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PROTEINES À LA >UNE<

Issue 26, May 2009
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On love and milk

Mammals feed their progeny. From birth to the time of weaning, their young ones suck the mother's milk…along with its sugar, lactose. Human milk is very sweet – almost 7% of it is made up of lactose. Cow milk, for instance, only contains about 5%. Besides lending an agreeable taste to milk, lactose is also one of the tiniest wonders of nature. Once absorbed and digested, it supplies the growing body with a significant source of energy and is important for brain development.

Despite these advantages, 70% of the world's population progressively lose their faculty to digest lactose. For many, the change goes unnoticed while for others, consuming milk products can turn digestion into an intestinal nightmare. Stomach aches, bloated bellies, flatulence and diarrhea haunt the process of digestion – otherwise known as lactose intolerance. So how is it that what is such an essential sugar during our childhood can cause such food disturbances later on in life?

The fall of lactase

Lactose is normally digested in the small intestine by way of the cells which line its interior, and whose membranes carry the lactase enzyme. Lactase, consequently, is in direct contact with food. When the enzyme binds a lactose molecule, it slices it into two smaller sugars – glucose and galactose. The glucose is subsequently 'burned' to produce energy and the galactose is integrated

into certain lipids and proteins which are used by the brain.

The quantity of lactase that humans synthesize over the years varies. We produce a lot at birth and then, during our first months on earth, lactase level starts to decline and becomes stable – at its lowest level – between the age of 3 and 5. Whether we continue to drink milk or not, the fall of lactase is inevitable. And that is because it is under severe genetic control; there is nothing we can do about it. If it is of any solace, the decrease in lactase level is not particular to the human race – it is the fate of every other mammal too…

There is, however, an exception: the great majority of Northern Europeans still produce high levels of lactase as adults! The persistence of the lactase enzyme in these populations is due to genetic changes which have come about over time and which influence lactase synthesis. This is not really surprising as it is most certainly the consequence of a simple adaptation to a diet enriched in milk products, which dates about 10'000 years back to the dawn of domestication in the Western World.

And bacteria ?

So if lactase progressively walks out on the digestive tract, what happens to the lactose we ingurgitate? Well, it glides past our small intestine, almost unscathed, and continues its heady descent down into the colon where it is dealt with by hordes of bacteria, many of which are supplied with lactases. The bacteria digest the lactose but not the way our intestines do. Bacteria do it without oxygen, thereby transforming the lactose into gas and small fatty acids. A process known as fermentation… These molecules are then absorbed by other bacteria – who do their very best to get rid of them. But they don't always manage. There are times when the gases and the fatty acids accumulate thus causing the symptoms known as 'lactose intolerance'. The gases are guilty of creating flatulence and bloating whilst diarrhea is caused by the release of water as lactose slips through the intestines. The intensity of pain due to lactose intolerance varies from one person to another, depending on the person's gender, his or her age but most of all, the hardiness of their intestinal tract, the speed of transit and, naturally, the quantity of lactose ingested.

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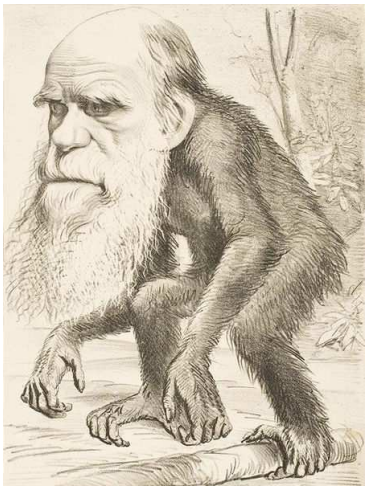
Many scientists have tried to pin down the origin of Darwin's constant complaints, and lactose intolerance is one of the latest findings. Researchers have spent hours delving into the naturalist's diary where he painstakingly marked down his own observations in an attempt to understand himself where his troubles came from. Some have suggested that his disorders were probably psychosomatic, while others believe that Darwin could have suffered from heart disease, an intestinal ulcer or some kind of allergy.



