Gnathostomes : chimeras of insect and chordates?

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Summary
The gnathostomes present all the chordate characters, which justifies their being placed into this taxon. The arthropods on the other hand are considered to belong to a totally distinct branch, but, when setting the list of the features differentiating the gnathostomes from the agnates the investigator cannot fail to notice that they are all homologues of insect traits. Homologies are found at the level of anatomy, of functionality, at the molecular and genetic levels. The hypothesis that we are in presence of a chimera or hybrid of insect and agnate comes to mind.
A plausibility study supports the hypothesis and allows to upgrade it to theory.
Additionally, the present study brings out a novel interpretation of the origin and functions of the cerebellum.
Another conclusion: gnathostomes appeared in freshwater streams.

Resumen
Los gnatóstomos presentan todos los caracteres típicos de los cordados y por eso están clasificados en este taxón. Los artrópodos están analizados como una rama biológica separada, sin embargo, cuando se listan los rastros que diferencian agnatos y gnatóstomos no se puede ocultar que están todos homólogos de caracteres de insectos. Las homologías existen a nivel anatómico, funcional, molecular y genético. La hipótesis de una quimerización de insecto con cordado no puede ser descartada.
Haciendo un estudio de plausibilidad lleguemos a emitir la teoría que los gnatóstomos son una quimera de agnatos y insectos. La presente investigación entrega una interpretación nueva del origen y de la función del cerebelo.
Otra conclusión: el gnatóstomo nació en ríos de agua dulce.

Résumé
Les gnathostomes présentent toutes les caractéristiques typiques des chordés, raison pour laquelle ils sont placés dans ce taxon. On estime que les arthropodes appartiennent à une branche séparée, et pourtant, en établissant la liste des traits qui différencient les gnathostomes des agnathes on doit reconnaître que ce sont tous des homologues de traits d'insectes. Il y a des homologies au niveau anatomique, fonctionnel, moléculaire et génétique. L'hypothèse d'une chimérisation ou hybridation d'un insecte et d'un agnathe vient à l'esprit.
Une étude de plausibilité supporte cette idée. On peut donc la présenter comme théorie nouvelle : le gnathostome est une chimère d'agnathe et d'insecte. La présente étude fait apparaître de surcroît une interprétation nouvelle de l'origine et des fonctions du cervelet.
Autre conclusion : le gnathostome est apparu en eau douce.

Introduction

Current taxonomy describes a continuous evolutionary line linking the annelid to the agnate vertebrate, all the way to the gnathostome. In parallel, another series goes from the same annelid to the arthropods, another vast group that extends from the scolopendra to the winged insects. The fossils indicate that both groups appeared at approximately the same time, unfortunately the traces left by the insects are few and very fragile.
The evolution of the first of these groups kept on going until a rather near past – the coming to be of homo sapiens – but the evolution of the second group appears to have come to an end hundreds of millions of years ago.
In the series that goes from the agnate to the gnathostome a brutal transition is observed; it is enumerated and pushed aside temporarily in Sebastian M. Shimeld introduction.
[1] ‘We view the evolution of vertebrates as the acquisition of characters along the chordate stem lineage. These characters, established by comparison to outgroups (i.e., amphioxus and tunicates), include (*i*) neural crest cells and their derivatives; (*ii*) elaboration of placode-derived structures; (*iii*) elaboration of the brain, including rhombomeric segmentation; (*iv*) cartilage (and possibly mineralization); (*v*) the axial skeleton and the head skeleton; and (*vi*) a large increase in total **number** of **gene**s in the genome. Other characters present only in jawed vertebrates, including paired appendages, hinged jaws, an adaptive immune system, and specialization of the axial skeleton along the anterior-posterior axis, were probably acquired later, on the jawed vertebrate stem lineage, and will not be considered here.’(*underlined by this author*).
The present advances of biology drive us to look for a cause to the extended changes that lead to the gnathostome from the lamprey with no intermediary steps.[i] [2]

We suggest focusing on the traits discarded by Shimeld, elements that are not found in any chordate except the gnathostomes. They interest us for two major reasons:

1. They appear in all gnathostomes, including the early ones
2. They are found in the insects

Let’s show in a frame the elements that are found in the lamprey, in the insects and in the gnathostomes.

[i] http://www.ncbi.nlm.nih.gov/pubmed/12395382

	Insect	Lamprey	Gnathostome
chord		+	+
Pharyngeal slits		+	+
Neural crest[ii]		+	+
Dorsal CNS		+	+
Midline fins		+	+
Post-anal tail		+	+
Vertebras		+	+
Buccal pieces	+		+
Pairs of segmented lateral appendages	+		+
Specialized locomotor extremities	+		+
Cerebellum	+		+
Internal Fecundation	+		+
Aerial breathing	+		+
Myelin	+		+
Adapt. Immunological System[iii]	+		+
T Cells	+		+
HOX	+		+
Opsin Rh1	+		+
Nkx 2.1 in brain	+		+
Honeybee genes	+		+
Abdominal breathing.	+		+
Thalidomide toxicity on 3 pairs of lateral appendages	+	?	+
Acoustic communication			

Table. 1 – this table shows the similarities and differences between insects, agnates and gnathostomes. The elements common to insects and gnathostomes are the same that separate lampreys and gnathostomes

Given the genetic homologies it is hard to believe that the anatomical similarities brought about by these genes are but analogies. In fact, it has already been accepted that the

[ii] Part of the migration of the neural crest cells is absent in the gnathostomes: blocked. http://www.ncbi.nlm.nih.gov/pubmed/11604127?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_Discovery_RA

[iii] http://www.genetics.org/cgi/reprint/147/2/713.pdf
(Alignment of molecular sequences have shown homology between antimicrobial proteins of mammals and insects confirming an ancient ancestry….)

similarities are homologies and not analogies [3]
The number of macroscopic homologues between both groups – gnathostomes and arthropods – increases as we get into more modern arthropods, into the winged insects. Further away from the early arthropods is further away from the annelid that is supposed to be the only direct ancestor of both groups.
As we observe the large number of characteristics common to gnathostomes and insects, we feel justified to wonder if the arthropods and gnathostomes are indeed two groups that evolved independently, in parallel, or if it would be wiser to review the relative position of both groups, to see the insects as ancestors of the gnathostomes, as much as the chordates.
This is the reason why we express the hypothesis that the gnathostome has two distinct parents, the agnate and the insect, that the gnathostome is a chimera. [iv]

Most research is being carried at the genetic and embryological levels. We proceed instead to a flight over the entire landscape to make sure that no tree is hiding the forest. The advances by the academic research bring proofs and arguments that were missing in earlier macroscopic studies; we are entirely in their debt.
Given the altitude of our flight, the details are missed, and experts will tend to refute our description of the steps of evolution as we present them; nevertheless this analysis will help looking for discrete links.

DATA

In our description we look at the 'gnathostome' as if there was such an animal. There are in the 'gnathostome' many kinds of inherited genetic potentials, that are expressed or hidden. This is why for instance a side limb may be a fin, a wing, a leg or be missing as in the snake. We shall justify this postulate later in the text, basing it on recent scientific progress.

The fish

The aquatic vertebrates are classified in two taxons, the agnates – deprived of mandible – and the gnathostomes – with mandibles.[4]
In fact, as we can see in table 1., even in nothing but anatomy these two taxons differ by more than just the mandible.
The gnathostomes – placoderm first, and then fish appeared some four hundred millions years ago and they started readily to evolve. All the early gnathostomes disappeared leaving nothing but fossils, abandoning the planet to other more evolved, more complex species.

The gnathostomes can be put into two large categories, those with cartilaginous skeleton and those with bony skeleton.
Let's see some of the points in which they differ from the agnates.

[iv] http://gos.sbc.edu/n/nv/nv.html (Christiane Nüsslein-Volhard, Nobel Price)

Level skeleto-neuro-muscular.

In the placoderm there is a craniothoracic exoskeleton which could be a homologue of the corresponding exoskeleton of the insects. This exoskeleton does not extend caudal to the 'thorax', not caudal to the posterior fins, or the anus of the placoderms.
Furthermore, it can also be speculated that the armor seen on the lateral fins in some placoderms is part of the same inherited exoskeleton.
Placoderms were swimming using the lateral fins as well as the tail, a tail which usually had no fin.
The same general disposition is found in the holocephals, the chimeras, chondrychtiis. (holocephalii, chondrychties) [v],[vi]

1. **Mandible**

The gnathostomes are the first vertebrates with inferior and superior jaws. These rigid half-belts allow for catching food, tearing pieces of it, or enclosing it in the mouth cavity, all techniques permitting finding food in a larger variety of preys.
During the same evolutionary step the tongue and the trapeze come to be – the agnate doesn't have anything like them – .
The tongue moves the food to the opening of the esophagus from the front of the mouth. The esophagus captures the bolus and inserts it into the tubular digestive tract by peristaltic suction. From the esophagus onwards the technique is that of the annelids.

The jaws are each composed of two 'bones' sutured on the midline. In most gnathostomes, the mouth opens by contraction of muscles between the 'skeleton' of the neck or the pharynx and the inferior mandible, and closes by action of powerful muscles between mandible and maxillary.
Hemichordates and agnates don't have anything of the kind.
The insects have complex 'mouth' pieces composed often of as many as nine elements. These pieces exist in a variety of shapes adapted to the specific diet of the animal. In some species, the mouth pieces catch the prey, others prepare it, before finally others present them to the esophagus. [5]

2. **Lateral appendages**

Segmented legs with specialized extremities.

Locomotor appendages of the gnathostomes : fins

From another viewpoint fishes can be classified in three main groups : see fishes, river fishes and mixed fishes – anadromous – that are born in freshwater and migrate to the high sea, only to return later on to their birth environment to lay their eggs.

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[v] http://es.wikipedia.org/wiki/Chimaeriformes

[vi] http://www.elasmo-research.org/education/shark_profiles/chimaera.htm

The fins of the freshwater and anadromous fishes are situated in the ventral part of the body, in the same coronal plane. They are anterior and posterior pairs; they can take hold on the ground and on any solid obstacle, being used as practical limbs.

The fins of sea fishes are located practically on a single transversal plane, they are superior and inferior. In most instances they couldn't touch the ground, but this is of little importance as they live in a vertical world (the corals) or in open sea. In the dactylopterus volitans, a sea fish, the 'posterior' fins are used to walk on the sea floor, and the upper fins open as wings. This indicates that walking on two legs and flying using the anterior limbs – homology with the bird – appears in the fish, and should not be seen as an invention by the reptiles.

_Extremities
The fins of the cartiloginous fishes are clearly linked to the axial skeleton by cartiloginous belts. These fins are more than simple oars. In some instances – chondrichtii and sarcopterygii (shark and coelacanth for instance) – the fins contain a number of segments. The number of segments and the importance of the belts are less in fishes that have appeared later in evolution -
In the newer gnathostomes, the tetrapods, the fins are replaced by members with a variety of extremities dedicated to running, climbing with suction cups or claws, digging…

Locomotor appendages of the insects: the insects have three pairs of thoracic limbs, each one composed of as many as nine segments. The three pairs are situated in the same coronal plane, they support the body away from the ground. The anterior limbs may have additional functions such as cleaning the head – mosquitoes and flies – or catching preys – praying mantis – and participate this way directly to feeding.
In some insects the receptors of hearing as located on the limbs, in others tympanums are to be found on the thorax, posterior to the anterior limb.
In some insects the extremity of the limb is an oar, or a paw for climbing, or for digging, with suction cups, or claws…

3. Cerebellum

The gnathostomes have a cerebellum, the lampreys don't.

