganic mercuric compounds). Mercury volatilization showed that four of the isolated Bacillus cereus strains were able to reduce water soluble ionic form of mercury into volatile form via the well known enzymatic reduction. The effect of increasing concentration of mercuric chloride and phenyl mercuric acetate in the growth of this mercury reducing strain was also determined. To study the native physico-chemical parameters, which influence the bioavailability of mercury to bacteria in Pulicat Lake ecosystem, a total of 60 water and 30 sediment samples were collected and analyzed for pH, temperature, dissolved oxygen, salinity, nitrate, nitrite, silicate, phosphate, organic matter and organic carbon. Increased levels of phosphate, nitrite, nitrate, silicate, organic matter and organic carbon during the post monsoon reduce the bioavailability of mercury by forming complexes which may increase the concentration of mercury in the sediments during post monsoon.

3. **Kannan SK**, **Mahadevan S**, **Krishnamoorthy R**.
   Characterization of a mercury-reducing Bacillus cereus strain isolated from the Pulicat Lake sediments, south east coast of India.
   Arch Microbiol.185(3):202-11, 2006
   Department of Applied Geology, University of Madras, Guindy campus, Post Bag No: 5327, 600 025, Chennai, Tamil Nadu, India, skk2k@rediffmail.com.

Pulicat Lake sediments are often severely polluted with the toxic heavy metal mercury. Several mercury-resistant strains of Bacillus species were isolated from the sediments and all the isolates exhibited broad spectrum resistance (resistance to both organic and inorganic mercuric compounds). Plasmid curing assay showed that all the isolated Bacillus strains carry chromosomally borne mercury resistance. Polymerase chain reaction and southern hybridization analyses using merA and merB3 gene primers/probes showed that five of the isolated Bacillus strains carry sequences

similar to known merA and merB3 genes. Results of multiple sequence alignment revealed 99% similarity with merA and merB3 of TnMERI1 (class II transposons). Other mercury resistant Bacillus species lacking homology to these genes were not able to volatilize mercuric chloride, indicating the presence of other modes of resistance to mercuric compounds.

4. **Karunasagar D**, **Balarama Krishna MV**, **Anjaneyulu Y**, **Arunachalam J**.
Studies of mercury pollution in a lake due to a thermometer factory situated in a tourist resort: Kodaikkanal, India
Environ Pollut. 2006
National Center for Compositional Characterization of Materials (CCCM), Bhabha Atomic Research Centre, Department of Atomic Energy, ECIL Post, Hyderabad 500 062, India.

Kodaikkanal, India, suffered mercury contamination due to emissions and waste from a thermometer factory. Kodai Lake is situated to the north of the factory. The present study determined mercury in waters, sediment and fish samples and compared the values with those from two other lakes, Berijam and Kukkal. Total mercury (Hg(T)) of 356-465ng l(-1), and 50ng l(-1) of mercury in methyl mercury form were seen in Kodai waters while Berijam and Kukkal waters showed significantly lower values. Kodai sediment showed 276-350mg/kg Hg(T) with about 6% methyl mercury. Berijam and Kukkal sediments showed Hg(T) of 189-226mg/kg and 85-91mg/kg and lower methylation at 3-4% and 2%, respectively. Hg(T) in fish from Kodai lake ranged from 120 to 290mg/kg. The results show that pollution of the lake has taken place due to mercury emissions by the factory.

5. **Kumar A, Gupta AK.**
Acute toxicity of mercury to the fingerlings of Indian major carps (catla, rohu and mrigal) in relation to water hardness and temperature
J Environ Biol.27(1):89-92, 2006
Department of Aquaculture, College of Fisheries, Maharana Pratap University of Agriculture & Technology, Udaipur-313 001, India.

In the present study short-term (96 hr) toxicity of mercury in relation to water hardness (270 and 560 mg/l) and temperature (16 degrees C and 35 degrees C) to the fingerlings of Indian major carps, i.e. catla, rohu and mrigal has been evaluated using static bioassay. The LC5o indicates that both water hardness and temperature played significant role in mercury toxicity. The test fishes were found most resistant with water hardness of 560 mg/l at 16 degrees C as compared to that of water hardness of 560 mg/l at 35 degrees C and water hardness of 270 mg/l at both the temperatures, i.e. 35 and 16 degrees C. Whereas the order of relative sensitivities of these fishes for mercury ions were recorded as catla>rohu>mrigal. The safe concentrations of mercury were ranged in between 12.133 to 19.689 microg/l for catla; 64.039 to 82.555 microg/l for rohu and 73.510 to 89.585 microg/l for mrigal for both the water hardness and temperature.

6. **Mukherjee AB, Zevenhoven R.**
Mercury in coal ash and its fate in the Indian subcontinent: A synoptic review.
Sci Total Environ;368(1):384-92, 2006
Department of Biological and Environmental Sciences, Helsinki University, P.O. Box 27, FIN-00014 Helsinki, Finland. arun.mukherjee@helsinki.fi

In the Indian subcontinent power generation is mainly dependent upon the thermal power units and coal is burnt as a fuel for the production of heat and electricity. In India, bituminous and sub-bituminous coals are used which contain over 40% of ash. At present, 80-90 million tons of fly ashes are generated from 85 existing coal based thermal power plants. Coal contains trace metals of which mercury is most toxic for humans and aquatic fauna. The problem of mercury in the society is not new, but in recent years the Indian subcontinent has gained the reputation of being "a dumping ground for mercury". This study focuses on mercury in fly ash and its releases to the atmosphere and soils cross the country. The utilisation of coal ash in India is also addressed although it is still in its nascent stage. About 10% of produced fly ashes are used in India whereas in Western countries its use is typically over 70%. Regulations from India's Ministry of Environment and Forestry should increase coal fly ash utilisation, although this would require that cost-effective new technology is put to use. As to the release of Hg from ashes disposed of in the environment, the scarce literature suggests that this is negligible or zero, and less problematic than wet or dry deposition of Hg from flue gases.

7. **Rajgopal T Ravimohan[1] H V.Mascarenhas[2] P**
Epidemiological surveillance of employees in a mercury thermometer plant: An occupational health study
Indian J. Occ and Env Med, Vol. 10 – No. 1 pp 11-18, 2006
Vice President, Medical and Occupational Health
1 Medical Officer,
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A cross-sectional epidemiological survey of 255 individuals (130 current permanent employees, 64 contract workers, 55 ex-employees and 6 scrap dealers) coupled with a retrospective cohort study of the occupational health of 290 employees (all permanent employees who ever worked in the factory over a span of 15 years) was conducted in a mercury thermometer plant at Kodaikanal in India. The cross-sectional study done in March 2001 was based on a clinical protocol developed by the US Dept. of Labor, Mines Safety and Health Administration and was supplemented by the analysis of mercury in urine (HgU) through Inductively Coupled Plasma Emission Spectrometry (ICP) and relevant biochemical investigations. Group averages of HgU in this study was 23.8 µg/L and were well

within WHO-recommended limits of group means (50 µg/L). Group analysis was supplemented by appropriate individual analysis. The retrospective cohort study (for the years 1988-2001) included clinical evaluation coupled with analysis of biological monitoring done through Cold Vapor Atomic Absorption Spectrometry (CVAAS). Group averages of mercury in urine measured between 12.9 to 31.9 µg/L over the working life of the factory, and they too were supplemented by appropriate individual analysis. The protocol for epidemiological surveillance and indeed for the occupational health surveillance conducted over the life of the factory (biological monitoring, workplace environmental monitoring, shop floor health and safety practices and clinical evaluations) have been independently validated by the Netherlands-based TNO, the All India Institute of Medical Sciences, and the Indian Association of Occupational Health. None of the employees in this factory were found to be suffering from any ill health that could be attributed to Hg exposure.

Keywords: Biological monitoring, cohort, environmental monitoring, epidemiological surveillance, mercury

8. Bhan A, Sarkar NN
Mercury in the environment: effect on health and reproduction
Rev Environ Health;20(1):39-56, 2005
Department of Reproductive Biology, All India Institute of Medical Sciences, Ansari Nagar, New Delhi-110029, India.

Mercury is a heavy metal that is found naturally in the environment in various forms. Human activity can release mercury into the air, water, and soil. Mercury is also released into the environment after its conversion to methylmercury by bacteria. Mercury was once used in medicine, but the medicinal aspect changed because of its devastating poisoning effect on humans and animals. Today, mercury is one of the most potent neurotoxins known, having a number of adverse health effects in animals and humans. As the sources of mercury are many, the general population is exposed to mercury in day-to-day life, in occupational settings, and in cases of accidental exposure. In addition, ignorance about the use of mercury in cosmetics and religious materials has opened an additional source of exposure. Therefore, making people aware of mercury's effects on health, its sources of entry into the environment, and its chelating remedies becomes a necessity so that strategies can be adopted to minimize use and exposure.

9. Bhattacharyay G, Sadhu AK, Mazumdar A, Chaudhuri PK
Antennal deformities of chironomid larvae and their use in biomonitoring of heavy metal pollutants in the river Damodar of West Bengal, India.
Environ Monit Assess, 108(1-3):67-84, 2005
Entomology Research Unit, Department of Zoology, University of Burdwan, Burdwan 713 104, West Bengal, India.