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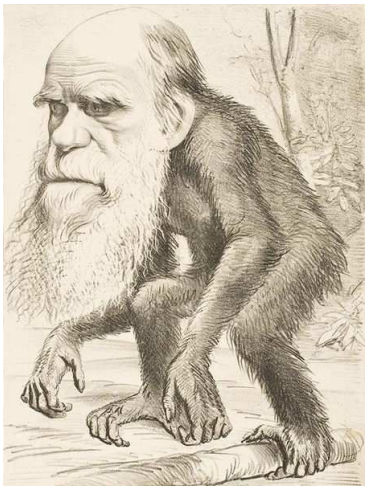

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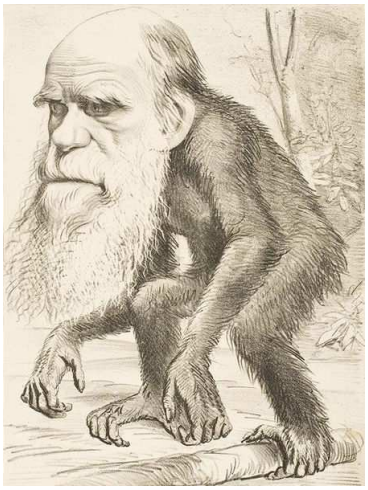

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On love and milk

Mammals feed their progeny. From birth to the time of weaning, their young ones suck the mother's milk…along with its sugar, lactose. Human milk is very sweet – almost 7% of it is made up of lactose. Cow milk, for instance, only contains about 5%. Besides lending an agreeable taste to milk, lactose is also one of the tiniest wonders of nature. Once absorbed and digested, it supplies the growing body with a significant source of energy and is important for brain development.

Despite these advantages, 70% of the world's population progressively lose their faculty to digest lactose. For many, the change goes unnoticed while for others, consuming milk products can turn digestion into an intestinal nightmare. Stomach aches, bloated bellies, flatulence and diarrhea haunt the process of digestion – otherwise known as lactose intolerance. So how is it that what is such an essential sugar during our childhood can cause such food disturbances later on in life?

The fall of lactase

Lactose is normally digested in the small intestine by way of the cells which line its interior, and whose membranes carry the lactase enzyme. Lactase, consequently, is in direct contact with food. When the enzyme binds a lactose molecule, it slices it into two smaller sugars – glucose and galactose. The glucose is subsequently 'burned' to produce energy and the galactose is integrated

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There is, however, an exception: the great majority of Northern Europeans still produce high levels of lactase as adults! The persistence of the lactase enzyme in these populations is due to genetic changes which have come about over time and which influence lactase synthesis. This is not really surprising as it is most certainly the consequence of a simple adaptation to a diet enriched in milk products, which dates about 10'000 years back to the dawn of domestication in the Western World.

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So if lactase progressively walks out on the digestive tract, what happens to the lactose we ingurgitate? Well, it glides past our small intestine, almost unscathed, and continues its heady descent down into the colon where it is dealt with by hordes of bacteria, many of which are supplied with lactases. The bacteria digest the lactose but not the way our intestines do. Bacteria do it without oxygen, thereby transforming the lactose into gas and small fatty acids. A process known as fermentation… These molecules are then absorbed by other bacteria – who do their very best to get rid of them. But they don't always manage. There are times when the gases and the fatty acids accumulate thus causing the symptoms known as 'lactose intolerance'. The gases are guilty of creating flatulence and bloating whilst diarrhea is caused by the release of water as lactose slips through the intestines. The intensity of pain due to lactose intolerance varies from one person to another, depending on the person's gender, his or her age but most of all, the hardiness of their intestinal tract, the speed of transit and, naturally, the quantity of lactose ingested.

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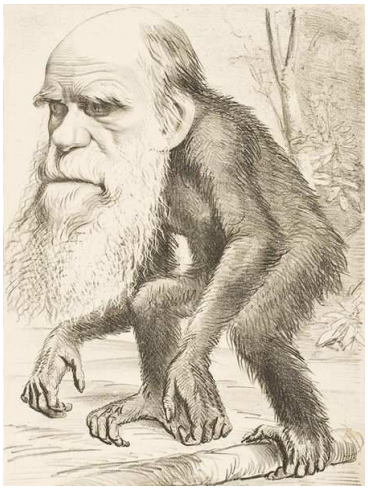

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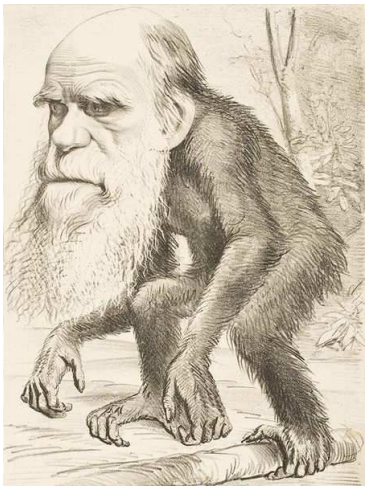