The fish cerebellum is the largest component of his central nervous system. [vii] [6,7]

Level of the vital functions.

1. **Fecundation**

[vii] (Nieuwenhuys and Nicholson, 1998 The lamprey cerebellum is rudimentary and its homology with the corpus cerebellum of the gnathostomes is still unresolved… the transcript *LjPax6* corresponding to the cerebelar primordium is not observed in the myelencephalon. This suggests that the cerebelar pattern regulated by *LjPax6* evolved independently after the divergence between gnathostomes and agnates.

The reproduction of the rays, of the sharks and several other cartilaginous fishes is internal. These fishes are viviparous, or oviparous, or ovoviviparous. It has been established that the same held true for the placoderms, and the latest fossil discovery supports that theory.
The reproduction of the other fishes is external, and that of the amphibians is external also.
The reproduction of the agnates is external.
The fecundation of many insects is internal . Most insects lay their fecundated eggs, but there are some species that are viviparous, and others that are ovoviviparous.

1. **Vital cycle**

The anadromous fishes – freshwater/salt water – lay their eggs in freshwater and the newborns swim to the sea where they grow to adulthood. When adult they return to freshwater. There are no fish using the inverse migrating pattern with the possible exception of the eel.
The anadromous fishes are primitive, some have a cartilaginous skeleton.
The sea lamprey – agnates – live in the sea and reproduce in freshwater, they are anadromous. [viii]
There are insects that live in the air and lay their eggs in water, the mosquito for instance.

2. **Aerial breathing**

Placoderms used to live in freshwater[ix] and others in the sea.
Breathing air directly, with lungs is a process that appeared very early in the gnathostomes. It is admitted that the placoderm bothriolepis was anadromous and air breathing.
The cartilaginous fishes – chondrychthyes and some actinopterigii (chondrostei) – are probably close to the early gnathostomes such as the placoderms.

The lung fishes, dipnoos, as their name indicates are air breathers. They are the sarcoptirigios cartilaginous.
The lung fish of South America is a total air breather. [x]

Some fish get out of water rather commonly.
Most insects live in the atmosphere, many have an active abdominal inspiration/expiration cycle.

Molecular level

[viii]. http://marinebio.org/species.asp?id=542
[ix] , http://www.ucmp.berkeley.edu/vertebrates/basalfish/placodermi.html
[x] http://animals.jrank.org/pages/1960/Coelacanths-Lungfishes-Sarcopterygii-SOUTH-AMERICAN-LUNGFISH-Lepidosiren-paradoxa-SPECIES-ACCOUNTS.html

Surfactant
To breathe air, SPA-1 is required.
This surfactant is to be found in the respiratory tissues of the insects and in those of the aerial tetrapods. There is none in the agnates and none in the fish that don't breathe air.

Hox
The HOX molecules are involved in the development of the embryo.[2]
The HOX molecules of the gnathostomes and those of the insects are identical. They have the same functions in the formation of the limbs.
Obviously there are not to be found in the agnates. [xi]

Opsin Rh1
The opsin Rh1 molecule is found in the formation of one of the ocular pigment in both gnathostomes and insects.
It does not play that role in the lamprey.

Nkx 2.1
The Nkx 2.1 gene acts in the formation of the central nervous system of the gnathostomes and that of the insects.
It does not have the same function in the agnathe.

Genetic level

The drosophila fly has many genes similar to those of the human [2]. The bee has still more [xii]. There is no report of such a large genetic similarity between insects and agnates.

Celular level

Myelin
Myelin is an insulator deposited around axons. It facilitates a faster propagation of the nerve impulse.
Some nerves of the gnathostomes are wrapped into myelin. The same is true for some insect nerves.
There is no myelin around the agnates nerves. [xiii] [9]

[xi] http://www.auburn.edu/academic/classes/zy/0301/Topic15/Topic15.html

[xii] http://www.bcm.edu/news/item.cfm?NewsID=725

http://www.bcm.edu/news/item.cfm?NewsID=725

[xiii] 'ix Bullock, T.H., Moore, J.K. and Fields, D. (1984) Evolution of myelin Sheath: both lamprey and hagfish lack myelin. Neurosc. Lett. 48, 145-148

Adaptable immune system.

As the gnathostomes, some insects have an adaptable immune system with T cells. There is nothing similar in the agnates.

Re-expressed traits

1. **Thalidomide effect**

The tragic inhibitory effect of thalidomide in the formation of the limbs of the human embryo indicates that there is an exclusive link, narrow, between the formation of the ear and that of the human inferior and superior limbs. Administered at therapeutic doses, this drug blocks, in human, the development of the nerves, bones and muscles of the legs, arms and middle ears. It has no effect on the rest of the skeleton.[10]

2. **Abdominal breathing**

Abdominal breathing appears in the reptiles and could be seen as a simple evolution, a simple addition to the program of the immediate ancestors, the amphibians.
Many insects use abdominal breathing. In the insects with aquatic larvae such as the mosquito, the larva uses branchias i.e. breathes passively, and the adult breathes actively, which tells us that the insects genome contains side by side the branchial and the abdominal breathing programs.
Cutaneous breathing is found in all levels of evolution; abdominal breathing is its most dynamic form.

Discussion

Land colonization

The dry ground colonization by flora and fauna didn’t happen right from the start.
Life-forms appeared in water much earlier.
At the end of Cambrian and the beginning of Silurian, most animals lived in the sea and some edible life-forms started to appear on the earth.
The subsequent earth colonization by animals started necessarily at the sea shore.

Even though it is likely that rivers appeared very early as sea water evaporates and falls as rain where the landscape makes it more likely, the very nature of water flow makes it hard for simple creatures to go upstream.

Two processes of land colonization:
1. some animals walk out of the sea
2. some are thrown by waves.

The first way would force the animals to find a way to breathe air as soon as they come out of the sea. It they find a way to keep their skin wet, they can still get their oxygen by skin breathing.

The second could allow for a step-by-step process. First they live in the pools formed by sea water. Then this salt water is diluted with rain and streams of fresh water: adaptation to freshwater is selected. Ultimately these pools occasionally dry out: forced selection of air breathing mutations.
At a later stage some of these land creatures reach rivers and springs by land.

It is unlikely that animals swam upstream i.e. against an energy gradient and against a negative alimentary gradient: spring water is necessarily poorer in organic nutrients.
This leads us to conclude that the early colonization of the river banks and of the springs was done by land dwellers.

Why would animals leave a rich and secure environment and expose themselves to uncertainty?

Why did these animals venture in such a different biotope?

Some authors suggest that the colonization of the earth, the coming to be of the amphibians and later on of all the tetrapods is due to their running away from the large sea predators. In reality there is no example in the biosphere, be it that of the plants, that of the animals and even human history to illustrate such a theory. No good territory is ever permanently abandoned because of the predators.
Rather, population growth makes it more difficult to find food, and thus the search of own satisfaction by each member, together with the increasing social pressure pushes part of the supernumerary, mostly the young and weak, to explore further and further away from the original territory. The carnivorous follow for the same reason.

Thus there are two reasons for migration: want of food and exploring instinct.

1. **Insects**

Arthropods and other animals risked themselves out of water. The parapodes changed into articulated limbs give the arthropods the advantage of better mobility over the other animals where there is little or no water.
The mouth pieces make it possible to increase the size and the variety of the sources of food.
Out of the water, these immigrants find something to eat, unicellulars at first and then, as they became available, various plants that they learn to suck. Later on, symbiosis with bacteria allows them to digest the cellulose.
These groups grew quickly in number.

The arthropods left a large variety of fossils, starting with the trilobite which informs us that primitive arthropods appeared rather early, first in the sea and then on dry land.

More advanced forms such as the arachnids and even hexapods followed. Animals of both groups share the land with us, which indicates that they adapted perfectly to a dry environment.

1. **Chordates**

It may be that some primitive chordates settled on the dry land, but to this day it doesn't seem so. The present representatives of agnates, myxines and lampreys are aquatic. Being entirely soft, the hagfish didn't leave many fossils. The oldest known fossil is only 350 millions years old which is much less that the oldest gnathostomes. Its genome however seems to indicate that it is much older. New studies support the conclusion that it is an ancestor of the lamprey.

Evolution: micro, macro mutations, symbiosis.

Evolution follows a limited number of rules:

1) Evolution takes place by small steps
2) Each novelty is represented in all the segments of the same group – for instance: segmented limbs in each thoracic and abdominal segment of the primitive arthropods; continuous dorsal fin in the lamprey…. As another example: as the insect's thorax is composed of three segments, the early winged insects had three pairs of wings[xiv] as predicted by the present rule 2.
3) Each function can be inhibited in some segments by addition of genes: the abdominal segments loose their legs… - apparently, 'nature' chooses hiding y re-enacting over erasing and re-inventing (convergence), this is why there are insects with three, two, one and zero pairs of wings, as they get progressively inhibited[xv]. We suggest that the wing is expressed anew in some gnathostomes.
   We shall call the process 'expression/repression'.
4) Each function which is occulted is atavistic and may be expressed anew: it is possible to provoke the apparition of legs in segments normally deprived of them.
5) And as a corollary, each function remains associated with the tissues in which it first appeared.

At first sight it seems easier to change from zero legs to two or three pairs, and for this reason the phylogenic notion that the mollusk[xvi] is the closest ancestor of the vertebrates is not shocking, but evolution proceeds in the opposite direction as is amply illustrated in the progressive evolution of the annelids and arthropods, a direction described in our rule 2.

[xiv] Jarmila Kukalová. Stenodictya http://animalpicturesarchive.com/view.php?tid=2&did=27065 and http://www.google.com/search?client=opera&rls=en&q=stenodictya&sourceid=opera&ie=utf-8&oe=utf-8

[xv] http://www.physorg.com/news64767304.html

[xvi] Present philogenetic conclusion.

What brought the arthropod to the insect from the scolopendra[xvii] is a series of small steps. The thorax got further differentiated and the segmented legs of the abdomen shrunk… the lobster. Then the abdomen got entirely suspended and the abdominal breathing established itself: the arachnid.
Then the number of legs decreased to three pairs, one per each thoracic segment, and zero for the abdomen.
Each of these small steps was accompanied by important improvements of the nervous system. Further improvements gave the bee memory and power of abstraction.
It is advanced but probably not too complex, as all of this is supported by a small number of neurons. Millions of years, no doubt were necessary to reach this level of functional complexity.

We mention the lamprey's fin which shows that all segments of the trunk are able to produce some elements of that midline fin. Evolution, later on, limits the number of segments that participate in the making of the midline fins.
The same succession of events can be observed in the formation of the fish bones. The primitive fossils show as many pairs of fish bones as there are vertebras – megalodon – , but in modern fish, only the anterior vertebras have lateral fish bones – partial deletion/repression.
Biologists speak of a Principle of Parsimony, but we prefer to call it a Principle of Small Steps, because the concept of parsimony supports rather well the idea that the number of limbs went from zero to nothing more than two or three pairs, something which is very economical – granted – but something which does not match the series of observed facts.
We share the opinion that the single pair of pectoral 'fins' of some ostracoderms are not real fins. Conclusions from fossils are risky at best.
Evolution occurs because some new mutant finds a niche, an opportunity to feed for instance, that its ancestors ignored or couldn't reach, or couldn't digest. The newcomers are generally not as strong as the previous species, they cannot take their food.
The newcomers are weaker than the species already present when they appeared; if it weren't so, these precursors would be eliminated. This is rarely is observed. Even though they are weaker, the newcomers remain because their debility is compensated by some new trait.
There is one evolutionary circumstance where the early animal is run away from its feeding ground, it is when some event has weakened the first occupant. The newcomer then uses the food with enough efficiency to prevent the return of the previous occupant.. This results either in complete extinction, or at least in leaving to the first occupant nothing but the poorest edges of the biotope.
This may be why the sarcopterygians – coelacanth and lung fish – are found in deep ocean, benthic feeders, or at the other extremity, in very shallow water where their lungs are an advantage. It must also be the reason why the placoderm vanished.