Analyses of sediment and water indicate the presence of heavy metal pollutants like lead, zinc, copper, mercury and cadmium of

the river Damodar of India. These metals are responsible for causing morphological deformities of antennae and other parts of chironomid larvae. Percentage of deformity correlated positively with the concentrations of Pb in water and sediment (r > 0.6) at the confluence point. A new severity index, SISS (antenna) has been proposed here to assess deformity at the family or subfamily level.

10. **Das S**, **Sahu BK**.

Interaction of pH with mercuric chloride toxicity to penaeid prawns from a tropical estuary, East Coast of India: enhanced toxicity at low pH.

Chemosphere, 58(9):1241-8, 2005

Department of Marine Sciences, Berhampur University, Bhanja Bihar, Berhampur 760 007, Orissa, India.

Toxicity tests were conducted to study the interaction of pH and the response of two size groups of penaeid prawns i.e. Penaeus monodon and Penaeus indicus to different sets of five concentrations of HgCl2 (0.01-0.09 mg l(-1)) under a broad range of pH conditions (5-9). Behavioural responses varied according to test solution concentration and nominated values of pH. Abnormality was detected in the higher concentrations with lower pH in smaller size group of P. monodon. High mortality was observed at higher concentration of test solution with low pH. Irrespective of species and size group LC50 demonstrated similar trend of variation with respect to time period. At pH 9 the threshold limit for 65-75 mm size group of P. monodon and P. indicus was 0.043 and 0.049 mg l(-1) respectively while it was 0.041 and 0.035 mg l(-1) respectively at pH 8; and 0.038 and 0.044 mg l(-1) respectively at pH 7. Relative toxicities were significantly varied except for bigger size groups in the studied pH ranges. The result was pronounced at pH 5 with maximum 1.61 times for inter-hour relative toxicity in contrast to all. At pH below 7 of mercury resulted more toxic compared to high pH range (>7) might be due to acid toxicity itself. At each pH smaller size groups were sensitive while bigger shown tolerant. P. monodon were more sensitive than P. indicus. The toxic order of pH effect was 9<8<7<6<5. Toxicity increased significantly ($p>0.01$) in acidic medium compared to alkaline.

11. **Mukherjee AB**, **Zevenhoven R**.

Mercury in coal ash and its fate in the Indian subcontinent: A synoptic review

Sci Total Environ. 2005

Department of Biological and Environmental Sciences, Helsinki University, P.O. Box 27, FIN-00014 Helsinki, Finland.

In the Indian subcontinent power generation is mainly dependent upon the thermal power units and coal is burnt as a fuel for the production of heat and electricity. In India, bituminous and sub-bituminous coals are used which contain over 40% of ash. At present, 80-90 million tons of fly ashes are generated from 85

existing coal based thermal power plants. Coal contains trace metals of which mercury is most toxic for humans and aquatic fauna. The problem of mercury in the society is not new, but in recent years the Indian subcontinent has gained the reputation of being "a dumping ground for mercury". This study focuses on mercury in fly ash and its releases to the atmosphere and soils cross the country. The utilisation of coal ash in India is also addressed although it is still in its nascent stage. About 10% of produced fly ashes are used in India whereas in Western countries its use is typically over 70%. Regulations from India's Ministry of Environment and Forestry should increase coal fly ash utilisation, although this would require that cost-effective new technology is put to use. As to the release of Hg from ashes disposed of in the environment, the scarce literature suggests that this is negligible or zero, and less problematic than wet or dry deposition of Hg from flue gases.

12. Murtaza I, Dutt A, Mushtaq D, Ali A.
Molecular cloning and genetic analysis of functional merB gene from indian isolates of Escherichia coli
Curr Microbiol, 51(5):297-302, 2005

Molecular Biotechnology and Biochemistry Laboratory, Division of PHT, S.K University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Kashmir, India. imz_murtaza@hotmail.com

Studies were carried out to characterize organomercurial lyase genes from wild type mercury-resistant Escherichia coli isolates, previously collected from five geographically distinct regions of the Indian subcontinent. PCR amplification followed by DNA sequencing of amplified fragments showed three merB identical to the previously characterized mer B from E. coli pR831b that were thus considered as the same gene. The remaining two genes derived from E. coli isolates of an almost mercury-free site (Dal lake, Kashmir) and designated as pIAAD3 merB and pIAAD14 merB showed slight variation (2%) at base. However, this variation in pIAAD3 due to the absence of base "T" at 479 position results in complete frame shift and the predicted MerB-like polypeptide derived from it showed 21.53% divergent at its C terminal end from the previously characterized pR831b MerB. The expression profile of pIAAD3 merB in pQE30 and pUC18 vectors each demonstrated 22.2 kDa proteins. The induced DH5alpha E. coli cells possessing pIAAD3 merB cloned in pUC18 vector split phenyl mercuric acetate (PMA) into benzene and inorganic mercury efficiently, thus giving a clue that the expressed gene product is biologically active. The current study suggests that such genetic changes may take place in the continued absence of mercury pressure, and with such modifications, they finally break down to act as vestigial remnants. Further work is going on in our lab to exploit pIAAD3 merB for the bioremediation of mercury-polluted sites.

13. Rajnikant Sharma[1] and Shamsh Pervez[2]

Toxic metals status in human blood and breast milk samples in an integrated steel plant environment in Central India

Environmental Geochemistry and Health, Volume 27, Number 1 39 – 45, 2005

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2 School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur, 492010, India

Owing to its unique nutritional and immunological characteristics, human milk is the most important food source for infants. Breast milk can, however, also be a pathway of maternal excretion of toxic elements. Selected toxic elements (As, Pb, Mn,a Hg and Cd) were determined in human breast milk and blood samples obtained from 120 subjects related to an integrated steel plant environment located in central India. Samples of breast milk and blood from subjects living outside the steel plant environment were also analyzed for comparative study. Higher levels of these toxic elements were found in blood samples as compared to breast milk samples. Plant workers showed the higher presence of these metals in their breast milk and blood samples compared to the residents of the area and the subjects living outside the industrial environment, respectively. Mn, Pb and Hg have shown a higher tendency to associate with blood and breast milk than As and Cd. The order of occurrence of these metals in blood and milk samples thus found is Mn>Pb>Hg>As>Cd.

Key words blood - central India-human milk-infants-particulate matter-toxic elements

14. Gupta N, Ali A.

Mercury volatilization by R factor systems in Escherichia coli isolated from aquatic environments of India

Curr Microbiol, 48(2):88-96, 2004

Gene Expression Laboratory, Department of Biosciences, Jamia Millia Islamia, New Delhi-110025, India

Ten Escherichia coli strains isolated from five different aquatic environments representing three distinct geographical regions of India showed significantly high levels of tolerance to the inorganic form of mercury, i.e., mercuric chloride (HgCl(2)). MRD14 isolated from the Dal Lake (Kashmir) could tolerate the highest concentration of HgCl(2), i.e., 55 microg/mL, and MRF1 from the flood water of the Yamuna River (Delhi) tolerated the lowest concentration, i.e., 25 microg/mL. All ten strains revealed the presence of a plasmid of approximately 24 kb, and transformation of the isolated plasmids into the mercury-sensitive competent cells of E. coli DH5alpha rendered the transformants resistant to the same concentration of mercury as the wild-type strains. Mating experiments were performed to assess the self-transmissible nature of these promiscuous plasmids. The transfer of mercury resistance from these wild-type strains to the mercury-sensitive, naladixic acid-resistant E. coli K12 (F(-) lac(+)) strain used as a recipient was

observed in six of the nine strains tested. Transconjugants revealed the presence of a plasmid of approximately 24 kb. An evaluation of the mechanism of mercury resistance in the three most efficient strains (MRG12, MRD11, and MRD14) encountered in our study was determined by cold vapor atomic absorption spectroscopy (CV-AAS), and it was noted that resistance to HgCl(2) was conferred by conversion of the toxic ionic form of mercury (Hg(++)) to the nontoxic elemental form (Hg(0)) in all three strains. MRD14 volatilized mercury most efficiently.

15. Mukherjee S, **Mukherjee S**, **Bhattacharyya P**, **Duttagupta AK**.
Heavy metal levels and esterase variations between metal-exposed and unexposed duckweed Lemna minor: field and laboratory studies
Environ Int, 30(6):811-4, 2004
Department of Zoology, Calcutta University, 35 B.C. Road, Calcutta-700019, West Bengal, India

Environmental homogeneity is being continuously disturbed and affected by artificially introduced loads of chemical toxicants that also include heavy metals. The Tiljala wetlands of the eastern fringe of Calcutta, West Bengal (India) are a virtual sink for the deposition of urban and industrial wastes that get admixed with the aquatic environment. We have selected Lemna minor (duckweed), as a representative of the biota surviving therein for the present study. Concentrations of lead, cadmium, chromium, zinc, copper and mercury in the fronds of Lemna were measured to peep into the range of input of heavy metals in the duckweed subjects. Natural unexposed population of duckweed from a domestic pond in Batanagar area, 24 Parganas, West Bengal (India) was also found to accumulate similar concentrations of these metals when cultured in artificially contaminated water in the laboratory. The exposed individuals also exhibited polymorphism with respect to the loci of esterase, as compared to an unexposed control plants. Therefore, the present study suggests EST variations of L. minor to be a potential biomarker of heavy metal pollution.