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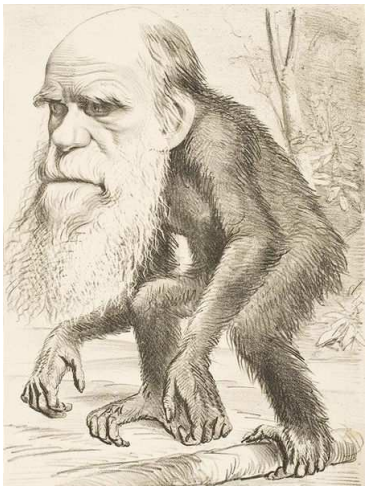

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On love and milk

Mammals feed their progeny. From birth to the time of weaning, their young ones suck the mother's milk…along with its sugar, lactose. Human milk is very sweet – almost 7% of it is made up of lactose. Cow milk, for instance, only contains about 5%. Besides lending an agreeable taste to milk, lactose is also one of the tiniest wonders of nature. Once absorbed and digested, it supplies the growing body with a significant source of energy and is important for brain development.

Despite these advantages, 70% of the world's population progressively lose their faculty to digest lactose. For many, the change goes unnoticed while for others, consuming milk products can turn digestion into an intestinal nightmare. Stomach aches, bloated bellies, flatulence and diarrhea haunt the process of digestion – otherwise known as lactose intolerance. So how is it that what is such an essential sugar during our childhood can cause such food disturbances later on in life?

The fall of lactase

Lactose is normally digested in the small intestine by way of the cells which line its interior, and whose membranes carry the lactase enzyme. Lactase, consequently, is in direct contact with food. When the enzyme binds a lactose molecule, it slices it into two smaller sugars – glucose and galactose. The glucose is subsequently 'burned' to produce energy and the galactose is integrated

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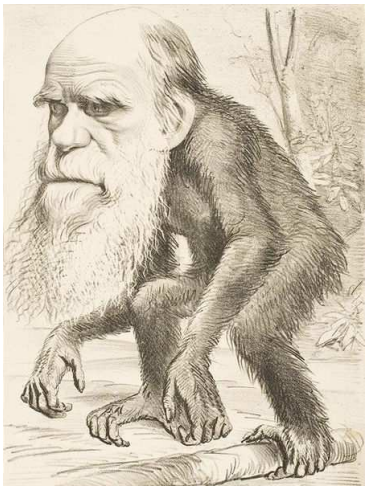

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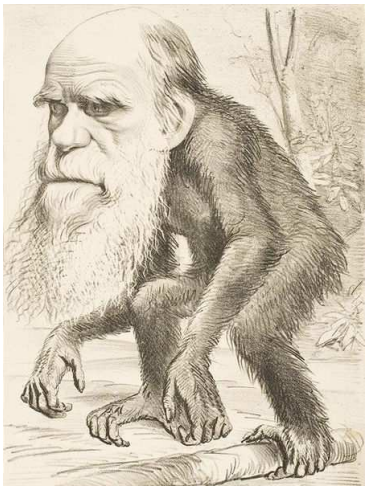

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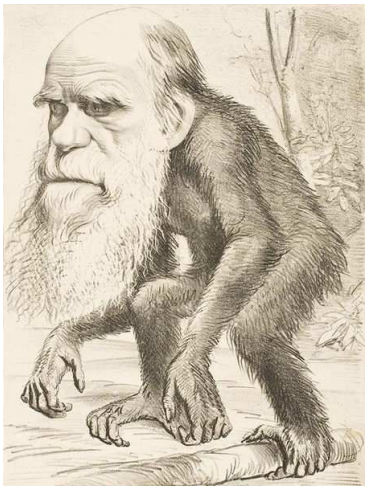

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On the origin of flatulence

Having problems digesting? Want to swallow something healthy? Bifidus yoghurt, fermented milk and lactase pills are all the rage. Just a trend? Could be. But who would refuse something to soothe a digestive discomfort or – more specifically – facilitate the absorption of lactose? Lactose? Lactose is the predominant sugar found in milk. With the passing of years, humans gradually lose the capacity to digest lactose and some of us may even become intolerant to it. It is, in fact, a very widespread inconvenience known as 'lactose intolerance', and depends on the synthesis of one particular protein: lactase.

On love and milk

Mammals feed their progeny. From birth to the time of weaning, their young ones suck the mother's milk…along with its sugar, lactose. Human milk is very sweet – almost 7% of it is made up of lactose. Cow milk, for instance, only contains about 5%. Besides lending an agreeable taste to milk, lactose is also one of the tiniest wonders of nature. Once absorbed and digested, it supplies the growing body with a significant source of energy and is important for brain development.