The same relationship exists between predators and prey. The predator is necessarily weaker than the healthy preys, otherwise it would eat them all and then starve to death.

[xvii] Since nothing is known with much precision, we shall use the names of representative animals. Here for instance Scolopendra to represent any similar looking animal.

Competing hypothesis

During the last two centuries the origin of the gnathostome has been described as an evolution of the chordate, while at the same time emphasis was applied to the rejection of any link between arthropods and vertebrates.
The partial table that we present at the beginning shows that there are many differences between the agnate – the lamprey – and the gnathostome, differences that happen to be at the same time similarities between the gnathostome and the insect.
This is the reason why we feel it necessary to present an alternate hypothesis.

Why should the first theory remain unchallenged?

The current theory was conceived when little information was available, a situation that has changed during the last half century. The anatomical facts such as the chord, the post-anal tail clearly place the fish, the vertebrate in the same group as the myxine.
This early opinion was supported also by the first fossils that showed that the insects appeared hundreds of millions of years after the first fish.

All of this must be considered anew because today the 'fish' have been separated into agnates and gnathostomes. [xviii]
In the present analysis the agnates are left aside, all is centered on the gnathostomes that appeared hundred of millions of years after the agnates. If investigators such as Janvier had insisted earlier – a century earlier – in the need to underline the discontinuity between agnates and gnathostomes, it is possible that the latter would have been perceived right from the start as the son of the insect.

The advances of genetics, physiology, neurology and microbiology must also be taken into consideration. These progresses yield the data that appear in the second half of table 1., they are recent data that all shorten the distance between insect and gnathostome.
Who can be sure that if this information had been available earlier the gnathostomes wouldn't have been entered into another taxon?

The insect can be seen as an annelid with an appendicular system of locomotion, and the chordate as an annelid with a chord. The first one has external support to improve the efficiency of its muscles, the other one, an internal support: the first one is more efficient on solid territory, the other in water.
The gnathostome is but an annelid with both the panoply of chordate and that of insect.

Are we stating that the early theory is false? That it is impossible for the mutations observed in the arthropod to have appeared by convergence in the chordates?
The mutations indicated by the changes within the ranks of arthropods demonstrate a gene natural tendency to alter into these new forms. This suggests that what happened

[xviii] Philippe Janvier (1997) http://www.tolweb.org/Vertebrata

easily to the arthropod genes may have happened with the same facility to the chordate genes.

Hypothesis

It can safely be assumed that genetic mutation does not occur in an absolute random fashion, that some combinations are more susceptible to form than others: at the molecular level, the laws of physics and of chemistry intervene the same way for all.

On the other hand, the selections depend on the surroundings, i.e. on the laws of physics, chemistry and biology.
In each niche the ambient and the acting laws are the same for both groups, the same for the gnathostome's family and for the arthropod's; for this simple reason, many similar traits will appear.

The surfactants are a concrete example of such mechanism.
SPA surfactant can be found in the agnates and the fishes. In the tetrapod a variant is present, SPA-1[xix].

Some author see SPA as the protosurfactant, the second form being nothing more than a mutation that adapts it to aerial breathing.
The scene gets a little more complex when taking into account the fact that SPA-1, the air adapted version is also found in insects.

The chain of events may be the following: SPA comes from some common aquatic ancestor, some annelid maybe. This surfactant goes into the ancestor of the chordate, and also into the ancestor of the insects, by two parallel paths. The surfactant remains in the SPA form in the agnate, but mutates into the SPA-1 form in the aerial insect.
The present hypothesis states that the gnathostome is a chimera of chordate and insect, thus it would have the genes for both forms of the surfactant.
Depending on the surrounding circumstances, the gnathostome will then activate the SPA – in fish – or the SPA-1 – in the other gnathostomes, depending on whether it lives in water or breathes air. It is mutation by selection.

It is also possible though that the gnathostome has received nothing but SPA and that this molecule is mutated to the SPA-1, this mutation being simple, natural. This second interpretation supports both theories equally.
This example allows us to estimate that it is impossible at this point to evaluate the relative value of both hypothesis using nothing but the presence of a single trait common to both gnathostomes and insects.
What dips the balance in our favour is the number of similarities, of homologies.

[xix] http://pubs.acs.org/cgi-bin/abstract.cgi/bichaw/2003/42/i32/abs/bi0347196.html

Furthermore we know precious little about the early hexapods. They may have already possessed many advanced characters when they first mixed their genes with those of the agnates. The cockroach is very ancient, yet it has an adaptative immune system, differentiated wings, it emits sounds with its wings – i.e. it communicates with friends and foes – who knows what the participant of this union brought into the wedding basket?

Is it correct to call this set of evolutions convergences? It seems to be more than a parallel development.
Convergence is possible, but that so many characteristics of the insect appear at the same time into the offspring of the agnate comfort the doubt.

1. **Current explanation of the homologies gnathostome insects.**

Few genes are vital. The ulterior accessories of little importance for the survival of the individual, such as appendages or brain may be present in many distinct forms and may even be absent: the central, the vital, no!

What separates the chordates from the insect is not vital; chimerization would not meet with important obstacles.

Hybrids and chimeras have problems of reproduction, if only because the parents do not have the same number of chromosomes. [xx]
By chance encounters however it is possible that two animals come together with the same number of chromosomes, or numbers whose sum is divisible by 4.
Tissue rejection? Maybe not. Annelids and most insects do not elicit any immunological response by the human organism.
The various authors talk about one homology at a time, the number of common genes for instance, or the adaptability of the immune system, and each one explains his observations suggesting that the coincidence is due to the fact that chordates and insects have some common ancestor.
This is a logical explanation, that doesn't differ from the present hypothesis except about the identity of this ancestor. The number of such common characters makes it highly improbable – we insist on this point – that they appeared practically all at the same time, in the first gnathostomes, unless, as we propose, they came as a single cluster.
It is said for instance that the mandibles appeared first, and the fins much later, however there are no fossils to support this statement, fossils with mandibles but without lateral appendages.

We must also take into consideration the fact that there is no ancestor of the arthropod with the characteristics of the insects, which means that the novelties in relation with the annelids are the fruit of numerous evolutionary steps inside the taxon arthropod. The fact that the genome of the bee is the only one close to that of the gnathostomes helps repel the common explanation.

[xx] Michael A. Goldman Origin híbrida de poliploidia en caracoles de agua dulce, genus Bulinus

The bee is one of the most modern insect, which means that it is the result of all the evolution of the arthropods. It is not possible that all its traits popped out, all finalized, from its distant ancestors, the annelids.
The gregarious behavior, the memory and the abstraction ability have not been seen together in any animal anterior to the insect.
This does not mean that the modern bee is the ancestors of the gnathostomes, but that some primitive 'bee', anterior maybe to the creation of flowers, may very well be our grandmother.

Taxonomy as all of science is in effervescence. All the theories are doubted, their value estimated by probabilities, with also the duration of their acceptation being a very heavy factor: the older the theory, the more accepted! This makes sense, but we must not neglect the risk of ankylosis: this author remembers how the geologists used to laugh aloud when first appeared the theory of the continental drift. Today, it is taught in kindergarten.

2. Chimerization

Is chimerization possible?
The advances of in-vitro biology demonstrate that chimerization is rather easy. It can be argued that it is a form of symbiosis, and for this reason it would be extraordinary that it not be one of the forms of evolution of the animal kingdom.

Progress in genetics shows that, in nature, there are spontaneous cases of chimerization, even in the human. Thus it is not beyond reason to imagine that during the shared millions of years there was a large number of chance encounters between gametes or zygotes of all kinds of animals, in all possible conditions of temperature, pressure, pH, salinity… external factors all known to facilitate biological accidents.

If in the limited time span of a century spontaneous cases of chimerization happened in the human that has no more than 6 milliards (10^9, US,billions) individuals, it is very possible that chimerization took place inside much larger populations, in a time span of tens of millions of years. There is no need for more than one successful chimerization.
It can be argued that in the case of human chimerization both parents are human; but there is a lot of genetic difference between two randomly chosen humans, more than the difference between arthropod and lamprey.
Arthropods and chordates both come from annelids. The annelids are simple genome animals.
We need a few lines of semantics. The word chimera comes from mythology; it names a fantastic animal with characteristics and powers of various animals.
In biology the word has two distinct meanings. The chimera is a species of fish that seems to be made of parts of various animals.
Unfortunately, chimera also means an animal that has tissues from two distinct sources, more a graft than a symbiosis. In this case it is not a new line, but a unique accident.
The work hybrid is used when speaking of the mixture of two animals. It is the case of the mule.

As our hypothesis suggests the potential union of two animals bringing each its own characteristics, we should probably call the gnathostome a hybrid. However the result of this event is more a symbiosis, the grafting of two animals, and the word hybrid does not satisfy us.
The new steps of genetics create every day new chimeras with animal tissues linked to human embryos, chimeras that are killed within a few days. Who knows if these creatures would mature in 'animals' able to reproduce? Are those hybrids? Chimeras?
We shall continue to use the word chimera to describe the product of this hybridization/symbiosis. It is an operational definition.
This taxon is that of the gnathostome, animal group that, with the traits of the two most elaborate animal taxons gave living tissues the ability to develop all the way to man, a fantastic creature.
We just said that some chimeras happen accidentally. There are also some natural hybrids that are able of reproduction. The lonicera is one such instance[xxi][11]. This means that the hybridation suggested in the present hypothesis cannot be ruled out. It is unlikely, not impossible.
At first sight it would seem that the giraffe is unlikely.

Regardless of the exact identity of the ancestors of the chordates and of the arthropods, they were annelids and for this reason probably shared a large proportion of genes and embryological tissues: the precursors of the digestive system, those of the respiratory system, those of the circulatory system and even the hydroskeleton, its muscles and nervous system.
This implies that these ancestral annelids shared practically all their vital functions. The vital organs appeared in the early annelids and were present in all ulterior animals. It is possible however that by chance mutations systems with similar functions came to be, distinct but probably not very different. There is a nucleus, a common pattern. The ancestors of both sides were annelids, identical in this, but distinct already in the ways they move and the way they feed.

Back to the lonicera, both parents do share many identical genes, but we must keep in mind that drosophila and honeybee have a large number of genes similar to those of humans.
On the arthropod/insect side, we choose as the model ancestor the polychaete[xxii] with its parapodia and simple biting mouth pieces – they have chitin mandibles; on the agnate side we choose the earthworm, deprived of lateral appendages and mouth pieces, feeding by suction.
Both come from the same primordial annelid and are differentiated by nothing more than the ways they move, they feed, they breathe and reproduce: accessories relatively secondary.

3. Tetraploidy

[xxi] http://www.nature.com/nature/journal/v436/n7050/full/nature03800.html

[xxii] The philogenetic analyses eliminate the polychaete as ancestor, and rather suggest some mollusk. Until such time that this issue is settled, we'll continue using the polychaete as ancestor of the arthropods.