16. Jha SK, **Chavan SB**, **Pandit GG**, **Sadasivan S**
Geochronology of Pb and Hg pollution in a coastal marine environment using global fallout 137Cs
J Environ Radioact.;69(1-2):145-57, 2003
Environmental Assessment Division, Bhabha Atomic Research Centre, Mumbai, India. skjha@magnum.barc.ernet.in

Global fallout 137Cs was used for dating sediment cores and estimation of recent sedimentation rates (up to 1 cm/y) in the Thane Creek, which lies in the southern part of the Deccan belt of India. The residence time of 210 Pb in the Thane Creek water was calculated to be 0.7 years. Further, the concentrations of Pb (up to 70 microg/g) and Hg (up to 10 microg/g) in sediment profiles were measured to assess the anthropogenic input of contaminants due to large-scale industrialization, which has taken

place in this area over the last two decades. The depth-wise concentration profile of Hg shows positive evidence of continued fresh input into the Creek.

17. R. Saraswat, Sujata R. Kurtarkar, A. Mazumder and R. Nigam
Foraminifers as indicators of marine pollution: a culture experiment with Rosalina leei, Available online 29 July 2003
National Institute of Oceanography, Dona Paula, 403 004, Goa, India

In order to develop a viable foraminiferal proxy for heavy metal pollutants, juvenile specimens of Rosalina leei were subjected to different mercury concentrations (0–180 ng/l). Initially considerable growth was observed in specimens kept in saline water having a mercury concentration up to 100 ng/l. But with the gradual increase in concentration of mercury the growth rate started decreasing. Total growth achieved was significantly lower in case of specimens kept at relatively higher mercury concentrations then those maintained in normal saline water. The most significant result of this experiment was the addition of abnormal chambers in the specimens kept at higher mercury concentration. Later the specimens kept at highest concentration (180 ng/l) were subjected to progressively increasing concentration of mercury to see the further effects and it was found that the specimens were still living at as high a mercury concentration as 260 ng/l although there was no growth.

18. Rajgopal T
Mercury pollution in India.
Lancet, Vol. 362, Iss. 9398; p. 1856, 2003

Abstract not available

19. Ram A, Rokade MA, Borole DV, Zingde MD
Mercury in sediments of Ulhas estuary
Mar Pollut Bull;46(7):846-57, 2003
Regional Centre, National Institute of Oceanography, Mumbai, 400 053, India. anirudhram@hotmail.com

Hg levels in water, suspended particulate matter and sediment of the Ulhas estuary are under considerable environmental stress due to the indiscriminate release of effluents from a variety of industries including chlor-alkali plants. Concentration ranges of dissolved (0.04-0.61 micro gl(-1)) and particulate (1.13-6.43 micro gg(-1)) Hg reveal a definite enhancement of levels in the estuary. The Hg burden in sediment upstream of the weir that limits the tidal influence is low (0.08-0.19 micro gg(-1)) with low C(org) content (1.8-2.9%). The high Hg content of the sediment just below the weir varies seasonally (highest concentration recorded being 38.45 micro gg(-1)) due to incremental accretion of sediment as the fresh water flow over the weir progressively decreases. The 30 km segment of the estuary sustains markedly high levels of Hg in the sediment with an

exponential decrease in the seaward direction from the weir. Higher concentrations than the expected background prevail in all the estuarine cores up to the bottom, though the overall concentration decreases from about 20 micro gg(-1) in core 7 (inner estuary) to 1 micro gg(-1) in core 31 (outer estuary). The Hg in sediment is associated with C(org), while its correlation with Al, Fe and Mn is poor. The Hg profiles in cores from the Arabian Sea (stations 34, 35 and 37) have a distinct horizon of enhanced concentration in the 5-60 cm segment. Based on 210Pb dating of core 37, the sediment at the bottom of this core is inferred to have been deposited in the year 1949, roughly two year prior to the establishment of the first chlor-alkali plant and represents the background (0.06-0.10 micro gg(-1)). The Hg profiles in the offshore cores indicate a marked increase in transfer of Hg to sediment subsequent to 1980, with a peak around 1990-1992. Based on the index of geoaccumulation it is considered that the estuarine segment between stations 4 and 23 is extremely polluted, while the sediment from the open coast is moderately polluted in the top 25-30 cm with respect to Hg. The enrichment factor of Hg in the sediment is 350-700 for core 4 and decreases to 0-7 for the open-shore cores.

20. **Ramaiah N**, **De J**.

Unusual rise in mercury-resistant bacteria in coastal environs.
Microb Ecol, 45(4):444-54. Epub 2003

National Institute of Oceanography, Dona Paula, Goa 403 004, India. ramaiah@darya.nio.org

A sharp rise in mercury-resistant bacteria (MRB) capable of tolerating very high concentration of Hg was observed over the last 3-4 years in the coastal environs of India. While none or negligible colony-forming units (CFU) of bacteria were counted on seawater nutrient agar with 0.5 ppm (2.5 microM) Hg (II) as HgCl2 until 1997, from 13 to over 75% of the CFU grew on 20 times higher, 50 microM, Hg concentrations from almost every recently examined marine sample. Although exceptionally high counts of MRB (96% of CFU) were recorded from samples collected from the polluted zones off Mumbai, the MRB capable of growth on seawater nutrient agar with 50 microM Hg were quite abundant in most samples collected from many locations with few or no pollution effects. We noticed for the first time the occurrence of aerobic heterotrophic bacterial isolates capable of growth with 250 microM Hg. Such MRB grew with higher concentrations of many other toxic xenobiotics than the Hg sensitive ones. Based on the unusually high populations of viable MRB and some simple experiments, we propose that many marine bacterial species are selected, possibly through acquisition of plasmids and/or transposable elements and modifying Hg, whose concentration, according to recent studies, is on the rise in marine habitats.

21. Sharma DC
Concern over mercury pollution in India.
Lancet .Vol. 362, Iss. 9389; p. 1050, 2003

Abstract not available

22. Subramanian V, Madhavan N, Saxena R, Lundin LC.
Nature of distribution of mercury in the sediments of the river Yamuna (tributary of the Ganges), India
J Environ Monit. Jun;5(3):427-34, 2003
School of Environmental Sciences, Jawaharlal Nehru University, New Delhi-110 067, India. subrama42@hotmail.com

Suspended Particulate Matter (SPM), surface (bed sediments) and short length cores of sediments collected from the largest tributary of the river Ganges, namely the river Yamuna, were analysed for total mercury as well as its fractionation in various size and chemical sites in the sediments following standard procedures. Also, attempts were made to determine the vertical distribution in sediments in relation to the recent timescale of a few decades. Our observations indicate that the SPM in general showed higher levels of total mercury compared to the surface sediments while at places the enhancement could be by a factor of 10, say around 25 microg g(-1) in the downstream region that integrates the industrial midstream and agricultural downstream terrain near its confluence with the Ganges. Surface sediments in the upstream direction near the Himalayan foothills and SPM in the lower reaches showed significant high Index of Geoaccumulation (Igeo) as defined by Muller. Size fractionation studies indicate that the finer fraction preferentially showed higher levels of mercury while in the lower reaches of the river, the total mercury is equitably distributed among all size fractions. The proportion of the residual fraction of mercury in relation to mobile fractions, in general decreases downstream towards its confluence with the Ganges river. In sediment cores, the vertical distribution show systematic peaks of mercury indicating that addition of this toxic metal to the aquatic system is in direct proportion to the increase in various types of human activities such as thermal power plants, land use changes (urbanisation) in the midstream region and intensive fertiliser application in lower reaches of this vast river basin.

23. Murtaza I, Dutt A, Ali A.
Relationship between the persistence of mer operon sequences in Escherichia coli and their resistance to mercury
Curr Microbiol;44(3):178-83, 2002
Gene Expression Laboratory, Department of Biosciences, Jamia Millia Islamia, New Delhi-110 025, India.

Studies related to geographic distribution of E. coli carrying mer operon sequences were carried out on the Indian subcontinent. Out of the 80 E. coli isolates, collected from five geographically distinct

regions of India, 68 were found to be resistant to one or the other heavy metal used in the study. Among these isolates, 36 were found to be resistant to the inorganic form (HgCl2) and only 5 to resist both the inorganic and organic forms of mercury. Colony hybridization studies revealed 35 isolates out of 68 to hybridize with the probe. Interestingly, some of the mercury-sensitive isolates (Hgs), especially from the Dal Lake, were found positive in hybridization studies. These findings, supported by mercury volatilization studies, indicate the presence of nonfunctional/vestigial mer sequences in the isolates collected from different environments. On the other hand, few of the mercury-resistant isolates (Hgr) from the Yamuna River did not show any sign of hybridization. Further, volatilization studies also indicated an alternate mode of resistance mechanism operating in them. The studies demonstrate that the mer operon sequences share very high homology among the E. coli isolates collected from different geographical locations, and this metal resistance may be a genetic character that arose from a common ancestral background.