Despite these advantages, 70% of the world's population progressively lose their faculty to digest lactose. For many, the change goes unnoticed while for others, consuming milk products can turn digestion into an intestinal nightmare. Stomach aches, bloated bellies, flatulence and diarrhea haunt the process of digestion – otherwise known as lactose intolerance. So how is it that what is such an essential sugar during our childhood can cause such food disturbances later on in life?

The fall of lactase

Lactose is normally digested in the small intestine by way of the cells which line its interior, and whose membranes carry the lactase enzyme. Lactase, consequently, is in direct contact with food. When the enzyme binds a lactose molecule, it slices it into two smaller sugars – glucose and galactose. The glucose is subsequently 'burned' to produce energy and the galactose is integrated

into certain lipids and proteins which are used by the brain.

The quantity of lactase that humans synthesize over the years varies. We produce a lot at birth and then, during our first months on earth, lactase level starts to decline and becomes stable – at its lowest level – between the age of 3 and 5. Whether we continue to drink milk or not, the fall of lactase is inevitable. And that is because it is under severe genetic control; there is nothing we can do about it. If it is of any solace, the decrease in lactase level is not particular to the human race – it is the fate of every other mammal too…

There is, however, an exception: the great majority of Northern Europeans still produce high levels of lactase as adults! The persistence of the lactase enzyme in these populations is due to genetic changes which have come about over time and which influence lactase synthesis. This is not really surprising as it is most certainly the consequence of a simple adaptation to a diet enriched in milk products, which dates about 10'000 years back to the dawn of domestication in the Western World.

And bacteria ?

So if lactase progressively walks out on the digestive tract, what happens to the lactose we ingurgitate? Well, it glides past our small intestine, almost unscathed, and continues its heady descent down into the colon where it is dealt with by hordes of bacteria, many of which are supplied with lactases. The bacteria digest the lactose but not the way our intestines do. Bacteria do it without oxygen, thereby transforming the lactose into gas and small fatty acids. A process known as fermentation… These molecules are then absorbed by other bacteria – who do their very best to get rid of them. But they don't always manage. There are times when the gases and the fatty acids accumulate thus causing the symptoms known as 'lactose intolerance'. The gases are guilty of creating flatulence and bloating whilst diarrhea is caused by the release of water as lactose slips through the intestines. The intensity of pain due to lactose intolerance varies from one person to another, depending on the person's gender, his or her age but most of all, the hardiness of their intestinal tract, the speed of transit and, naturally, the quantity of lactose ingested.

The trouble with Darwin

The role of the intestinal flora in digesting lactose explains in part the current trend of milk products treated with lactase or enriched with bacteria – such as *Bifidobacterium* or *Lactobacillus* – which populate our intestinal tract on a natural basis anyway. Despite their success, the benefits of fermented milk and bifidus yoghurt, for example, remain controversial.

Charles Darwin (1809-1882) never got the chance to taste such products which could well have lessened his unremitting physiological ailments. For the best part of forty years, the father of the theory of evolution suffered from symptoms which, today, scientists believe to be characteristic of lactose intolerance. Though many a doctor rushed to the famous naturalist's side and numerous diets and types of medicine were tried out – not to mention many visits to various spas for hydrotherapy – not one could find what was wrong with the great man. In those days, lactose intolerance was unheard of, although Hippocrates had already described similar disorders 2000 years ago.

Fig.1 *Portrait of Charles Darwin by George Richmond, towards the end of the 1830s.*

Lactose intolerance

Lactose intolerance is brought about by a lack of lactase in the intestinal tract. Besides the genetic adaptation described above, lactase function can also be diminished following damage to the inside of the small intestine due to disease or gastro-intestinal infection – in which case the symptoms are usually only temporary. There is also an extremely rare hereditary form of lactose intolerance which occurs already at birth and where lactase is practically inexistent.

Darwin's health had always been frail but it got much worse when he returned from his voyages on HMS Beagle in 1836. This could be explained by going back to old eating habits and the novel regular intake of milk products – something he had not been used to while voyaging. Darwin suffered almost continuously from nausea, flatulence, headaches, palpitations, joint pains, trembling, exhaustion and depression…

Many scientists have tried to pin down the origin of Darwin's constant complaints, and lactose intolerance is one of the latest findings. Researchers have spent hours delving into the naturalist's diary where he painstakingly marked down his own observations in an attempt to understand himself where his troubles came from. Some have suggested that his disorders were probably psychosomatic, while others believe that Darwin could have suffered from heart disease, an intestinal ulcer or some kind of allergy.

