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CAMBRIDGE SOCIETY FOR THE APPLICATION OF RESEARCH

'Mother Knows Best'

The importance of omega-3 oils in human brain development

Professor Michasel A Crawford FIBiol, FRCPath
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London Metropolitan University (formerly Queen Elizabeth Hospital for Children)

Monday 12th May, 2003: ***7.30 p.m. - 9.00 p.m.***
The Wolfson Lecture Theatre, Churchill College, Cambridge

Chair: Brian Ford, *CSAR Member of Council*
Vote of Thanks: to be confirmed

<u>About the Speaker</u>:

Michael Crawford graduated in Chemistry from Edinburgh, following it with a PhD in Chemical Pathology at the Royal Postgraduate Medical School in London. He then worked as a Visiting Research Fellow in Uppsalla, Sweden (where I used to live!) before moving to Uganda, where he was the Head of the Dept. of Biochemistry at Makerere University Medical School. He returned to become a Visiting Professor at the University of Nottingham, in the Department of Biochemistry and Human Nutrition. From 1965 to 1989 he was Head of the Department of Biochemistry at the Nuffield Institute of Comparative Medicine, London.

He was awarded the Gold Medal for Science and Peace by the Albert Schweizer International University earlier this year, where he is an honourary professor.

<u>Michael Crawford writes</u>:

"Conventional wisdom is that humans evolved a large brain in order to compete with the large carnivores for food on the savannahs of Africa. The struggle for survival evolved up right stance for hunting and the large brain for competition. There is little scientific evidence to support it and little one can conclude as of significance to contemporary issues.

A study we conducted in the 1970's[i] showed that the food product of such hunting activity was virtually devoid of docosahexaenoic acid (DHA), a required component of brain cell membranes which we reported in 1972 to be a determinant of brain growth.

Moreover, with increase in body size in the savannah species, the size of the brain relative to the body, declines logarithmically. The marine mammals are the exception to this rule[ii]. The rhinoceros with a one-ton body weight has only 350 gram of brain. A dolphin with about a tenth of the body weight has 1.8 Kg of brain and is the closest to *H. sapiens* in relative brain to body weight ratio. Moreover, unlike the land-based species, it has ample docosahexaenoic acid in its liver and adipose stores.

In the early seas, 600 million years ago, animals evolved with visual systems. They used vitamin A and docosahexaenoic acid in the photoreceptor. Docosahexaenoic acid was also used in the synaptic junctions, which evolved to transmit and receive messages to and from the evolving multi-cellular and differentiated parts. Despite the 600 million years of evolution docosahexaenoic acid has been the molecule used in the signalling membranes of visual and neural systems in the fish, amphibia, reptiles, mammals and or course humans.

This astonishing conservation of docosahexaenoic acid in the brain's signalling system led us to postulated that it had been a determinant of human evolution. Limited supplies on the savannahs would then have been associated with decline in brain capacity as body size increased whereas an abundance would stimulate neural development. This hypothesis was capable of testing by examining what happens when you deprive the brain of docosahexaenoic acid. Studies on the visual system in 1972, defined a requirement for docosahexaenoic acid in the photoreceptor[iii]. We described the first primate in capuchin monkeys led[iv]. Later we described a specific neural dependence on docosahexaenoic acid in chickens. Much evidence in experimental animals demonstrated structural[v], cognitive and visual dependence on the docosahexaenoic-ω3 family whilst studies on preterm infants demonstrated a similar requirement. Although the data in term infants is less secure because different doses were used, the dose level common in human milk did result in significant advantages in visual and cognitive function. Moreover docosahexaenoic acid has been identified as a ligand for the RXR nuclear receptor and to stimulate the expression of genetic information in the brain, encouraging neural growth. In effect there is now pretty sound evidence for a structural and functional requirement providing a science base which was underlined in adrenoleukodystropy. Infants supplemented with docosahexaenoic acid exhibited new mylenation., proven by use of MRI imaging of the brains[vi]

We have therefore concluded that H. sapiens had to evolve in a coastal habitat and make use of its docosahexaenoic acid rich food chain. The brain first evolved in the sea 600 million years ago and still depends on marine nutrients. A coastal origin would have provided the best of both land and sea.

Furthermore, there is now fossil evidence of a coastal origin from the lakes in the Rift Valley and the African coast. The concept of a coastal origin now has the support of Professor Philip Tobias one of the founders of the savannah hypothesis.

This proposition raises a question: why docosahexaenoic acid? It is not liquidity as its precursor with 5 double bonds is more abundant, less susceptible to peroxidation and differs little in liquidity. We have argued that it is the final double bond, which is the key to its function in neural signalling systems. Theoretically, docosahexaenoic acid may posses a special quantum function which traps it into the signalling process and facilitates electrical transmission.

<u>Organising Secretary's Notes</u>:

Omega-3 oils are essential to human brain development; seemingly, we have an absolute requirement for them in our diet. The interesting thing is…….. they only come from fish[1]. In fact, they don't even come from fish; they come from *algae* which inhabit the fish. So there are fish-free omega-3 oils, grown in fermenters.

One formula milk for feeding babies is enriched with omega-3 oils (SMA). Cow's milk (the basis fo most formula milks) contains none. Human mothers sacrifice their body's supply of omega-3 oils to feed the foetus and the infant. Half of their omega-3 oils is used during a single gestation and the ensuing lactation. It takes the mother about two years, on our current diet, to restore her omega-3 oils to the pre-pregnancy level.

All of which says………….. if you're human, eat fish!!

Richard Freeman
CSAR Organising Secretary

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[1] True, some omega-3 oils do occur in flax; but they are too short for our purpose, and have to be elongated into docosahexanoic acid or eicosapentanoic acid. Elongation is very inefficient, and only a few per cent of the total intake of plant omega-3 oils is converted to the form which we need for our nervous system.

i Crawford, M.A., Casperd, N.M. and Sinclair, A.J. (1976) The long chain metabolites of linoleic and linolenic acids in liver and brain in herbivores and carnivores. Comp. Biochem. Physiol. 54B: 395-401.
ii Crawford, M.A., Cunnane, S.C. and Harbige, L.S. (1993) A new theory of evolution: quantum theory. IIIrd International Congress on essential fatty acids and eicosanoids, Am. Oil Chem. Soc. ed A.J. Sinclair, R. Gibson, Adelaide, 87-95.
iii Anderson RE, Maude MB.(1972 Lipids of ocular tissues. 8. The effects of essential fatty acid deficiency on the phospholipids of the photoreceptor membranes of rat retina. Arch Biochem Biophys; 151(1):270-6.
iv Fiennes, R.N.T.-W., Sinclair, A.J. and Crawford, M.A. (1973) Essential fatty acid studies in primates: linolenic acid requirements of Capuchins. J. Med. Prim. 2: 155-169.
v Budowski, P., Leighfield, M.J. and Crawford, M.A. (1987) Nutritional encephalomalacia in the chick: an exposure of the vulnerable period for cerebellar development and the possible need for both w6 and w3 fatty acids. Br. J. Nutr., 58: 511-520.
vi Martinez, M., & Vazquez, E. (1998). MRI evidence that docosahexaenoic acid ethyl ester improves myelination in generalized peroxisomal disorders. Neurology, 51, 26-32.