24. Das, S., S.K. Patro and B.K. Sahu

Biochemical changes induced by mercury in the liverof penaeid prawns Penaeus indicusand P.monodon (Crustacea : Penaeidae) from Rushikulya estuary,east coast of India

Indian Journal of Marine Sciences 30(4): 246-252, 2001

Department of Marine Sciences, Berhampur University, Berhampur - 760 007, Orissa,

The biochemical components viz. protein, lipid and carbohydrate of the liver of two important penaeid prawns were significantly reduced, following six days of exposure to 0.005 ppm and 0.01 ppm of mercuric chloride during various reproductive stages i.e. preparatory, prespawning, spawning, and postspawning. Liver protein recorded highest in contrast to lipid and carbohydrate irrespective of the species, sex and medium of exposure. Depletion percentage with respect to control for protein was less compared to lipid and carbohydrate and the maximum depletion was at 0.01 ppm Hg medium. The effect of mercury was more in Penaeus indicus than that of Penaeus monodon (in the female and prespawning stage). Liver-lipid deleteri- ously affected the female P. indicus during spawning while carbohydrate affected it prominently during preparatory stage. Hg concentration of 0.01 ppm had much damaging effect on liver. The change caused due to test solutions in the biochemical constituents of the liver of the prawns indicated that female was more affected than male.

25. Das-S; Patro-SK; Sahu-BK.

Variation of residual mercury in penaeid prawns from Rushikulya Estuary, east coast of India

Indian-J.-Mar.-Sci. 30: 33-37, 2001

Department of Marine Sciences, Berhampur University, Berhampur - 760 007, Orissa,

Two commercially important penaeid prawn species were collected from Rushikulya Estuary, Orissa, India for assessment of Hg content during March 1994 - February 1995. The levels of mercury were determined by employing modified Bethege appratus and subsequently using a mercury analyser. The study revealed that Hg concentration in the edible parts of Penaeus monodon and P. indicus at both the stations was higher than that in the non-edible parts during monsoon. Reverse trend prevailed in the premonsoon season. The station 2, located near a chlor-alkali factory, exhibited higher values as compared to station 1 located near the mouth. Further higher Hg concentrations in P. monodon and lower in P. indicus was noticed at both the stations. Residual concentrations of mercury in the organisms were found to be fairly below the legally permissible limit of Hg in fish and fishery products in India.

26. **Tewari A**, **Joshi HV**, **Trivedi RH**, **Sravankumar VG**, **Raghunathan C**, **Khambhaty Y**, **Kotiwar OS**, **Mandal SK**.

The effect of ship scrapping industry and its associated wastes on the biomass production and biodiversity of biota in in situ condition at Alang

Mar Pollut Bull;42(6):462-9, 2001

Central Salt & Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavnagar 364 002, India.

The main pollutants for the ship scrapping industry and its associated wastes at Alang are heavy metals, petroleum hydrocarbon and bacterial contaminations. The concentration of iron, manganese, cobalt, copper, zinc, lead, cadmium, nickel and mercury were 25 to 15,500% more at nearshore station of Alang as compared to control site at Piram. The concentration of heavy metals in the nearshore station of Alang was always higher than its concentration at 10 km away. The concentration of petroleum hydrocarbon was 16,973 and 53,900% more at the nearshore and 10 km away respectively at Alang as compared to controls. The concentration of chlorophyll-a and phaeophytin were in non-detectable range (< 0.2 and < 0.1 mg m3) or much lower concentration at both the stations of Alang as compared to controls. The total viable count, total coliform, Escherichia coli, Vibrio cholerae, Vibrio parahaemolyticus and other Vibrio, Streptococcus faecalis, Shigella, Salmonella, Proteus, and Klebsiella were always higher (17%-605%) at the nearshore station of Alang as compared to control. Similar trend was observed at 10 km away from Alang. Bacteria in sediment also showed the same pattern of variation. Phytoplankton counts at the nearshore station and 10 km away from Alang were only slightly raised. In contrast to phytoplankton, the zooplankton showed considerable reduction of growth (-10 to -66%) at Alang.

27 The Hindustan Times
India-bound shipment of mercury scuttled. January 25, 2001 (www.hindustantimes.com/nonfram/250101/dtLFOR30.asp).

28 Dey-S; Patke-DS.
Mercury biotransformation and its potential for remediation of mercury contamination in water.
Journal-of Environmental-Biology. 21(1): 47-54, 2000
Div Microbiol Sci, Agharkar Res Inst, GG Agarkar Rd, Pune 411004

Bacterially mediated ionic mercury reduction to volatile Hg plays an important role in the biogeochemical cycling of mercury in contaminated freshwater hot spring. This process could be stimulated to reduce the concentration of inorganic mercury in the water. A study of the utility of this approach using a thermophilic Streptomyces, alongwith the mechanism is described

29 Pant-A.
Toxicity and uptake of mercurials in a cyanobacterium
Environmentalist, 20 (4): 295- 300, 2000

Nostoc calcicola cells exposed to mercuric chloride (0.05–0.25 μM), methyl mercuric chloride (0.05–0.15 μM) and the fungicide ceresan (phenyl mercuric acetate; 0.05–0.20 μM) showed sensitivity in the sequence: methyl mercury3) over phenyl mercuric acetate (0.51×103); inorganic mercury occupied the intermediate position with a bioconcentration factor of 1.32×103. The data infer that larger molecules of organomercurials may not be taken up by cells at the rate and extent comparable to the smaller species. cyanobacteria-organomercurial-bioconcentration factor-volatilization

30 Sait-MSPM; Srinivasan-GN; Kader-JAMA.
Adsorption study of mercury on charcoal.
Bull.- Electrochem. 16: 140-143, 2000

Abstract not available

31 Jha SK, Krishnamoorthy TM, Pandit GG, Nambi KS
History of accumulation of mercury and nickel in Thane Creek, Mumbai, using 210Pb dating technique
Sci Total Environ;236(1-3):91-9, 1999
Environmental Assessment Division, Bhabha Atomic Research Centre, Mumbai, India.

The study area Thane Creek, lies on the southern part of the Deccan belt of India between latitude 18 degrees 53'-19 degrees 04' N and longitude 72 degrees 48'-72 degrees 53' E and includes the Ulhas river estuaries. Lead-210 (half-life of 22.3 years) is used for an estimation of recent sedimentation rate in Thane Creek using radiochemical separation and alpha counting of its grand-

daughter 210Po. The concentration of Hg and Ni in vertical depth profiles of sediment is estimated to assess the anthropogenic input of these nuclides due to large-scale industrialization which has taken place at this site during last two decades. Depth-wise concentration profiles of Hg and Ni indicate positive evidence of continued fresh inputs into the Airoli section of Thane Creek.

32 Kaladharan-P; Pillai-VK; Nandakumar-A; Krishnakumar-PK.
Mercury in seawater along the west coast of India
Indian-J.-Mar.-Sci. 28: 338-340, 1999

Abstract not available

33 Sarkar-SK; Bhattacharya-B; Bandopadhaya-G; Giri-S; Debnath-S.
Tropical coastal organisms as qualitative indicators of mercury and organomercury for sustainable use of living resources
Environ.-Dev.-Sustainability 1: 135-147, 1999

Abstract not available

34 Selvaraj-K.
Total dissolvable copper and mercury concentrations in innershelf waters, off Kalpakkam, Bay of Bengal.
Curr.-Sci. 77: 494-497, 1999

Abstract not available

35 Krishnakumar-PK; Bhat-GS; Vaidya-NG; Pillai-VK.
Heavy metal distribution in the biotic and abiotic matrices along Karnataka coast, west coast of India.
Indian-J.-Mar.-Sci. 27: 201- 205, 1998

Abstract not available

36 Mishra BB; Nanda-DR.
Reclamation with cyanobacteria: toxic effect of mercury contaminated waste soil on biochemical variables.
Cytobios, 92: 370-371/203-208, 1997
Department of Botany, College of Basic Science and Humanities, Orissa University of Agriculture and Technology, Bhubaneswar, India.

During an attempt to decrease the toxicity of industrial waste (soil) from a chloralkali factory by blue-green algae, the effect of the waste soil mixed in varying proportions with garden soil, on biochemical variables was studied. The nucleic acid, protein and free amino acid content of the algae decreased significantly with increasing time and waste soil concentration. The algae accumulated a substantial amount of mercury from the medium depending on the duration of algal growth and waste soil concentration. An increase in RNA/DNA and a decrease in the ratio of protein/RNA and protein/free amino acids was observed.

37 Namasivayam-C; Senthilkumar-S.
Recycling of industrial solid waste for the removal of mercury (II) by adsorption process.
Chemosphere, 34: 357-375, 1997

Abstract not available

38 Pandit GG, Jha SK, Tripathi RM, Krishnamoorthy TM.
Intake of methyl mercury by the population of Mumbai, India
Sci Total Environ, 205(2-3):267-70, 1997
Environmental Assessment Division, Bhabha Atomic Research Centre, Bombay, India

Reversed phase high performance liquid chromatography (HPLC) with ultra violet detection (UV) was optimised for separation and quantification of methyl mercury in coastal sediment and fish samples. The extraction efficiency of methyl mercury from sediment and biological samples was found to be 56% with a detection limit of 0.5 ng for a 200 microliters sample volume. The concentrations of methyl mercury and the relative fractions with respect to total mercury were distinctly lower, 5.9-65.5 ng/g (3-8%) in sediment compared to biological samples, 20.4-344.5 ng/g dry wt. (33-97%). The daily intake of methyl mercury by the Mumbai population through marine food is about 0.5 microgram forming 62% of the total mercury intake from this route.