It is likely that a chimerization, the adding of the genome of an animal to that of another results in a final genome that is much larger than any of the participants.

In fact, the genome of the early gnathostome still with us, show a tetraploidy – nothing is known about the placoderm's.

The discovery of the fish tetraploidy has been seen as an evolutionary process allowing an increase in the number of accidental mutations, without external input. It would be an evolutionary step accelerating the process.
Ulterior studies led to the conclusion that this multiplication was made in two steps, first a diploidy that appears in the agnate, between the myxine (hagfish) and the lamprey, and then a second duplication between lamprey and gnathostomes.
It is true that in laboratories, manipulating the ambient during the first cellular divisions duplications can take place.
It can thus be reasonably concluded that diploidy and tetraploidy are nothing more than the result of such natural accidents.
Nevertheless, this explanation does not justify the large number of homologies between insects and gnathostomes, or the anatomical idiosyncrasies of mammal's anatomy.
For our hypothesis, the tetraploidy is due to the addition of the genome of both participants, the addition of the genome of the agnate to that of the insect. It is not a multiplication, it is an addition.
The progress that justifies its selection comes from the summation of the best of two distinct animal currents.

Despite its alleged evolutionary advantages tetraploidy decreases as new species appear that are further and further away from the first member of that taxon. Tetraploidy is not selected, on the contrary, probably because it takes more material to copy four chromosomes than to copy two, and because this loss does not affect viability.

Since Susumu Ohno, it has been thought that both duplications have the same cause[xxiii].
Our observations do not allow us to guess with certainty what causes the first diploidy, but they lead us to doubt that the second duplication is a simple increase in the genome, that it is but the doubling of the lamprey's genome.
We have not found any deep study of the content of both groups of chromosomes in the fish cells: are the alleles of these chromosomes identical two by two?
According to our hypothesis it is unlikely that they be.

We feel that a deeper analysis of the data is warranted.

Insects

4. **Adaptation to the aerial life: breathing, wings.**

[xxiii] http://www.blackwell-synergy.com/doi/abs/10.1111/j.1095-8312.2004.00329.x?cookieSet=1&journalCode=bij

Let' start with the insect evolution.
It is improbable that the adaptation to the aerial life required more than a single step. The first hexapods that came out of the sea used a branchial apparatus, they had not solved the problem of dryness. It is likely that in a fist step they resided in salt water pools, then in pools of water less and less salt, to finally withstand freshwater. Such stagnant water is poor in oxygen, thus natural selection gave the upper hand to those with the largest branchias.
Later on, these large branchias were moved by muscles, allowing for more gas exchanges with the stale surrounding water.
Branchias and their muscles do not represent any new invention, they are already present in the parapodia of the polychaetes.
Such pools are susceptible of drying up, condemning to death the animals that live in them, unless they find some other way to collect oxygen.
All anterior animals are able to breath directly through their skin. When exposed to air, the insects started to use this atavistic technique[xxiv]. They improved it, with tracheas, and with active abdominal breathing.
Their branchias dried up; their muscles and the wind converted them into wings.
The wings accelerated the conquest of the dry land, even that of isolated islands.

5. Reproduction

Another problem associated with life outside of water is that of reproduction. The gametes and zygotes are not easily protected against dryness.
Some annelids use internal fecundation, the first arthropods don't.
The insects that live on the dry land rediscovered internal fecundation, either by convergence or by genetic inheritance.

6. Progress in catching food

The arthropod great step forwards over the annelid is the segmented lateral appendage. It gives access to a larger amount of food sources, and allows getting to the food before the annelids.

a. Locomotion of the insects: legs

With segmented legs the animal moves faster than the annelid and has the ability to move up and down. Of course, on dry land the leg gives a clear advantage where speed is concerned, and the invention or discovery of wings gives mastery of the third dimension.

b. Alimentation of the insects

[xxiv] http://www.reuters.com/article/oddlyEnoughNews/idUSN1522299020071115?pageNumber=1&sp=true

The mouth pieces are yet another advantage, but they are nothing absolutely new, they are improvements of the mouth pieces already present in some annelids.
The appendages of the head segments of some annelids have already evolved in specialized forms. This is the reason why these segments did not follow those of the thorax and abdomen and did not grow segmented appendages, one pair per segment.
Even though they do not follow the general pattern, the mouth pieces of the arthropods do evolve and improve.
Insects show a very large variety of mouth pieces.

c. Communication

The insects use sound to communicate. For this to happen they need sound generators and hearing. Hearing is a specialization of the perception of vibrations. This perception is already present in simpler animals; it allows the detection of other animals – preys, predators.

d. Memory

Some insects have memory. The bee's memory allows it to remember where it found food.

Memory's birth is the beginning of the conquest of the fourth dimension; it will allow using data from the past together with those of the present.

Furthermore, it seems, in the beehive the bee expresses this information in an abstract form, by its 'dance'. The other workers register this abstract message and decrypt it as they leave the beehive, going straight to the food that has been indicated this way.
Even though this description was worth a Nobel price for its author, it is presently questioned – nothing remains unchallenged.
There is no doubting the insect's memory, on the contrary.
The control of just three pairs of legs, the control of flight and these 'modern intellectual' faculties prove the existence of a sophisticated nervous system.

Description of the gnathostomes.

Body plates

Reconstructions from fossils show animals covered with a partial exoskeleton. They are present in ostracoderms and in placoderms alike. They cover head and thorax. In some instances they also cover the lateral appendages. On their side, insects have a strong exoskeleton over the head and thorax.
As they exist in the ostracoderms the placoderms plates could come either from these agnates, or from the insects.

Cartilage

In bony animals, cartilage is the first draft of the skeleton. We can thus assume that cartilaginous animals are more ancient than bony ones.
There are exceptions however as it appears that the sturgeon, a mostly cartilaginous fish, descends from a bony fish. Ossification fails to manifest itself. The same is probably true for the lung fish and for the coelacanth. Repression/deletion.
We are then in presence of true cartilaginous fishes and false cartilaginous. Both groups are representative of the early fishes, although not to the same extent.

Segmentation of the paired appendages

The paired appendages of the elasmobranches are segmented. As we move from primitive to modern fishes, the number of segment decreases. There is either elision or repression. The ulterior segmentation of the limbs of the tetrapods suggests repression/expression.

It is remarkable that the more primitive the fish, the larger the number of segments in its fins. This supports the concept that the early fin was a swimming leg, such as that of some insects. Mutations and selections insured that the number of segments decreases to its limit, zero.

Localization of the paired appendages

The paired appendages of all primitive fishes are in a ventral position. With the exception of the elasmobranches, these fishes are considered to be high energy fishes, as they live mostly in streams. This could be either an adaptation to shallow environment, or to an aquatic medium full of obstacle.
It could also not be an adaptation but rather a trait inherited from some ancestor.
This trait wouldn't have been eliminated by the freshwater fishes as ventral fins come handy in high energy shallow water and in a mostly horizontal world, filled with all kinds of vertical obstacles, grasses and the like.
Osteostraci apparently have paired pectoral appendages, but there are serious reasons to doubt that they are true appendages and related in any way to the gnathostomes'.
It is usually considered now that paired appendages all have the same origin, whether they be fins or limbs. They would come from a common ancestor. Of course, we totally agree with this opinion, where we differ is by saying that this common ancestor is the insect, whereas the other biologists reject this concept and do not give any name.

Tail shape

The post-anal tail is a characteristic of the chordates. In the early gnathostomes as in the ostracoderms, it is either tubular or heterocercal. Heterocercal is an indication that the animal was roaming or swimming in shallow water.

Extremities and rostrum:

The insects present a large variety of extremities of their legs. The number of segments of these legs is not even universal.
Does this mean that each has a genome for various types of legs? It is more likely that the early insect had polyvalent genes that could readily mutate to produce one or the other type of extremity. For our hypothesis, these polyvalent genes, these early programs are found also in the gnathostomes, something similar to the HOX and to the many genes already confirmed.
Using these very insect genes, the first gnathostomes were rapidly able to express fins or legs, selecting them to match the depth of the water where they lived, evolving into fish or amphibians.

The differentiation between these two groups of vertebrates – aquatic and terrestrial – would have appeared earlier than the differentiation of the fishes in species ever better adapted to open sea, before the migration of the lateral posterior fins to an anterior and inferior position.
It used to be thought that the neural crest of the agnates was the origin of rostrum and mandible: this has been dropped [xxv] ,[xxvi] [11]. The embryological migration of the ventral elements of the neural crest of the agnates is inhibited in the gnathostome, and for this reason does not participate in the formation of the rostrum.
It can be thought that the remains of the buccal set of the insects are to be found in the rostrum of the gnathostome. [xxvii], [12]
In most vertebrates the bones of the rostrum are fused together. The corresponding muscles got converted into cutaneous muscles, muscles mostly of expression in the human.
The nervous centers of these skin muscles contract them and give them tone as if dealing with isometric contractions, since their corresponding bones cannot be moved any longer.

The fact that there are two pairs – we state that in fact there are three pairs – of lateral appendages in the gnathostome shows that there is indeed an important genetic contribution from an animal already quite distant from the polychaetes, an animal deprived of abdominal 'parapodia'.
Part of our hypothesis makes us see in these anterior and posterior limbs – arms and legs in human – yet another homology with the insect, the modern manifestation of the thoracic legs of the insect.

[xxv] http://www.ncbi.nlm.nih.gov/pubmed/11604127?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pub

[xxvi] http://www.ncbi.nlm.nih.gov/pubmed/16351951?ordinalpos=19&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum

[xxvii] http://dev.biologists.org/cgi/content/full/128/18/3521#SEC4FirefoxHTML\Shell\Open\Command

http://www.ncbi.nlm.nih.gov/pubmed/16351951?ordinalpos=19&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum

Several theories have been offered to explain how the mandible was formed from the pharyngeal slits. None is convincing enough to eliminate the competition.

Furthermore, recent studies about the migration of the neural crest cells in the embryo do not match any of these theories. We shall have to wait for the result of the research that the present theory should provoke, to know if the bones and muscles of the face and mandible come from something else than the neural crest of the agnate.

Advantages of mandibles and teeth:

- As they close the oral cavity, the mandibles encircle all that was close enough. This volume is much larger that the opening of the esophagus.
- Catching a prey with its mandibles, and throwing it in the air as needed, the animal can align it with the esophagus, and bring it closer to it.
- Punching with its teeth the flesh of animals too large for a single bite, shaking its head violently, the animal can tear off pieces. This is how sharks and carnivorous mammals share their preys. They don't use incisors to cut.

Pharynx, tongue and trapeze

In the chapter 'anatomy' we must include the coming to be of the pharynx, of the trapeze and of the tongue, complex structures all. They also all appeared at the same time, yet another coincidence hard to explain with the current theory of convergences.
If on the contrary we follow the reasoning of the present hypothesis, we realize that aside from the muscular and skeletal elements that link the posterior and middle thoracic legs of the insect, there are others between the middle and anterior legs, others still between thorax and head – what could be the neck of the gnathostome that have one – plus tissues between the skull and the various mouth pieces, a vast list of rigid structures and of muscles present in the insect, whose genes could easily generate the anatomical parts used in new functions, such as pharynx, tongue…
The advances of genetics and pharmacology should identify the exact links using genetic alterations and drugs acting on specific anatomic sets, in the insect and in the gnathostome.

We work exclusively from the results published by the various research centers, thus we are limited as many publications charge a fee for access. Some titles that look very appetizing in the internet remain outside our grip.
Life was easier when we had physical access to Yale's library.