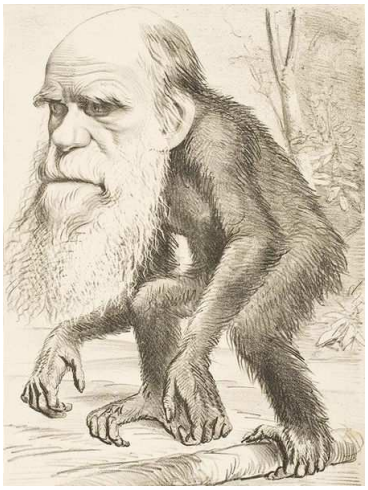

Fig.2 *Caricature of Charles Darwin published on 22nd March 1871 in the satirical magazine, The Hornet.*

Throughout his life, Darwin's health had always been fragile. Other members of his family were also of frail constitution and some of his own children seemed to be afflicted with the same troubles. If Darwin had suffered from lactose intolerance, and if he suffered from a hereditary form…it could explain the appearance of the same problems in different generations of the Darwin family. It is a possibility. However, the existence of a genetic factor in lactose intolerance is still not clearly understood. But scientists are becoming aware of a surprising phenomenon: some adults continue to produce lactase – resulting from genetic changes observed in Northern Europe – but they are also more sensitive to a fleeting intolerance to lactose in the event of stress or intestinal infection. Could this have been the case for Darwin? Was he the carrier of such genetic variations? The answer lies in his DNA…which would mean that scientists would have to be able to get hold of some of his hair or a bit of his skin…

Rough times…

Throughout his life, Darwin's chaotic health hampered with his research and kept him away – no doubt much to his relief – from the inflamed discussions around his theory of evolution which was published in 1859 in The Origin of Species. Many of his detractors believed that he was just finding excuses to shun criticism. Confined to his house, he wasn't even able to attend the legendary 1860 debate in Oxford. This debate confronted the Bishop of Oxford Samuel Wilberforce with Darwin's most ardent defendant, Thomas Huxley, during which Wilberforce is said to have asked Huxley whether he descended from a gorilla on his father's side or his mother's side. Huxley famously replied that he "would rather be descended from an ape than from a cultivated man who used his gifts of culture and eloquence in the service of prejudice and falsehood".

The concept of organisms which are transformed with the passing of time was not new. It had already germinated in the minds of the learned as far back as the 3rd century AD and reappeared in the 18th century – when Darwin's own grandfather outlined it in verse, no less. But like all novel concepts – especially those which counter fundamental beliefs – it needed mature minds and a grandson to suggest a mechanism which met with educated and receptive ears. However, because of the questions the theory raises on the origins of humankind, it is hardly surprising that it still meets with much religious opposition despite its recognition by scientists worldwide.

Excerpt from *The Origin of Species* – Charles Darwin

«Owing to this struggle for life, any variation, however slight and from whatever cause proceeding, if it be in any degree profitable to an individual of any species, in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual, and will generally be inherited by its offspring.... I have called this principle, by which each slight variation, if useful, is preserved, by the term of Natural Selection, in order to mark its relation to man's power of selection.»

A little respite

Though criticism gave Darwin little respite, his health did improve fortuitously following a low-milk diet. Diminishing your intake of milk products to alleviate symptoms seems obvious today, but it wasn't in Darwin's time. Lactose intolerance is now well-known, and relief is fast when diagnosed. However, tracking down lactose is becoming a very laborious task. It is omnipresent. Besides it being found in all milk products, it is also hidden in bread, medication, drinks, sauces and certain meat preparations. Following the success of milk farms, are we now heading into another evolutionary turn? The next millennia will tell us…

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For further information

On the Internet:

- On lactose intolerance : http://digestive.niddk.nih.gov/ddiseases/pubs/lactoseintolerance/
- Charles Darwin on Wikipedia: http://en.wikipedia.org/wiki/Charles_Darwin

Learn more:

- Lomer MC. et al, "Review article: lactose intolerance in clinical practice - myths and realities", Aliment Pharmacol Ther. 27(2):93-103 (2008) PMID: 17956597
- Campbell A.K. and Matthews S.B., « Darwin's illness revealed », Postgrad. Med. J. 81:248-251(2005) PMID: 15811889

Illustrations:

- Header illustration (Maternity, Mary Cassatt), Source: Wikipedia
- Fig.1, Source: Wikipedia
- Fig.2, Source: Wikipedia

At UniProtKB/Swiss-Prot:

- Lactase-phlorizin hydrolase (lactase), Homo sapiens (human): P05067

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