39 Pervez-S; Pandey-GS.
Mercury spillage through smoke-stakes of an integrated steel plant: Effects on soil and ground water.
Indian-J.-Chem.-Technol. 4: 49-52, 1997

Abstract not available

40 Rajathy-S.
Mercury in water, sediment and in some estuarine organisms of the Ennore Estuary, Madras, Tamil Nadu.
J.-Mar.-Biol.-Assoc.-India, 39: 174-177, 1997

Abstract not available

41 Sadhukhan PC, Ghosh S, Chaudhuri J, Ghosh DK, Mandal A.
Mercury and organomercurial resistance in bacteria isolated from freshwater fish of wetland fisheries around Calcutta
Environ Pollut;97(1-2):71-8, 1997
Department of Biochemistry, University College of Science, Calcutta University, 35, Ballygunge Circular Road, Calcutta-700 019, India

Mercury-resistant bacteria belonging to the genera Bacillus, Escherichia, Klebsiella, Micrococcus, Pseudomonas, Salmonella, Sarcina, Shigella, Staphylococcus and Streptococcus were isolated from gills and guts of fresh water fish collected from

wetland fisheries around Calcutta, India, contaminated with mercury compounds. The total number of bacteria, as well as Hg-resistant bacteria, were always higher in guts than gills. Bottom-dwelling fish contained higher number of bacteria, including Hg-resistant bacteria, than surface and middle water dwelling fish. They belonged either to narrow-spectrum or to broad-spectrum Hg-resistant groups and they also possessed other heavy metal and antibiotic resistant properties. In the presence of toxic levels of HgCl(2), phenylmercuric acetate (PMA) and methylmercuric chloride (MMC), the lag in growth of the bacterial strains gradually increased with increasing concentration of Hg-compounds. Narrow-spectrum Hg-resistant bacterial strains volatilized only HgCl(2) from the liquid medium in the range of 64-89%, whereas the broad-spectrum group exhibited a high level of HgCl(2) (80-94%), PMA (72-84%) and MMC (64-80%) volatilizing capacity with inducible mercuric reductase and organomercurial lyase enzyme activities in their cell-free extracts. Cell-free extracts prepared from narrow-spectrum Hg-resistant bacterial strains induced by HgCl(2) exhibited Hg(+2)-dependent NADPH oxidation, indicating the presence of only mercuric reductase enzyme

42 Pahan-K[1]; Chaudhuri-J[2]; Ghosh-DK[3]; Gachhui-R[4]; Ray-S[5]; Mandal-A*.
Volatilization of mercury from natural water by a broad-spectrum Hg-resistant Bacillus pasteurii strain DR2
Environmentalist, 16: 179-185, 1996

A broad-spectrum mercury-resistant bacterial strain was isolated from contaminated water and was identified as Bacillus pasteurii strain DR2. It could volatilize Hg-compounds including organomercurials from its growth media. It utilized several aromatic compounds as a sole source of carbon. The bacterial strain eliminated HgCl2 from sterile river water and the presence of benzene, toluene, naphthalene and nitrobenzene at 1 mM concentration in the system increased the rate of mercury volatilization, the volatilization rate being highest with benzene. When 1.7×107 cells of this bacterial strain were added per ml of non-sterile water the bacterial strain volatilized more than 90 percent of mercury from mercuric chloride and organo-mercurials like PMA, thiomersol and methoxy ethyl mercuric chloride (MEMC). In the absence of this bacterial strain the volatilization of PMA and MEMC due to the presence of other Hg-resistant organisms in nonsterile polluted water ranged between 20–25 percent and of HgCl2 was about 40 percent. However, in the presence of B. pasteurii DR2 volatilization of these Hg-compounds from non-sterile water increased by 20–40 percent. In the presence of 1 mM benzene the rate of mercury volatilization was even higher. In all the cases the rate of volatilization was higher in the first seven days than in the next seven days.

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2 Dr K. Pahan, Postdoctoral Associate, Department of Cell Biology and Paediatrics, Medical University of South Carolina, USA;
3 Dr J. Chaudhuri, Senior Lecturer, Department of Molecular Biology, BKC College, Calcutta, India;
4 Dr D.K. Ghosh, Postdoctoral Associate, Department of Biochemistry, University College of Science, Calcutta, India;
5 Dr R. Gachhui, Postdoctoral Associate, The Cleveland Clinic Foundation, Cleveland, USA;
6 Dr S. Ray, Postdoctoral Associate, The Johns Hopkins University School of Hygiene and Public Health, Department of Biochemistry, Baltimore, USA.

43 Pandya CB, Sadhu HG, Sathwara NG, Ghodasara NB, Shah GM, Parikh DJ, and Kashyap SK
Assessment of occupational exposure to mercury and its health risks
Indian J Ind Med 42 (1): 11-14, 1996

This study has tried to assess the morbidity resulting from occupational exposure to mercury. Biological monitoring of blood and urine of those exposed was carried out and areas where mercury levels in the ambient air have exceeded TLVs have been identified.

Key Words*:* Occupational Exposure; Mercury/AE; Mercury Poisoning; Occupational Diseases/CI; Mercury/AN; Mercury/BL; Mercury/UR; Air Pollutants, Occupational/AN; Chemical Industry; Environmental Monitoring; Human; Male

44 Samudralwar DL, Garg AN.
Minor and trace elemental determination in the Indian herbal and other medicinal preparations.
Biol Trace Elem Res;54(2):113-21,1996
Department of Chemistry, Nagpur University, India.

Medicinal plants described in the Indian "Ayurvedic" literature viz. Tulsi (Ocimum sanctum), Gulvel (Tinospora cardifolia), bitter Neem (Azadirachta indica), Kanher (Nerium Andicum), Vekhand (Acorus calamus), and Peacock's feather (ash) were analyzed for minor and trace elements by instrumental neutron activation analysis. The samples and the standards from the National Institute of Standards and Technology, USA and IAEA, Vienna were irradiated for 5 min, 1 h, 5 h, and 10 h with thermal neutrons at a flux of 10(12)-10(13) n cm-2 s-1 in APSARA and CIRUS reactor at BARC, Bombay. High resolution gamma ray spectrometry was performed using a 45 cm3 HPGe detector and a 4096 MCA system. Concentrations of 13 elements were determined. Zinc, manganese, and sodium were significantly higher in Tulsi leaves while zinc is higher in Neem leaves. Peacock's feathers were found to be rich in manganese, iron, copper, and zinc. A high concentration of mercury was also found in the peacock's feather ash. The therapeutic significance in restoring ionic balance is discussed.

45 Zerpa R, Huicho L, Guillen A.
Modified India ink preparation for Cryptococcus neoformans in cerebrospinal fluid specimens
J Clin Microbiol;34(9):2290-1,1996
Universidad Nacional Mayor de San Marcos, Lima, Peru

A novel modified India ink technique for the diagnosis of Cryptococcus neoformans in cerebrospinal fluid specimens is described. It employs 2% chromium mercury and India ink. This technique allows a clear identification of some external and internal structures of the organism. Three layers from the outer capsule that have previously been discerned only by electron microscopy are distinguished.

46 **Pavithran K**.
Mercury and aplastic anaemia.
Natl Med J India;7(5):252, 1994

Abstract not available

47 **Sheerin NS**, **Monk PN**, **Aslam M**, **Thurston H**.
Simultaneous exposure to lead, arsenic and mercury from Indian ethnic remedies
Br J Clin Pract;48(6):332-3, 1994
Department of Medicine, Leicester Royal Infirmary

We report the case of an Asian woman who was exposed to toxic levels of lead, arsenic and mercury through the use of Indian ethnic remedies, and who suffered symptomatic lead poisoning. We know of no other case of exposure to such a combination of heavy metals from this source. We believe that control of the dispensing of these compounds is essential.

48 **Ali M**.
A brief history of Indian alchemy covering pre-Vedic to Vedic and Ayurvedic period (circa 400 B.C.-800 A.D.)
Bull Indian Inst Hist Med Hyderabad;23(2):151, 1993
Indian Institute of History of Medicine, Hyderabad

History of Indian alchemy can be traced to pre-Vedic period. The archaeological excavations at Mohenjodaro and Harappa in the Indus valley have brought to light that, the people in ancient India were possessing chemical knowledge as early as in the pre-historic period. In Vedic period single herbs were prescribed. Minerals and animal substances were also prescribed but no compound preparations were in use. Alchemy in India, was started for the preparation of an elixir of life for imparting immortality and later for the transmutation process for converting base metals into gold. Indian alchemy derived its colour and flavour to a large extent from the Tantric cult. Then, during the iatro-chemical period all the previous accumulated alchemical ideas were put into something more practical and tangible. a number of preparations of mercury and other metals were evolved as helpful accessories in medicine. Here a bried history of this Indian alchemy is presented which will give an idea about the development of chemical knowledge in India in its multiple aspects.