1. Three pairs of lateral appendages?

The inhibitory effect of thalidomide takes place when administered on the days 24, 25 and 26 of human pregnancy.
The effect is synchronous with the forming of the ear, arm and leg buttons, respectively in that order. This led us to think that the middle ear might be a third, atrophied limb.

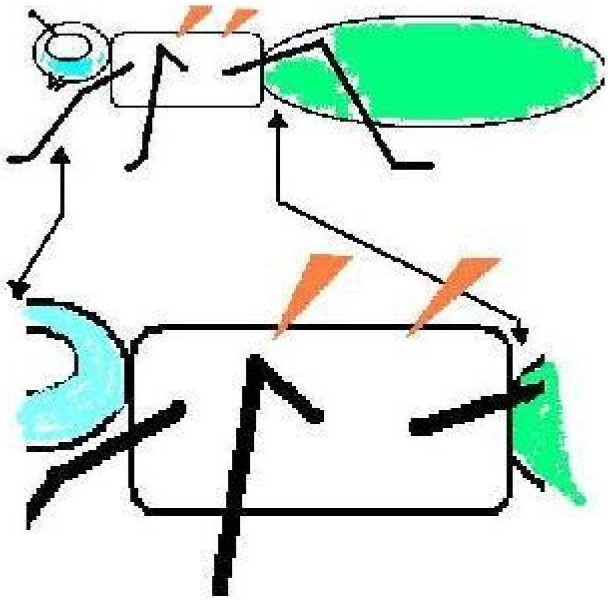

Fig 1. The description of the changes resulting in the idiosyncrasies observed in mammals and especially in human, we will use the lower part of this drawing. It shows practically nothing more than the thorax of the insect.

The anatomy of the chain of ossicles supports this hypothesis: the malleus would be the equivalent of the head of the humerus or the neck of the femur; the incus would be the equivalent of the humerus or the femur; the stape equivalent to the radio-ulnar, or tibia-fibula, ended with the tarsus or the carp.[10] . In fact, mechanically this chain of ossicles behaves as the four limbs

The bone that is closer to the 'belt' moves little (vibrations of the tympanum), its motion is amplified 20 times when it reaches the oval window.

At first sight there is little of that in the fish, even though it is known that they too communicate by sounds – yet another 'first' in chordates!

In the head of the fish the Meckel's cartilage is to be found, a cartilage that will diversify later into malleus and incus. Furthermore there is another solid structure, the spiracle.

For its embryological origin it has been concluded that this spiracle is due to the same gene that will create the stape in the animals with the entire chain of ossicles.

Thus, it can be assumed that this spiracle is, in the fish, the only remaining element of some unused anterior appendage. It may be similar to the bone in the whale abdomen that is the last trace of the rear legs of its terrestrial ancestors. It would be yet another example of the mechanisms of expression/repression. Hearing, in water, does not necessitate amplification.

Using the postulate 5 that states that the functions remain faithful to the structures that first presented them, the fact that this 'member' is linked to hearing, to the tympanum, anatomically and functionally lead us to see in it a homologue of the anterior thoracic limb of the insect.

The postulate of repression/expression gives a strong reason why this chain of ossicles has 'chosen' to copy the anatomy of the limbs when the same effect of amplification could have been achieved by simpler constructions.

The possibility that the ossicular chain is a reconstitution of the anterior thoracic limb of the insect is further supported by the presence of a coronal belt parallel to the scapular and pelvic belts.
This belt is formed in the midline by the hyoid and on both sides by the stylo-hyoid muscles and ligaments, originating on the styloid processes of the temporal bone. As the other two belts, this auricular belt is linked to the axial skeleton. [xxviii]
The final link of this belt with the axial skeleton is done by the trapeze, which 'coincidentally' makes its first appearance in the animal kingdom at this very evolutionary instance.
This complex program described here as insect inherited is partially repressed in the early gnathostomes, but is progressively re-expressed as hearing becomes more complex.

1. Abdomen in the thoracic cavity

To understand the abdominal wall, it is necessary to look first into that of an ancient ancestor, the exterior muscular wall of the annelid.
The displacement of the annelid is achieved by successive contractions of two muscular groups: circular muscles separated by grooves, and longitudinal muscles. The circular muscles form bands that are brought closer together by the contraction of the longitudinal muscles. When they contract, the circular muscles increase the pressure inside the hydro-skeleton, and this elongates the longitudinal fibers. The cycle is ready to start again.
The circular bands support the parapodia of the polychaetes, and in the next evolutionary step, they support the abdominal and thoracic limbs of the arthropods.

In the insect some new gene has replaced or repressed the 'limb' potential of the abdominal segments and there are no more than at most three pairs of thoracic limbs. Nevertheless, the longitudinal muscles stay unchanged where their insertions are concerned.
The circular and longitudinal muscles are the motors of the insects' active abdominal breathing. Chitin renders the thoracic muscles inactive or inefficient, except during molding. They are inefficient but they are present, at least in the genes.
There are three thoracic segments, thus there is a muscle between the cephalic part of the abdomen and the circle of the metathorax, another muscle between the metathorax and the mesothorax, and yet another one between the mesothorax and the prothorax, limiting the list to the muscles of this area.

[xxviii] in fact is some birds the beak is used to take a 'foothold' – a beakhold should we say – and the neck pulls the body forwards. The trapeze is then the link between the auricular and the clavicular belts.the same beakhold is used to swing from branch to branch.

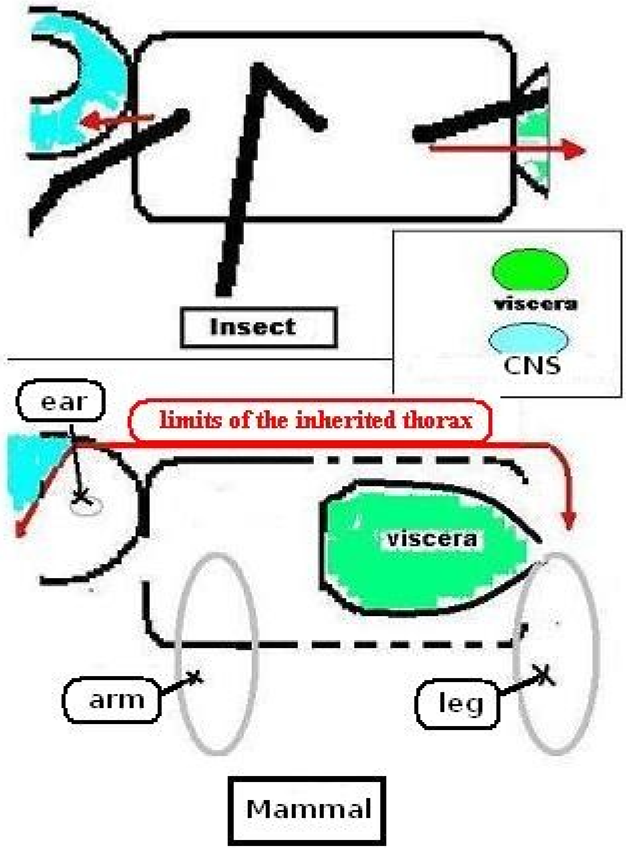

Fig.2 - The thorax has grown proportionnaly much more than the digestive abdomen: it encloses it entirely. The prothorax leg has moved forwards to underneath the cranium, and the mesothorax leg together with its pelvic belt is at the level of the anus.

The present hypothesis describes the appendicular belts and the locomotor appendages as the present form of the thoracic limbs of the insects.

This means that the modern form of the inherited thorax is the space between the inferior mandible, the cranium, the entire back all the way to the posterior limb, the pelvic floor. In front the thorax is limited by the abdominal wall, the ribs and the skin of the neck. The abdomen derived from the insects' is enclosed inside this 'thorax', limited anteriorly by the diaphragm, dorsally by the internal wall of the abdominal cavity, posteriorly by the anus and perinea, ventrally by the muscles of the abdominal wall.

2. **Particularity of the abdominal wall of the gnathostomes, especially in the mammal.**

The abdominal wall of these animals has three muscular layers. All three have the same role, and there is no functional reason that there be more than one layer except in obesity and mammals pregnancy.
The general belief, in as much as anyone has ever wondered, is that we are in nothing more than another pointless variation.

On the other hand if we think in terms of chimera and if we imagine that all voluntary muscles, except those of the vertebral column, are inherited from the insect, the abdominal wall makes sense. It would take additional genes to decrease the number of its layers.

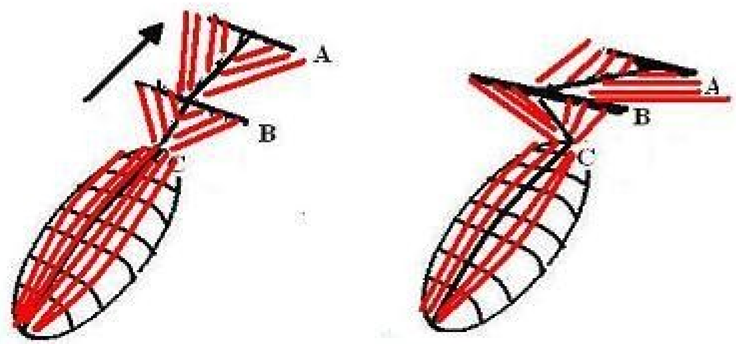

Fig.3 - In the insect, A is the mesothoracic belt, B is the metathoracic belt, and C the anterior belt of the abdomen. As the belts A and B are larger, the muscle fibers take an oblique orientation.

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According to our hypothesis the abdomen inherited from the insect is located now caudal to the ribs in the inherited thoracic cavity which goes from the auricular belt to the pelvic floor.
Its anterior wall is made of the three muscle layers yielded by the apparent invagination of the abdomen into the thorax. This ‘incorporation’ folds the tissues linking the thorax and the abdomen in the insect. The orientation of the muscle fibers of these layers supports the notion that this is an encapsulation

This does not mean that there is first the formation of an abdomen exterior to the thorax that would then invaginate as does the intestine of the physiological hernia of the embryo, but rather that the thorax forms itself around the abdomen. The muscle fibers of the three abdominal layers appear progressively as they would in the insect, formation lead by the original insertions:

- a first plane remains unchanged, made of the exterior fibers of the very abdomen between its two openings – in man, diaphragm and anus – ,
- a second plane made of the fibers between the anterior part of the abdomen and the pelvic belt, and at the same time
- a third plane between the pelvic and the scapular belts

in the same way that, in the insect, there is a musculo-cutaneous continuum between abdomen, posterior thoracic legs and middle thoracic legs.

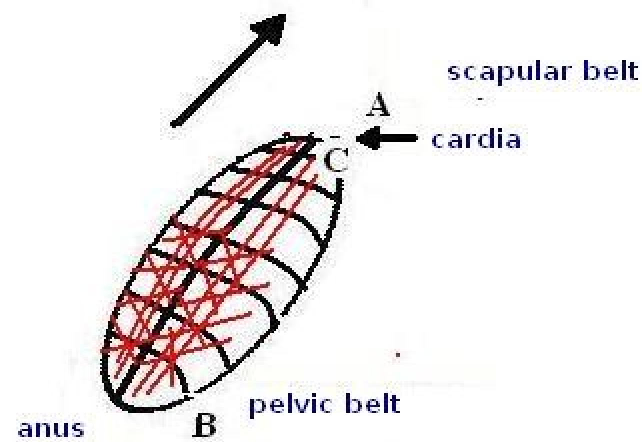

Fig.4 - The final result is that the anterior abdominal wall is made of three muscular layers. The orientation of the muscle fibers would be identical to that present in the human.

