SUBMISSION NO. 26

SUBMISSION FROM N.A.GIBSON, MSc, PhD., Associate Professor of Inorganic Chemistry (Retired), University of Sydney to the Inquiry into future water supplies for rural and regional Australia.

RE: the Term of Reference - Commonwealth policies and programs that could address and balance the competing demands on water resources.

While the quality of drinking water in cities and major towns is the responsibility of the local water authority, for those citizens not on the reticulation system, the responsibility is entirely their own. It has been known for some years that ingestion of lead can pose serious health problems; the use of lead in house paints was banned in the early 1970s and the use of tetraethyl lead has been phased out over the last twenty years, helped by the fact that lead poisons the catalyst now required to be used in the exhaust systems of cars to reduce air pollution. One source of lead pollution has, however, been generally overlooked. This is the lead which is present in drinking water collected from the roofs of houses in rural and semi-rural areas and stored in on-site tanks, where lead has been used on the roof, usually without the owner's knowledge. This first came to my attention early in 1997, when a lady told me her doctor had found quite unacceptably high levels of lead in her blood; she could not understand this until by chance a tree fell on her house, and the builder told her he would have to replace all the lead in the valleys of the roof. She had the valleys replaced (not with lead) and the tank water analysed: the result was 50 times the upper limit recommended by the NH&MRC. I enquired at the local council what the building regulations said about the use of lead on the roofs of houses where the water was collected for drinking. The answer was "Nothing". The council received revised regulations in August,1997 which now forbade the use of lead in these circumstances. Clearly many houses had been built in the district before this happened, so I contacted one of the Council officers, who put a notice in the two local newspapers. The local newspapers are not delivered, but have to be picked up from newsagents, so only a fraction of the Hawkesbury people would have sseen the advertisement, nevertheless about three dozen people contacted the Lead Advisory Service for advice. It would seem that if this problem is to be addressed, warning notices need to be placed in all the major newspapers throughout Australia.

The importance of this problem to the health of the nation can not be overstated; virtually all the chemical reactions in the human body are catalysed by enzymes, which consist of strings of aminoacids, usually with a metal atom at the active site of the enzyme, magnesium being the metal in over three hundred enzymes in the human body. Two of the important reactions involving magnesium-containing enzymes are the production of the neurotransmitters serotonin and phosphatidylserine. Serotonin is responsible for putting us to sleep at night; when the level drops to a certain point we wake up and the residual level keeps us in a good mood during the day. It is produced in the brain from the essential aminoacid tryptophan and then partially decomposed by enzyme-catalysed reactions as follows: Tryptophan --> (Tryptophan hydroxylase) --> 5-Hydroxytryptophan --> (Aromatic amine acid decarboxylase) --> Serotonin --> (Monoamine oxidase) --> 5-Hydroxyindoleacetic acid, where --> indicates a single conversion step, and ( ) indicates catalytic assistance of the conversion step by the

enzyme named. (Clearly the SSRI (Specific Serotonin Reuptake Inhibitor) antidepressants like Prozac depress the final step). Serotonin has also been shown to be derived in the brain from the long-chain polyunsaturated omega-3 fatty acids EPA and DHA (present in fish oil), but the detailed steps do not appear to have been worked out as yet, though the enzymes involved again have magnesium at the active site.

Aminoacids are all bidentate ligands, so a magnesium ion, which is six-covalent, will bind to two aminoacid residues of the enzyme to fold it to form an appropriate cleft, and then be able to weakly bind the reacting molecule so it can undergo the catalysed reaction. Tables of stability constants give log K1 = 3.5 for magnesium to glycine (which can be taken as a representative aminoacid). In general, for a bidentate chelate log K2 = log K1-1 and log K3 =log K1-2 (very roughly) so the reacting molecule will be held with a bond of strength log K3 = 1.5, weak enough to release the reaction product once formed. The stability constant for lead to glycine is given by log K1=5.5, so the bond from lead to an aminoacid is approximately one hundred times stronger than that from magnesium. Thus lead ions can be expected to displace the magnesium ions from the enzyme. Unlike magnesium, lead is four-covalent, so after it has bound to two aminoacid residues of the enzyme it cannot bind to the reacting molecule at all, so the synthesis of serotonin is blocked, and if enough lead ions are present, depression would be expected to result. This has been shown to be the case..

Phosphatidylserine (PS) consists of a head of a serine (hydroxyglycine) group joined to a body of a phosphate group then a glycerol residue, in turn joined to a tail of two fatty acid groups, one of which is saturated, and the other polyunsaturated. The function of PS is to bridge the synapse between two neurons (of which there are very many) in the brain, thus enabling memory, concentration, and all cognitive processes. It is known that PS controls the magnesium/calcium balance and that the serine head is the active part of the molecule, so it is reasonable to assume that that the serine head is in dynamic equilibrium with magnesium and calcium ions. If, however, lead ions entered the sytem, it would appear from the above that they would bind strongly and effectively irreversibly to the serine heads, displacing both magnesium and calcium ions and blocking the cognitive processes. In different parts of the body, enzymes chop off fatty acid tails and paste on others and also elongate ALA (alpha linolenic acid, found in green vegetables) to EPA and then to the even more important DHA. At least some of these enzymes contain magnesium at the active site, so will be inactivated by lead as discussed above. This seems to agree with literature from the Lead Advisory Service which quotes research work which reports that children with a blood lead reading above 15 micrograms/dL can have an IQ reduced by up to 5 units.

It would be very interesting to investigate whether lead is implicated in the condition ADHD in children, as it has been shown experimentally that ADHD children behave quite normally if given phosphatidylserine or fish oil.

I submit that if the problems of depression, misbehaviour and lowered intelligence are to be eliminated, particulary in the youth of the nation, it is absolutely crucial that every effort be made to remove lead from drinking water supplies.

If house owners find they have lead on their roof, they can most economically obtain pure drinking water by installing a water diverter between the roof and the water tank, and also a water purifier incorporating an ion-exchange column (not a simple activated carbon column) before the kitchen sink. Details can be obtained by contacting the Lead Advisory Service on 1800 626 086.

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