49 Dangwal-SK.

Evaluation and control of mercury vapor exposure in the cell house of chlor alkali plants

Environ.-Res. 60: 254-258, 1993

Central Labour Institute, Bombay, India

A pilot study was carried out in the cell houses of three chlor alkali plants to assess level of exposure to mercury vapors among workers by air and biological monitoring. Overall airborne mercury concentrations (mg/m3) were found to range from 0.05 to 0.42 (mean, 0.21, n = 68), 0.03 to 0.16 (mean, .08, n = 49), and 0.02 to 0.17 (mean, 0.04, n = 26), whereas urinary mercury levels (mg/liter) of the exposed workers of the respective plants ranged from 0.076 to 0.592 (mean, 0.207, SD, 0.107, n = 19), 0.015 to 0.220 (mean, 0.070, SD, 0.054, n = 16), and 0.013 to 0.275 (mean, 0.06, SD, 0.054, n = 23). Unattended mercury spillage on the floor and improper sealing of the lids of the end boxes of electrolysis cells were found to be main factors attributing to prevalence of mercury vapors in excess of the permissible exposure limit of 0.05 mg/m3. Based on the deficiencies observed, appropriate control measures have been suggested to reduce airborne mercury vapor concentrations in the work environment.

50 Nanda S.

The environmental impact of a chloro-alkali factory in a river basin in eastern India

Environmentalist, 13: 121-124, 1993

C/o Dr P.K. Tapaswi, Professor-in-Charge, Biological Sciences Division, Indian Statistical Institute, 203 B.T. Road, 700 035 Calcutta, India

It has been established that the electrodes of the dialyser in a chloro-alkali plant in Eastern India release mercury beyond the permissible limits into the River Koel. Mercury in elemental form, as well as certain organo-mercury compounds, including methyl mercury, have been detected at a distance of 25 km from the discharge point. Even at a distance of 5–10 km, the mercury content of the sediment may be as high as 0.6–3.2 mg kg–1 above the value of sediment upstream of the plant. This sediment itself is contaminated, probably by battery and paint factories, etc., still further upstream. Thus, the chloro-alkali factory has contributed 60–320 times above the permissible limit (0.01 mg kg–1) of mercury release, at a distance of 5–10 km from the point of release. Furthermore, various phytoplankton and zooplankton have been contaminated, leading to very high mercury contents in certain fish. This food chain, therefore, threatens man himself.

51 **Srikanth R**, **Rao AM**, **Khanum A**, **Reddy SR**.
Mercury contamination of groundwater around Hussain Sagar Lake
Bull Environ Contam Toxicol;51(1):96-8, 1993
Department of Botany, Osmania University, Hyderabad, India.

Abstract not available

52 **Lenka M**, **Panda KK**, **Panda BB**.
Monitoring and assessment of mercury pollution in the vicinity of a chloralkali plant. IV. Bioconcentration of mercury in in situ aquatic and terrestrial plants at Ganjam, India
Arch Environ Contam Toxicol, 22(2):195-202, 1992
Department of Botany, Berhampur University, India

In situ aquatic and terrestrial plants including a few vegetable and crop plants growing in and around a chloralkali plant at Ganjam, India were analyzed for concentrations of root and shoot mercury. The aquatic plants found to bioconcentrate mercury to different degrees included Marsilea spp., Spirodela polyrhiza, Jussiea repens, Paspalum scrobiculatam, Pistia stratiotes, Eichhornia crassipes, Hygrophila schulli, Monochoria hastata and Bacopa monniera. Among wild terrestrial plants Chloris barbata, Cynodon dactylon, Cyperus rotundus and Croton bonplandianum were found growing on heavily contaminated soil containing mercury as high as 557 mg/kg. Analysis of mercury in root and shoot of these plants in relation to the mercury levels in soil indicated a significant correlation between soil and plant mercury with the exception of C. bonplandianum. Furthermore, the tolerance to mercury toxicity was highest with C. barbata followed by C. dactylon and C. rotundus, in that order. The rice plants analyzed from the surrounding agricultural fields did not show any significant levels of bioconcentrated mercury. Of the different vegetables grown in a contaminated kitchen garden with mercury level at 8.91 mg/kg, the two leafy vegetables, namely cabbage (Brassica oleracea) and amaranthus (Amaranthus oleraceous), were found to bioconcentrate mercury at statistically significant levels. The overall study indicates that the mercury pollution is very much localized to the specific sites in the vicinity of the chloralkali plant.

53 **Loomba K; Pandey G. S**
Removal of Mercury from Chloralkali Plant Effluent Using Granulated Slag of Steel Plant
Indian Journal of Environmental Protection, 12 No. 7, 1992

Abstract not available

54 **Panda KK**, **Lenka M**, **Panda BB**.
Monitoring and assessment of mercury pollution in the vicinity of a chloralkali plant. III. Concentration and genotoxicity of mercury in the industrial effluent and contaminated water of Rushikulya estuary, India
Mutat Res;280(3):149-60, 1992
Department of Botany, Berhampur University, India

Aquatic mercury pollution of the Rushikulya estuary in the vicinity of the chloralkali plant at Ganjam, India was monitored over a period from October 1987 to May 1989. The concentrations of aquatic mercury in the water samples taken from the effluent channel and from different sites along the course of the estuary covering a distance of 2 km were periodically recorded and ranged from 0 to 0.5 mg/l. The bioconcentration and genotoxicity of aquatic mercury in the samples were assessed by the Allium micronucleus (MNC) assay. The frequency of cells with MNC was highly correlated not only with bioconcentrated mercury (root mercury) but also with the levels of aquatic mercury. The threshold assessment values such as effective concentration fifty (EC50) for root growth, lowest effective concentration tested (LECT), and highest ineffective concentration tested (HICT) for induction of MNC in Allium MNC assay for the present aquatic industrial mercury were determined to be 0.14, 0.06 and 0.02 mg/l, respectively.

55 **Prabu SK**, **Mahadevan A**.
Hybridization of transposon Tn501 for detection of mercury resistance sequences in a marine environment
Res Microbiol;143(3):341-5, 1992
Centre for Advanced Study in Botany, University of Madras, India

Total genomic DNA isolated by concentrating seawater and mercury-resistant bacteria were hybridized with a mer probe to detect the presence of homologous DNA sequences in marine coastal waters of the Bay of Bengal, India. Coastal water extracts induced with mercury hybridized with the mer operon of transposon Tn501. Most of the mercury-resistant bacteria that volatilized mercury also contained homologous DNA sequences to the mer probe.

56 **Soni, J. P.; Singhania, R. U.; Bansal, A.; Rathi, G.**
Acute mercury vapor poisoning
Indian Pediatrics, 29(3): 365-8, 1992

Abstract not available

57 **Vachhrajani KD; Roy Chowdhary A. and Datta KK**
Testicular toxicity of methylmercury: Analysis of cellular distribution pattern at different stages of the seminiferous epithelium
Reproductive toxiclogy Vol 6 pp. 355-361 1992

Stage-specific distribution of methylmercury (MM) and spermatogenic changes were analysed in rats adiminstered 5 or 10 μg MM/kg, ip. Daily for 15, 30, 60 and 90 days. MM deposition, as

grain number/cm^2 was noted in basal portions at later stages on day 15, which increased gradually by day 90. MM deposition was in the order of stages IV, VII, XIV, IX being higher in adluminal portions on days 30 and 60. MM-enriched cytoplasmic masses leaked out through disintegrated tubular membrane on days 60 and 90. Epithelial damage, at stages late XIV through IV, V through VI, VII through VIII, XIII through mid-XIV and IX through XII, accorded with the gradual deposition of MM. As profound cell death occurred between zygotenes to pachytenes and dividing spermatocytes to step 1 speratids, the spermatids were conspicuously decreased at later times. It is possible that MM distorts the barrier system at stages IX through XII, gets distributed within the tubule, and hence may pose a direct or Sertoli cell mediated effect at stages XII through early XIV in a dose-duration-MM burden related manner.

Keyword: methylmercury; testis; rat; seminiferous tubule; stages of spermatogenesis

58 Vachhrajani KD and Roy Chowdhary A.
Effect of methylmercury on spermatogenesis and acid phosphatase activity in the rat
Ind. J. Environ. Toxicol. Vol. 1(2) pp 111-115 1991

Immature male rats administered methylmercury chloride at 0.5 and 10μg/kg doses for 15, 30, 60 and 90 days. Histology of testis was done to analyse the charges in particular cell type at different stages of spermatogenesis. Acid Phosphatase (ACP) activity was localized histochemically to study the pattern of distribution at various stages. ACP activity distribution profile in control testis showed its association with meitic and post-meitic spermatogenic cells. In the treated groups, diminution in enzyme activity was noted at stages IX-IXV on days 30 and 60. This study suggest that ACP activity exhibit variations with respect to stage of spermatogenesis and the diminution in the activity by day 90 may be due to loss of particular cell type after methylmercury exposure.