The relationship between the various muscle insertions remain identical in the gnathostome as the ones they have in the insect. The result is an encapsulation that looks like invagination.

The chimera hypothesis justifies this second apparent idiosyncrasy.

The mammals abdominal breathing is active, a negative pressure in the lungs results from the contraction of the diaphragm, of some intercostals muscles and muscles of the neck. This is inspiration. Expiration pushes the gases to the outside. It is caused by the contraction of the abdominal wall, and the other intercostals.

This antagonist set is the new function of the ambulatory muscles of the hydroskeleton of the annelid. The diaphragm is the equivalent of the circular muscles, and the abdominals the new version of the longitudinal muscles.
It can be assumed that the mammal abdominal breathing is a new expression of the insect abdominal breathing mechanism, a program hidden but not erased as the gnathostome adapted to aquatic life.

Physiology

1. **Abdominal breathing**

The insect's genome contains three breathing programs; a passive one: the cutaneous, the program of the branchias which is half active when the branchias are moved, and a completely active program, a program that makes it possible to increase the oxygen supply. More oxygen is necessary to animals that live outside water and cannot rely on

buoyancy, necessary also to satisfy the requirements of a nervous system that improves the animal's living conditions, but at a great cost in energy.
The first insect came out of salt water, out of the sea and went on to live first, probably, in a niche as similar to its previous biotope as possible, a liquid medium. We spoke already of the branchias and their ulterior changes into wings.
In the aerial insect an important part of breathing is active, the gases are moved by contractions of the abdominal muscles.
In the agnates breathing is slightly active, the water that contains food and oxygen moves through the mouth and pharyngeal slits.
In some sharks, almost passive breathing, depending to a large extent on the motions of the animal. In more advanced fishes, breathing is active using the muscles of the gills. Some fish also swallow air from the surface and push it into the swimming bladder or in a lung, active variations, but not abdominal.
Given that there is no abdominal breathing in the fish or in the amphibians[xxix],, and given our assumption that the insects' genome is present in the gnathostomes, we can think that the program for abdominal breathing is occulted.
In the frog however, even though we cannot really call it an abdominal breathing, breathing is active and muscles of the abdominal wall participate.
In the reptile there is a diaphragm and clear abdominal breathing starts.
In the birds there is no diaphragm.
With the mammals abdominal breathing establishes itself as the dominant system of gas exchanges between blood and air.
Is this abdominal breathing really a new expression of the participation of the abdomen in breathing first introduced by the insects? Or is it nothing more that another analogy or convergence?

2. Reproduction

The internal reproduction of the placoderms and of many cartiloginous fishes indicates that this procedure is not necessarily a new acquisition that first appears with the reptiles. Given that the fishes live in water as did their ancestors the agnates which do not use this reproduction technique, either the gnathostomes invented internal reproduction, or they inherited it – which does imply that they would have an additional family line.
Why would the first fish invent internal fecundation, when, it is assumed, its ancestors were absolutely marine.
In fact it is more than simple internal fecundation, some sharks are viviparous.
A recent discovery in Autralia proves that gnathostomes viviparity started early in their existence. The Victoria Museum reports that a placoderm was discovered with an embryo in-situ, still attached to the uterus of its mother by an umbilical cord[xxx],[xxxi].

[xxix] In the frog it can be considered as almost abdominal, but in two steps of inspiration and two of expiration..
[xxx] http://www.ivyhall.district96.k12.il.us/4th/kkhp/1insects/buginfo.html

[xxxi] http://www.ivyhall.district96.k12.il.us/4th/kkhp/1insects/buginfo.htmlhttp://news.yahoo.com/nphotos/animal-kingdom-umbilical-cord-live-birth/photo//080528/photos_sc_afp/9ad265044db697246cb09ff19b4aa9d0//s:/afp/20080528/sc_afp/sciencebiologypaleontologysexfish;

"The discovery is certainly one of the most extraordinary fossil finds ever made. It is not only the first time ever that a fossil embryo has been found with an umbilical cord, but it is also the oldest known example of any creature giving birth to live young," said Dr John Long, Head, Sciences, Museum Victoria.'

We don't share this enthusiasm because there were already insects whose eggs hatch internally, and whose offsprings remain for a time inside the abdomen of their mother, alive[xxxii].

The fact that some placoderms already are viviparous is an additional argument supporting our idea, in that, in its reproduction at least, the ancestor of the gnathostome was aerial: an insect?

For our hypothesis such a reproductive process stems from the ancestors, the mechanism is inherited.

These legacies, internal reproduction and still more, viviparity are physiologically costly, but justified in air living animals, indispensable to protect eggs, gametes and offsprings from the elements: dryness, cold and heat.

Given that internal reproduction does not yield any advantage in an aquatic medium, that, on the contrary it is costly for the parent, the gnathostomes inhibit it in their next evolutionary step, the bony fishes. The corresponding genes are occulted by additional genes and the external reproduction of some arthropods returns to expression, a technique inherited from the annelids.

This inhibition of the internal fecundation remains until the establishment in a biotope totally aerial gives it again its efficiency, until the arrival of the reptilians.

This timetable is another indication that the tetrapods derived from the bony fishes – after the return to external fecundation – and not from the cartilaginous. However the mating embrace of the frog points to a vague reminiscence of an aerial past.

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[xxxii] http://www.ivyhall.district96.k12.il.us/4th/kkhp/1insects/buginfo.html

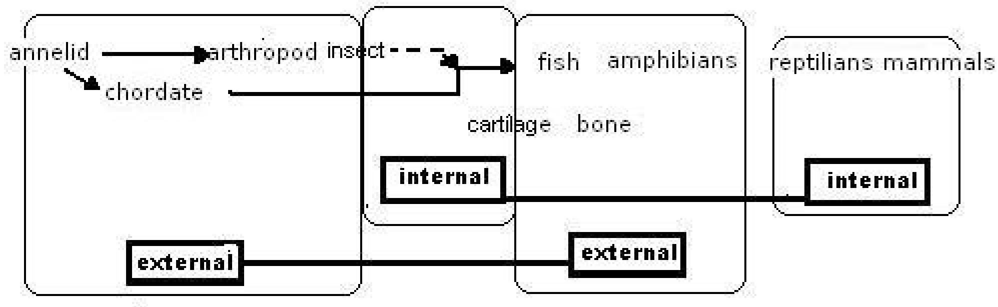

Fig.5 - Expression of the internal reproduction genes.
Most insects live outside water. In such environment, internal fecundation and internal gestation improve the yield of reproduction. As their descendants settle in an aquatic world, external reproduction is again more productive, until other mutants move to the open air. Internal means become the norm again, even in cetaceous.

Nervous system

1. Laryngeal nerves

The muscles of the larynx are innervated by two nerves.
According to the hypothesis of the chimera, the location of the cartilages of the larynx identifies them as insect legacies.
Where do they come from?
These muscles are at about the level of the auricular belt that we described, i.e. they are inside the inherited insect thorax. This makes us suspect that they have their evolutionary roots in the insect thorax.
The insect thorax has two groups of appendages: legs and wings. As the destination of the legs has already been attributed, the only remaining origin are the wings..
In the insects with wings, the wings are carried by the two posterior thoracic segments.
The wings consist of rigid elements and muscles.

There insect thorax is composed of three segments. In the insects that emit sound, the instrument is commonly the wing of the mesothorax.
It is possible that the laryngeal apparatus – cartilage, muscles and nerves – come from two segments of the insect thorax, and in particular from the middle one that is active in the sound production.
When the nervous system of the insect is united with that of the agnate, all the ganglia move to the central nervous system of the chordate; originally they are ventral.

They move cephalically and dorsally. They remain outside of the telencephalon.
In fact, given the size of all these animals, the displacement is very short.
At the same time, the cartilage and muscles move towards the oral cavity.

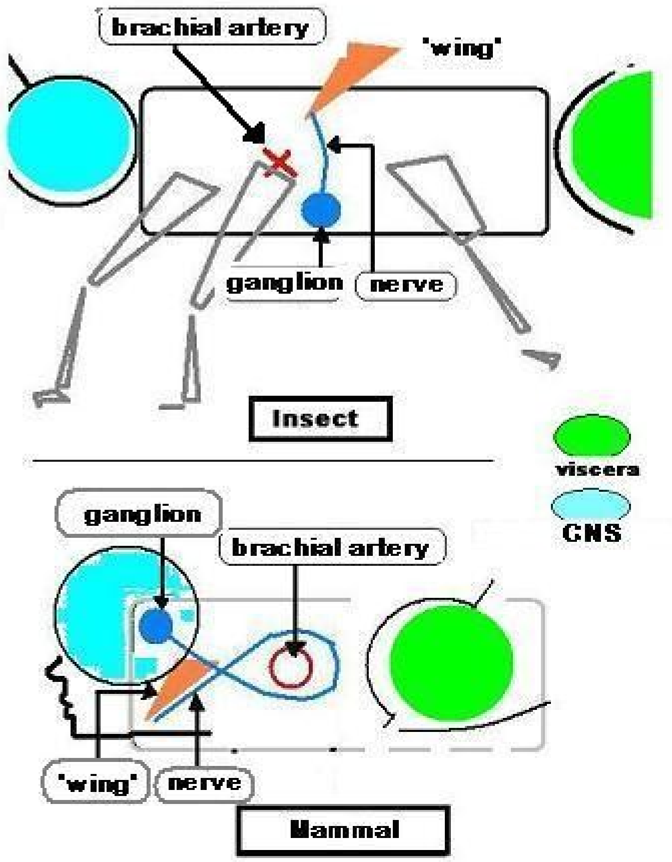

Fig.6 - In insects, the wing ganglion is ventral. To reach the position that we describe, the ganglion moves towards the CNS. The wing settles on the airways. The presence of the aorta on one side, of the brachial artery on the other forces the 'wing' nerve to stretch, creating a loop around the vessels.

The result of the cephalic displacement of the ganglia and of the motor structure is a stretching of the corresponding nerve. As the brachial artery happens on the combined trajectories, the nerve makes a loop around the artery, in the thorax
The organism doesn't behave as an electrician who disconnects and reconnects the wires at will; the link between muscles and their nervous center cannot be interrupted.
This, for the hypothesis of the chimera, is the reason for the idiosyncrasy of the trajectory of the recurrent laryngeal nerve.

Of course, the presence of the mammals' aortic arch makes the trajectories of left and right recurrent laryngeal nerves somewhat different.
The ganglia and wings of the other thoracic segment do not encounter any similar obstacle in their course and for this reason they present short and straight trajectories.
The production of sound by wings is relatively common in the insects: cricket, cockroach, praying mantis…. mosquito even.

In the gnathostomes that breathe by tracheas and lungs, vocalization is achieved by contraction of the muscles of the larynx, muscles innervated by the recurrent laryngeal. This indicates that here also, as in the ear, we observe a functional homology between the wing and its rigid parts and the appendages that derived from it in the gnathostome. Despite their lack of airways, fishes use various techniques to create the sound they use in their acoustic communications. This indicates the presence of an acoustic 'drive', something in their central nervous system is 'looking' for a signal to hear, and a way to emit some.

Why this migration of the wings towards the airways?
Maybe to add the traits of the insect branchias to those of the lamprey.