Keywords: methylmercury; seminiferous epithelium; acid phosphatase

59 Loka Bharathi PA, Sathe V, Chandramohan D.
Effect of lead, mercury and cadmium on a sulphate-reducing bacterium
Environ Pollut;67(4):361-74, 1990
National Institute of Oceanography, Dona Paula, Goa-403004, India

A sulphate-reducing bacterial strain isolated from the south-west coast of India resembling Desulfosarcina in its physiology was tested for its behaviour towards HgCl(2), CdSO(4) and Pb(NO(3))(2). The order of toxicity to growth of these metal salts in a lactate-based medium at 50 microg ml(-1) concentrations was Cd>Pb>Hg and to respiration Pb>Cd>Hg. Inhibitory concentrations (viz. 100 microg ml(-1) of HgCl(2) and 200 microg ml(-1) of Pb(NO(3)(2)) had a stimulatory effect when the substrate was changed to acetate.

With sodium acetate at 0.1% concentration, Hg and Pb had maximum stimulatory effect for growth and sulphide production. Experiments conducted directly with sediment slurries amended with lactate showed that all three metals (at levels below their inhibitory concentrations, i.e. 50 microg ml(-1) of metal salt for Cd and Hg and 100 microg ml(-1) for Pb) inhibited sulphate-reducing activity (SRA) with Pb decreasing the peak production by 68%. The order of toxicity in both lactate and acetate-amended slurry was Pb>Cd>Hg and Pb>Hg>Cd, respectively. With acetate, SRA in the presence of Cd and Hg was stimulated 110% and 27%, respectively. Pb inhibited SRA by 11%. There is a general reduction in the inhibition of sulphide production in slurries as compared with pure culture of the isolate.

60 **Rai LC**, **Singh AK**, **Mallick N**.
Employment of CEPEX enclosures for monitoring toxicity of Hg and Zn on in situ structural and functional characteristics of algal communities of River Ganga in Varanasi, India
Ecotoxicol Environ Saf;20(2):211-21, 1990
Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi, India

Effects of Hg and Zn on in situ nitrogen fixation, autotrophic index, pigment diversity, 14CO2 uptake, and change in algal community structure of Ganges water have been studied for the first time using CEPEX chambers in aquatic ecosystem of India. A concentration-dependent decrease in in situ nitrogenase activity of Ganges water with Hg and Zn has been noticed. No ethylene production was observed at 0.8 microgram/ml of Hg. However, an increase in the autotrophic index was observed in CEPEX enclosures treated with Hg and Zn. The AI value was maximum at 0.8 microgram/ml Hg after an incubation of 15 days. An increase in pigment diversity also followed the pattern of AI with the test metals used. Inhibition of 14CO2 uptake of phytoplankton of Ganges water was maximum at 0.8 microgram/ml Hg (79%) followed by Zn (69%). Carbon fixation showed an increase for 1 hr, after which no appreciable change was noticed. Maximum inhibition of algal number was observed at 0.8 microgram/ml Hg followed by 8.0 micrograms/ml of Zn in the CEPEX chamber. Members of Chlorophyceae showed more tolerance than Cyanophyceae and Bacillariophyceae. The filamentous forms were more tolerant to Hg and Zn. In contrast, unicellular forms were more sensitive to Hg. The test of significance (ANOVA) showed that metal-induced variations in pigment diversity, the autotrophic index, and the 14CO2 uptake were highly significant (P less than 0.001).

61 **Roy Chowdhary A. and Makhija S**
Methylmercury Chloride induced changes in testicular histomorphology and DNA, RNA, Protein content in rats.
Ind. J. Physiol & Allied Sci. Vol 44 (2), 1990

30 days old rats (weighing 75 $\pm$ 5 gm) were treated intraperitoneally with methylmercury chloride (CH_3HgCl) at the doses of 5 and 10 μg/kg over a period of 90 days. Testicular histomorphology and

testicular protein, DNA, RNA levels were noted at the interval of 15th, 30th, 60th and 90th days of the experiment. Gradual degeneration of testicular tissues along with DNA, RNA and protein levels were observed by day 90 in respect of dose and duration after CH_5HgCl treatment. Significant decrease in ration of protein: DNA and protein: RNA was noted on the 60th and 90th days in the experimental groups. Moreover, gradual decrement in testicular weight along with loss of germinal cell layers reveled that CH_3HgCl retarded the testicular cellular growth in rats.

62 Vachharajani KD; and Roy Chowdhary A.
Distribution of mercury and evaluation of testicular steroidogenesis in mercuric chloride and methyl mercury administered rats
Ind. J. Exp. Biol, 28 746-751,1990

Intraperitoneal administration of Methyl Mercury Chloride (MMC) and Mercuric Chloride (MC) to male rats in doses of 5, 10μg MMC/kg or 50, 100μg MC/kg for 90 days induced cellular disintegration of leydig cells which was conspicuous on day 30 and onwards in the exposed groups. Progressive degeneration of leydig cells and decreases their nuclear diameter and populations were associated with gradual increase in deposition of mercury. Gradual diminution of 3β-hydroxy-δ^5-steroid dehydrogenase activity in leydig cells after MMC or MC treatment was correlated with different structural deformations of the cells over 90 days. Moreover, a significant decrease in serum testosterone levels by day 90 confirmed steroidogenic impairment after MMC or MC treatment.

63 Roy Chowdhary A. Makhija S.; and Vachhrajani KD
Methyl mercury induced biochemical and histochemical alterations in rat testis
Ind. J. Physiol. Pharmec 33(4), 1989

The methyl mercury chloride (MMC) administered at doses of 5 and 10μg/kg over a period of 90 days to male rats caused enzymatic impairments in testicular tissue. The study at intervals of 15, 30, 60 and 90 days showed gradual diminution of testicular weight and gradual decrements in testicular protein and inhibition in testicular succinic dehydrogenase activity. Histochemical and biochemical studies reveled that testicular acid phosphatase activity was also inhibited at both the doses of MMC treatment. The inhibition of enzyme activity in testicular tissues after MMC treatment caused the impairment of both spermatogenesis and steroidogenesis in rats.

Key words: Testicular tissues; Protein; Succinic dehydrogenase; Acid Phosphate; Methylmercury chloride

64 Roy Chowdhary A. Makhija S.; Vachhrajani KD; and Gautam AK
Methyl mercury and mercuric chloride induced alterations in rat epididymal sperm
Tox Letters, 47, pp 125-134, 1989

Four week old male albino rats weighing 70±5g were treated intraperitoneally daily with 0.5 and 10 μg Methyl Mercuric Chloride (MMC)/kg or 0.50 and 100 μg Mercuric Chloride (MC)/kg body weight respectively, over a period of 90 days. Studies were carried out at intermittent intervals i.e. on days 0,15,30,60 and 90 of the experiment. Gradual decrements in body and epididymal weights were observed from day 30 onwards in both the MMC and MC treated groups. Morphological deformations of epididymal epithelium were noted from day 30 onwards in the mercurial-treated groups. MMC treatment caused severe degeneration of the epididymal epithelium on day 60 and 90 in comparison to MC treatment. Total sperm count was significantly less in the MC treated groups, while motile sperm count was affected most in the MMC administered groups. The frequency of sperm abnormality increased consistently at both doses of mercurial treatment over a period of 90 days. Maximum sperm abnormality among the treated groups was noted in the groups given 10μg MMC/kg. The observation reveled that MMC and MC have variable potency to alter epididymal structure and the sperm.
Key words: Methyl mercuric chloride; Mercuric Chloride; Epididymis; sperm

65 Sanzgiry-S; Mesquita-A; Kureishy-TW.
Total mercury in water, sediments, and animals along the Indian coast. Mar.-Pollut.-
Bull. 19: 339-343, 1988

Abstract not available

66 Vachhrajani K.D, Makhija S., Chinoy N.J. and Roy chowdhury A
Structural and functional alterations in the testis of rats after mercuric chloride treatment
J Reprod Biol Comp Endocrinol 8(2):97-104, JRBCE 118, 1988

Administration (I.p.) of mercuric chloride (MC) to immature (30±2 days old) Male albino rats at dosed of 50 and 100mg/kg body weight, daily for 90 days gradually decreased body and testicular weights. Progressive degeneration of testicular tissue was correlated with graded decrease in testicular protein, acid phosphatase and succinic dehydrogenase levels after MC treatment. Biochemical impairments in testicular tissue were observed by day 15 while, morphological changes were noted only after day 30 of MC treatment. The histological and biochemical alterations revealed that MC adversely affected the structural and functional integrity of testicular tissue.
Key words: Acid phosphatase: Mercuric Chloride; Succinic dehydrogenase; Testis.

67 Roy Chowdhary A. Vachhrajani KD; and Shah VC
Effect of methylmercury chloride on the hydrolytic enzymes of rat testicular tissues
Yokohama Med. Bull. 37; Nos. 5-6 pp. 123-128, 1987

Abstract not available

68 Roy chowdhury A.; Vachhrajani, K.D.
Effects of mercuric chloride on hydrolytic enzymes of rat testicular tissues
Ind. J.Exp.boil vol-25, pp-542-547,1987

Two groups of male albino rats (70 gm) were daily administered (i.p) doses of mercuric chloride (0.05 and 0.1 mg/kg body weight) , over a period of 90 days and observation were made on 15^{th},30^{th},60^{th} and 90^{th} days of the experiments. Spermatogenic inhibition and testicular degeneration along with gradual decline of hydrolytic enzymes, i.e. acid phosphatase , alkaline phosphatase, adenosine triphosphatase and 5'-adenosine monophosphatase in testicular tissues after mercuric chloride treatment were noted and found to be dose and duration related. The growth rates and the testicular weights of the experimental rats were noted to be retarded throughout the experimental period as compared to controls.