During the entire evolutionary sequence, branchias, wings and sound generator would be linked as suggested by postulate 5. Each of the superior parapodia expresses one or the other trait depending on the local requirements.
Did vocalization start before chimerization? It is well established that insects use acoustic communication.
The fact that manifestations of the superior parapodes appear in the vocal cords of the mammals as in the insect wings proves that the homologies between insects and gnathostomes are due to a chimerization? Not necessarily, it could be convergence or parallelism, by natural evolution of the same genes present in two distinct classes of animals.

2. Cerebellum

The insect's central nervous system is necessarily complex; it directs and coordinates with precision the motions of several mouthpieces and of the many thoracic appendages. As it is a complete animal its nervous system must integrate, mostly on-the-fly, optical, auditory, gustative, olfactive and tactile data of all kinds. In the honeybee at least, it must also drive the function of auditory communication, contain the memory circuits, code and decode the messages of its dance.

In the agnate, the locomotor musculature is directed by the telencephalon. In the fish, most of the new musculature is controlled by the cerebellum. In man, this control is shared.
The fish cerebellum is clearly larger than the telencephalon; however in most fishes the musculature most used in swimming is the same as that of the agnate, i.e. the muscles of the spine. Comparatively, the muscles of the lateral fins, those of the mouth and of the pharynx are small.
This proportion appears reversed in the placoderms and in the chimeras that look like them: these animals use their lateral appendages at least as much as their tails, heterocercal tails practically deprived of the midline fins that would amplify their action.

The common explanation is that the extra development of the cerebellum is necessary to control the swimming motions that are much more complex in the gnathostome than in the agnate. [xxxiii]
We do not feel that swimming justifies the creation of such an accessory brain. The agnates swim practically with the same efficiency as the first fishes, and the hagfish, still more primitive manages to make nodes with its body, a gymnastic probably as complex as the swimming of the fish.
Furthermore, we can wonder why and how these new nervous controls came to be. It would have been simpler, probably, to add these controls to those already in place. In last analysis, doesn't the modern telencephalon control all the muscles?
Which suggests that the centralization of all motor control into the telencephalon is a later development, creating a redundancy that is behind our superiority over the other species as we have the reflex response of the primitive animal – agnate and insect – as well as the willed response – late or anticipated – the conscious one.

If we take into account the degree of sophistication of the limbs and mouth, as well as other functions still to be encountered, it is hard to imagine that the cerebellum, in its complexity was created by simple gene duplication. It is very strange that right from its origin it be so important in size and function.
Given that the cerebellum comes to be precisely at the same time as the mandibles the pharynx and the lateral appendages, it is probable that it be part of the same legacy that we present.

At the time the gnathostome first appeared the only animal with such a developed neuro-muscular system present on earth is the insect.

In some university lectures they teach that the vertebrates' remarkable traits: complex sensorial system, complex brain, high level of mobility, complex behavior, these are the characters that distinguish the vertebrates, as a group, from the rest of the animal kingdom. [xxxiv]

We totally agree with the list, but it applies to the insects as much as it does the vertebrates. What separates the vertebrates from the other animal groups is the simultaneous presence in them of two systems of locomotion, each with its complete central nervous system. All the elements come from either or both origins. There is no doubt that the nervous system of the insect is more complex than that of the tunicate, the hagfish or the lamprey.

In all gnathostomes the cerebellum is one of the centers of control of the muscles. In man it has been shown that the fast decisions are taken by the cerebellum; furthermore the cerebellum is the manager of precise automatisms. The cerebellum is programmable and,

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[xxxiii] Peces tienen la tendencia a tener cerebelos largos por tener sus mundos tres dimensiones y por la necesidad de preocuparse por las corrientes y cosas parecidas; tetrápodos con patas en columna también tienen cerebelos largos por la más alta probabilidad de perder el balance.

[xxxiv] http://www.csupomona.edu/~dfhoyt/classes/zoo138/PRIM_FISH.HTML

contrary to what used to be taught, its action is not limited to the control of balance. New functions are added to its domain everyday; its malfunction is involved in various forms of dyslexia and autism.
In fact, since it is the part of the nervous system that reacts first to the stimuli, the cerebellum can be seen as the main controller of the striated muscles.
It has been shown that in professional sport competitors the proper response is launched when the cortex has not yet been informed of the challenging stimulus.
Our hypothesis suggests that the lateral appendages and all the new musculature found in the gnathostome stems from the insect genome; as always, nerves, bones and muscles do not appear independently but rather together.
The genes of the nervous system corresponding to the lateral appendages, to the mouth and to the tongue accompanied those of these motor sets. This is how a second nervous system came to be, beside the agnate's telencephalon, rather independent from it, a brain dedicated to gestures.

Describing the functioning of the human mind in 1965 [12], we concluded that necessarily there had to be two 'computers', almost in parallel, receiving the external stimuli, a slow one and a fast one. Until 2004 when we started our study of the fish, our concept was that these parallel operations were due to some partitioning of the telencephalon, something functionally similar to what is commonly done with the computer's hard disk.
Our concept has no relation with Paul McLean work, study that we had met when it first came out in the early 60's. Extending his 1952 description of the limbic system, Paul McLean published the notion of the 'triune' brain, composed of a human plane, a horse plane and a crocodile plane – today they say human, mammal and reptile – description of the brain where social and psychological behaviors are concerned. This description links psychology, brain anatomy and evolution of the gnathostomes.
The growth of our hypothesis about the origin of the fish leads to the concrete confirmation that there are indeed two simultaneous analyses of the external stimuli. It confirms that two computers operate, but they are not partitions of the same telencephalon, they are really two distinct, separate computers, anatomically distinct, with individual evolutionary origins.
The telencephalon is from the agnate, the cerebellum from the insect.
This description is not in conflict with McLean's. We hope science will reach a better understanding of the human complexity by combining both analyses.[xxxv] [13]

This section has considerably reinforced our hypothesis. The gnathostome has many traits that can hardly have been acquired without a direct enrichment of its genome by massive incorporation of insect genes.
We already established that chimerization is possible and for this reason may have been used as an extra mechanism of mutation in the course of animal evolution.

We have yet to determine is this specific chimerization may have taken place.

[xxxv] Leclercq Man, Worm and Ant.

Conditions of time and location

For chimerization to take place it is necessary that the end-result of the union and both pools of genes be

a. at the same place,
b. at the same time.

We must establish where and when the first gnathostomes appeared. We must also determine what are its antecedents, to finally estimate if both lived in this type of biotope when chimerization first occurred.

1. An agnate and some other animal would be the origin of the gnathostomes

What other animal? An annelid, an arthropod or an insect? So far we have chosen the insect, rather arbitrarily.
The features of the gnathostome are more numerous than what an annelid could provide, this eliminates the annelid as direct ancestor.

It could be an arthropod, a crustaceous. It would be easy to believe it as the crustaceous appeared much earlier than the insects.
The first gnathostomes could be chimeras of lamprey and crustaceous for instance. Then, with time, mutation by mutation the changes that took place in the arthropods leading finally to the insects could have occurred in these chimeras, transforming them into the gnathostomes with insect characteristics.

But this opinion is overly complex. Furthermore it does not match the three layers of the abdominal wall, the strange trajectory of the recurrent laryngeal nerve, that we assume comes from wings. These traits can hardly come from an animal simpler than a hexapod, and more specifically simpler than an insect. [14]
This process of elimination leaves us a single candidate:

Our choosing the insect as co-ancestor appears justified.

Before we get to know how they were really we shall have to wait until biotechnology succeeds in reconstructing out of pieces of DNA, the species that disappeared

As for the other parent, we say agnate, but it has to be something already advanced such as the lamprey which has vertebras and skull, an agnate with diploidia-

2. Where did the first gnathostome appear?

Which was the habitat of the first gnathostomes?

The placoderms are probably the first gnathostomes that correspond to the present hypothesis, descendants of agnates and insects.

The Bothriolepis is the placoderm that presents the largest number of traits clearly associated with our hypothesis.
Characteristics of the Bothriolepis:

- Internal reproduction
- Ability to breathe air
- Locomotion: it appears it used its lateral appendages to progress on the ground and maybe to dig as the sea turtles.

In other words, **the first gnathostome was an animal adapted to a semi-aquatic life**.

Did it appear in the sea or in freshwater?
It is assumed that this clad was sea dwelling before moving into rivers and other freshwater habitats.
It seems in particular that the acanthodians were first exclusively marine and only later moved into rivers where most of them are to be found near the end of their existence.
The acanthodians present us with many questions. They are far to being resolved. They seem to be part cartilaginous, part bony. Many show two pairs of lateral appendages, but in some instances there may be more between pelvic and pectoral fins. The Mesacanthus is thought to have another pair posterior to the pelvic, but is it a pair or is it a single midline fin?
Clearly there are gaps about the acanthodians real habitat, their mode of reproduction, and maybe about the date of their first coming to be. Its general characteristics lead us to see it more as an intermediary between the other early placoderms, than as the first of the kind. Until these uncertainties are lifted we shall not give much weight to the opinions about the first acanthodians.

We just established that the early gnathostome probably came from a semi-aquatic environment.

This is in line with its other trait: anadromy.

The anadromous fish lives in the sea and looks for freshwater to lay and fecundate its eggs.

We use a simplified theory of evolution, pretending that the various types of fish are a linear suite of mutants. It is an approximation, patterns pop out of its schematization that are otherwise blurred by too many details.

- The placoderms
- The elasmobranches – sharks, rays…
- The bony fishes

- – sturgeon
- Salmonids – salmons, trouts
- All other fishes – they are more modern.

Of those, only some placoderms, the sturgeons, the salmonids are anadromous.

The anadromy of the placoderm can be questioned as it appears that the placoderms used internal fertilization. What would be the reason to look for a special place to lay eggs for an animal that doesn't lay any? The fact that some similar placoderm fossils were found in marine sediments and river sediments does not necessarily mean that this animal lived in both media.
For millions of years presumably salmons have died where they laid eggs, i.e. upstream, near springs, yet there are no salmon cemeteries near those springs. The reason is that the current carries those skeletons downstream where they end up, all the way to the seashore as alluvions are what makes land gain on the sea near the estuaries and deltas.

Incidentally, the fact that the oldest bony fishes are found on sea shores could be proof that they were river fishes and not marine.
Thus we are not going to accept or reject that gnathostome anadromy started early, in the time of the placoderms.

It seems to appear first with the sturgeons and disappears quite rapidly after the salmonids
The anadromous fishes swim upstream which means that they fight two forces, the force of gravity, and a diminishing concentration of food. This doesn't make sense. Either there is a strong genetic instinct, or there is some positive tropism that they respond to.
Migration instincts exist in many species that are even more primitive than the fishes, some butterflies for instance.

The salmonids look for a special type of water environment. They need a rocky bottom, fast water and spring water either pure or mixed. Rocky bottom and fast water create rilles where water is fully oxygenated.
It could be that the salmonids respond to an oxygen tropism.
It is said also, but not strongly establishes that salmons aim for the very river where they were conceived. That could mean some mineral tropism as each spring has a very specific mineral content.
This point can be overlooked as salmons raised artificially show anadromy. They swim upstream and aim for springs, any spring of course. Thus the hypothesis of a positive taste tropism can be neglected.
The probable absence of such taste factor makes it easier to understand why there are salmons in different rivers, in different continents.
Even in the absence of this taste factor, the fact remains that the salmonids expulse their eggs and milt in spring water, i.e. practically sterile water.

What about the sturgeon? Its reproduction is not as clearly established as that of the salmonids. It is known however that it too needs rocky bottom, shallow water, quick water.