69 Roy chowdhury A.; Vachhrajani.K.D. and S.K.Kashyap
Inhibition of 3β-hydroxy δ^5 steroid dehydrogenate in rat testis by methyl mercury chloride
Adv Contra Delv Syst.vol-III ,41-45, 1987

Administration of methyl mercury chloride to rats at dosages of 5 μg and 10 μg/kg for 90 days caused progressive degeneration of testicular tissues along with reduction in testis and body weight. Defective steroid genesis and inhibition of spermatogenesis in the testicular tissues of experimental animals were confirmed by inhibition of 3β-hydroxy-δ^5 steroid dehydrogenase.

70 Panday VK, Parameswaran M, Soman SD.
The distribution of mercury in the Indian population
Sci Total Environ;48(3):223-30, 1986

Data have been obtained for the distribution of mercury in a non-occupationally exposed Indian adult group and compared with data available from other regions. The biological elimination half time for mercury of 33 days obtained here is in good agreement with the corresponding value for inorganic mercury compounds. The present work indicates that the relationship between dietary intake and blood concentration is only meaningful when long-term blood concentrations are measured.

71 Roy chowdhury A.; Vachhrajani KD, S.Makhija and S.K.Kashyap
Histomorphometric and biochemical changes in the testicular tissues of rats treated with mercuric chloride.
Biomed Biochem, Acta (45) 7,949-956, 1986

Gradual alterations of testicular tissues were noted in rats treated with mercuric chloride at dosages of 0.05 mg/kg and 0.10-mg/kg body weight (i.p.) over a period of 90 days. Significant reduction in body and testicular weights were observed throughout the experimental period in treated animals. Consequently, testicular protein. DNA and RNA also exhibited a similar type if diminution in the same groups. Moreover, high cholesterol and low ascorbic acid concentrations were found in testis at both doses. Testicular degeneration and permatogenic arrest were more pronounced in the high dose group over a period of 90 days

72 Control of Minamata disease episode in India.
Indian-Assoc.-Water-Pollut.-Control-Newslett. 22: 2-4, 1985

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73 Roy chowdhury A.; Vachhrajani and Chatterjee B.B.
Inhibition of 3 β-hydroxy-δ^5- steroid dehydrogenase in rat testicular tissue by mercuric chloride
Toxicology letters (27) 45-49, 1985

Histochemical investigation of 3 β-hydroxy δ^5- steroid dehydrogenase (δ^5-3β OHD) activity in the testicular tissue of rats administered mercuric chloride ($Hgcl_2$) at dosages of 0.05 mg/kg and 0.1 mg/kg(i.p) daily for 90 days reveal a graded inhibition of δ^5-3βOHD activity which was positively related to dosage and to the duration of treatment with this compound. This phenomenon may be mainly responsible for the inhibition of spermatogenesis, observed as a toxic manifestation of mercury compounds.

74 Singh, B; Shah, VR; Gulvady, NU; Parameswaran, M.
Mercury levels in blood and urine of healthy young adults.
Indian Journal of Occupational Health, 28(2):43-53, 1985
Key Words: Mercury poisoning; Blood; Immunity; Maternal fetal exchange; Occupational diseases; Urine

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75 Khandekar RN, Mishra UC, Vohra KG.
Environmental lead exposure of an urban Indian population
Sci Total Environ;40:269-78, 1984

Environmental lead exposure of the Greater Bombay population has been estimated by measuring lead concentrations in air particulates, water, food and cigarette smoke. Atmospheric lead concentrations in

different zones of the city varied between 82 and 605 ng m^3. The dietary intake of lead is estimated to be 245 micrograms day-1 and is calculated from the lead content in different food groups and the amount of that group consumed by an average resident of the city. The uptake by a non-smoker living in the city area is estimated to be 33 micrograms of lead per day, 75% of which comes from food, 15% from air and 10% from water. For a suburban resident 85% of the lead intake comes from food. The blood lead measurements and the contribution of atmospheric lead to the blood lead level are discussed.

76 Nair KGR; Madhavan-P.
Chitosan for removal of mercury from water
Fish.-Technol.-Soc.- Cochin. 21: 109-112, 1984

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77 Bhatnagar-SN; Oza-PP.
Mercury leaching from solid wastes of chlor-alkali plants
Asian- Environ. 3: 23-27, 1982

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78 Roy Chowdhury and Arora U
Toxic effect of mercury on testes in different animals species
Ind J.Physiol Pharmec 26(3) pp-246-249 1982

Testicular changes following the administration of mercuric chloride,($Hgcl_2$, in various dosages) over one month were studied in rats,mice,guinea pigs and hamsters,$HgCl_2$(5 mg/kg) caused a testicular degeneration and cellular deformation was observed in both the somniferous tubules and the leydig cells in all species: a significant decrease of testicular weight also resulted. There was no cellular deformation at the dose of 2 mg/kg: only spermatogenesis inhibition and leydig cell atrophy were observed in the animals. At the dose of 1 mg/kg. Testicular degeneration was observed only in the hamster, only partial degeneration was recorded in the rat and the mouse and no change was noted in the guinea pig.

Key words: testes, degeneration, spermatogenesis, mercuric chloride

79 Shrivastava AK, Tandon SG.
Studies on mercury pollution: microdetermination of mercury in biological materials by cold vapour atomic absorption spectrometry
Int J Environ Anal Chem.;11(3-4):221-6, 1982

A simple, rapid, precise and accurate method for the determination of mercury in biological material is described. Biological samples were digested with nitric acid and acidified potassium permanganate and determined by cold vapour analyser. The proposed method was successfully employed for the determination of mercury in samples of fish, hair and blood.

80 Mahdihassan S.
The tradition of alchemy in India
Am J Chin Med. Spring;9(1):23-33, 1981

The Aryan of ancient times was a nomad who lived mainly by hunting. The aged, incapable of partaking in such activity, were considered parasites and were exiled as lonely ascetics to the forest. The ascetic began searching for a strength-giving drug so that he could collect edible plants from the forest. He discovered ephedra or the soma plant as an energizer-cum-euphoriant. Feeling stronger and happier he entertained the idea of a drug of rejuvenation. The Aryan nomad as a hunter often over-exerted himself and became exhausted. He then took soma juice thrice daily to prevent exhaustion. With such benefits soma became a popular drink in the Aryan community as a whole. When the Aryans entered India soma became unavailable. Its need persisting, the ascetic substituted ephedra with a mixture of other drugs. If soma was Rasa, or the juice, the substituted medicament was called Rasayana, signifying "juice-incorporate". Rasayana again was geriatric medicine which promised rejuvenation. Later came contact with the Chinese and their use of mercurials. These proved to be efficient energizers and were accepted as Rasayana. Then Aryan medicine first extolled ephedra, next some herbal drugs, and finally mercurials. As energizers-cum-euphoriants, both ephedra and mercurials are anti-somnolents, a feature absent in intoxicants and nacrotics.

81 Murthy SR
An occurrence of cinnabar in Rasarnavakalpa
Indian J Hist Sci;14(2):83-6, 1979

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82 Ramamurthy-VD.
Baseline study of the level of concentration of mercury in the food fishes of Bay of Bengal, Arabian Sea and Indian Ocean
Bulletin-of-the-Japanese-Society-of- Scientific-Fisheries-(Nihon-Suisan-Gakkai-shi) 45 (11) 1405-1407, 1979

Abstract not available

83 Komerwar A. M; Asokan K; Krishnamurthy. S; Subbiah P; Yadav B. R; Udupa H.V.K.
Mercury Pollution from Chlor-Alkali in India and Role of TSIA for its Abatement.
Ind. J. of Env. Hlth, 20 : 284-289, 1978

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Important Links

- GotMercury.Org, a mercury-in-fish calculator, which uses FDA mercury data with the EPA's formula to determine your safe exposure.
- EPA fish consumption guidelines
- ATSDR - ToxFAQs™: Mercury
- ATSDR - Public Health Statement: Mercury
- ATSDR - ALERT! Patterns of Metallic Mercury Exposure, 6/26/97
- ATSDR - MMG: Mercury
- ATSDR - Toxicological Profile: Mercury
- National Pollutant Inventory - Mercury and compounds Fact Sheet
- The Why Files: Mercury Miasma
- WebElements.com – Mercury
- Material Safety Data Sheet – Mercury
- Hg 80 Mercury
- Global Mercury Assessment report 2002 by the UNEP.
- A summary of the UNEP report by GreenFacts.
- Natural Resources Defense Council (NRDC): Mercury Contamination in Fish guide — NRDC
- Global Mercury Trade
- Euro MPs back mercury crackdown
- United States Environmental Protection Agency (EPA) Clean Air Mercury Rule

- Link page to external chemical sources.

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