Due to their size they can't swim upstream to the springs, thus they are not overly sensitive to the purity of the water. Where man's 'improvement' of the water flow has eliminated this kind of biotope, sturgeons have disappeared. Conservationists are trying to reestablish the proper environment, with some success.
Thus, for the sturgeon as for the salmonid, better oxygenation is a must. Presence of spring water, we don't know, but probably not.

It is now time to remember the general theory: fishes first appeared in the sea.

Why would sea creatures bother to spawn in spring water, adjusting to freshwater, fighting the current, going where there is less and less food?
If this were an improvement, wouldn't the modern fishes all do the same?
Thus it appears that, whether this migration is directed by the strength of the stream or by an improvement in oxygenation, or purification, the fishes follow an instinctive program.

Instinctive programs are genetic. The offspring gets it from its parents together with the other genes.
What about the first offspring? The first anadromous fish, which did it get it from?
From the ancestor of which it is a mutant.

Did it get it from any of the more primitive gnathostomes? Not clearly since they are not anadromous.
And why would they be anadromous since so many of them are practicing the internal fecundation?
It is true that there are some sharks that look for well oxygenated marine streams for their mating – this could be a kind of atavistic behavior, looking for better oxygenation, a reminder of the same instinctive drive, but this hardly fits the description of anadromy as everything takes place in sea water.
We almost dismissed the placoderm as an anadromous animal. But if it were, where and from what ancestor would the first placoderm have gotten this instinct?
Thus, whether we conclude that the placoderm was anadromous or not, anadromy in later fishes must exist as instinct in all gnathostomes anterior to the salmonids. It is an instinct that is not expressed in the early gnathostomes as they are using internal fecundation. These animals do not express that gene, but they carry it.

According to our hypothesis, the gnathostomes have two ancestral lines, the chordates and the insects.
The anadromous instinct must have come either from the insect, or from the agnates.
It so happens that the sea lamprey is anadromous.

This is where that gene has come from.

This discussion doesn't prove chimerization, but it proves that the opinion that gnathostomatous fishes first appeared in the sea ought to be questioned.

Anadromy cannot have come from sea fishes, anadromy can only have started in river born animals.
If we want to maintain the theory that fishes started in the sea, and yet respect the conclusion that anadromy is more likely to have been inherited than reinvented, we would have to propose a dual origin of fishes:

- one group born in the sea,
- and the other anadromous, not out of the sea.

No doubt that it is easier to imagine that gnathostomes carrying the anadromy gene are the ancestors of all gnathostomes, than to imagine two separate origins.

If we consider that nothing but gnathostomes are true fishes, then fishes appeared first in rivers, not in the sea.

Anadromy, together with the ventral position of the two pairs of lateral appendages of the early gnathostomes, their internal fecundation, their facility to adapt to aerial respiration induces us to try for a larger view of the entire scene, starting just before the chimerization, all the way to the apparition of the tetrapods.

Let's assume that the dominant ancestor is the insect. It is an animal that breathes, that walks on the earth, that reproduces internally.
It gets 'contaminated', 'parasitized' by the lamprey, an animal that readily lives at the expense of other creatures.
The insect remains in charge of most of the motor skills – mouth and limbs – but this parasitic graft manages to impose to the insect its drive towards water. It may be because the insect has it hard to walk with the extra mass of the chordate above its back, it may be because the lamprey's brain has some influence on the mutant's behavior, it may be because the lamprey´s brain influences the long term behavior whereas the insect´s only react at present stimuli.

It is like horse and rider.

This 'infected' insect moves into shallow water, and progressively to deeper waters, keeping the segmentation of its limbs, although they turn into fins.
The move towards ever deeper water is facilitated by the existence of the mandibles that gives it better hunting capability.

This altered insect also keeps its internal reproduction.
Its quickly gives up its aerial breathing – some placoderms are thought to breathe air, and air breathing remains a potential used by various primitive fishes.

The next fish moves into the sea. Then it gives up its internal reproduction and this is when the lamprey's anadromous instinct reappears. Note that the paired fins of the anadromous fish are still ventral and used to push on the ground.

After a short while, the newcomers discover that they don't need to go into rivers to reproduce and become entirely marine. The position of the fins is changed, the posterior become anterior and inferior.
At about the same time some freshwater gnathostomes establish themselves in shallow waters and ossification changes their potential.
They are probably carnivorous that try to catch the terrestrial animals that come to drink, it increases the hunting ground of the trout.
The segmentation of the lateral appendages reappears, together with the aerial breathing. These are the amphibians.
They continue with external reproduction, and their offsprings have an aquatic life.
The fishes become totally aquatic, perfectly adapted to the marine and freshwater environments at about the time of appearance of the amphibians. The tetrapods start the invasion of the earth.

The line of evolution of the fishes stops rather fast, whereas the evolution of the aerial gnathostomes continues until recently, until homo sapiens.
Fishes evolve in a continuous medium whereas the quadrupeds evolve in a discrete world. This difference explains why evolution could continue in this aerial world which is more challenging.

This scenario gives a simple, logical image of this window of evolution, the beginning of the gnathostomes. It explains the appearance and disappearance of various traits

- abdominal breathing,
- internal/external reproduction,
- limbs/fins/limbs,
- aerial/aquatic/aerial life -

Is this the only possible scenario for anadromy?

How did the lamprey become anadromous?
There are marine lampreys that are anadromous, and freshwater lampreys.
Both groups prepare a 'nest' for their eggs and milt. This nest is in quick water, rather shallow, dug to have a stony bottom… exactly similar to that of the trout or the salmon.
It has been observed that some lampreys and trout use the same ´nest´ but not on the same date. This means that even in such details, the behavior of both animals is identical – expression, undoubtedly, of the same gene.
This indicates that the anadromy observed in some fishes is inherited from the lamprey.

As it comes from the lamprey, it supports the chordate origin of the gnathostomes.

If we accept so readily that a gene governing such a complex social behavior passes along the evolutionary line, it shouldn´t be too hard to accept that internal reproduction, aerial breathing, acoustic communication and all the other characteristics mentioned here have been transmitted the same way, rather than invented anew. If anything, the fact that anadromy passes from lamprey to gnathostomes supports the theory that all new traits are inherited.

There is little doubting that all animal life started in the sea, which means that the first anadromous animal couldn't have had the anadromy gene. There has to be some other explanation. Various hypotheses can be presented, but this is beyond the scope of this extended presentation. Could any of these other possible hypotheses be used here and this way avoid rejecting the belief in the marine origin of fishes?[xxxvi]
Of course, it could, but none could be as powerful as the genetic explanation. As there is a precedent to anadromy in chordates anterior the gnathostomes, as this precedent satisfies both the old theory and the new hypothesis, this genetic explanation of anadromy in the gnathostome is the more likely.

The gnathostome appeared in shallow agitated spring freshwater.

What about its ancestors?
The lamprey reproduces in freshwater, and is anadromous. Thus we can safely conclude that this particular ancestor was present when the first event took place.

One of the gnathostome antecedents – lamprey type – lived at the same time at the same location where the gnathostome first came to be.

We still have to find if the other potential ancestor was also present.

We have identified the ancestor that corresponds to the observations. We must make sure that there were insects in those days and that they reproduced near the very shores where the gnathostome appeared

3. **Land colonization by the insects**

The first hexapods appeared in the sea. They got out of it on foot. They had branchias and were not ready for air breathing. There is no reason to believe that they used internal reproduction in any form.
This means that the sharks didn't get their internal reproduction and the sarcopterygians didn't get their lung breathing from such marine insects.
Even though the paired appendages and the mouth pieces could have come from almost any insect, the types of breathing and reproduction that we just reminded cannot be legacies from the early insects.
The evolutionary sequence that we mentioned for the early animals, adapting progressively to less and less salted water could have been followed by the insects as well.
From freshwater, to dry land there is only a small geological and meteorological step. Insects were ready for freshwater, adapted to living in dry biotopes.
We described how this led to the discovery of the wing.
They also learned to change the passive skin breathing to an active tracheal breathing rendered necessary by the rigidity and airtightness of chitin that covers most of the body. They rediscovered and improved the annelid's internal reproduction.

[xxxvi] The internet it the perfect medium for such a discussion.

The winged insect is the only animal that could have brought to a chimerization all the traits that are observed in the gnathostome in addition to the chordate's.

There are very few insects in the sea. The larvae are able to withstand this environment, but it seems that the adults avoid it. These insects have an instinct that makes them look for dry earth and freshwater. Even though accidentally the eggs and the larvae may be carried into the sea by rivers and rain, most adults search dry land and freshwater to lay their eggs.

4. When did the insects first appear?

This question takes us into a difficult territory. The common theory that we question here is supported by the fact that the gnathostomes were on this planet hundreds of millions of years before the insects. This calendar used to be true, but recent investigations have changed these data.
It is known that the agnates were present everywhere at the end of Cambrian and start of Silurian, but the fossils of the hexapods and of the insects are few, and their date is much closer to the present.
We must shake the confusion and remember that we are not talking about just any fish, we are not talking about the agnates.

The gnathostomes appeared at the earliest 400 millions years ago (end of Silurian, start of Devonian) [xxxvii]. [13]
The vast majority of the first fossils or tracts of insects date of no more than 350 millions years[xxxviii] [16] At first sight, there is no match.
However closer observations of fossils and reasoning drove some authors to believe that the insect is older, that it dates from the Silurian, pushing its origin back to more than 400 millions years ago! [xxxix] Their argumentation is convincing.
Furthermore, the new analysis of the rhyniognatha suggests that the insects appeared 434 millions years ago, at the beginning of Silurian. DNA studies by Michael Gaunt and Michael Miles support this conclusion. [xl]
If this is true, there would have been insects on earth even before the first acanthodians, or at the same time.
Contemporary with the first gnathostomes there were wingless insects, say some authors, insects with three pairs of wings say others. If the ancestor was wingless, it had at least

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[xxxvii] http://www.ucmp.berkeley.edu/ordovician/ordolife.html

[xxxviii] **LABANDEIRA C. C.** [(1)] **; PHILLIPS T. L. ;Annals of the Entomological Society of America (Ann. Entomol. Soc. Am.) 1996, vol. 89, n°2, pp. 157-183 (6 p.1/4) http://cat.inist.fr/?aModele=afficheN&cpsidt=3041370**

Concluimos que el herbívoro era un insecto de la ordén Palaeodictyoptera y no un insecto himenóptero.

[xxxix] http://www.kendall-bioresearch.co.uk/fossil.htm

[xl] http://news.bbc.co.uk/1/hi/sci/tech/3478915.stm , http://www.nature.com/nature/journal/v427/n6975/full/nature02291.html

thoracic branchias, dry ones, as they were not used for breathing. Either type of insects could be the ancestor that we are suggesting.

It appears that the first physical condition is satisfied: when the first gnathostomes came to be, insects existed already.

Lampreys and insects used to live and are still living in the very habitat where the first gnathostome came to be, near rivers, and even near springs. The second physical condition is fulfilled also.

The first gnathostomes and their predecessors lived in the same habitat, at the same time, during a period of great biological turbulence.

The probability of chimerization continues to grow.

This habitat is the very place where the lamprey and insect zygotes may enter in contact, where, says our hypothesis, they got into the same cytoplasm.
Given that the lamprey's zygotes are liberated in freshwater, and that many insects live near freshwater, it is very probable that the first gnathostomes were first freshwater animals.

Evolution

Where did the first gnathostomes live?

But for their breathing sharks and rays can be seen as quasi terrestrial tetrapods.
Let's risk a chronological description of what happened after the apparition of the agnates and of the first insects:

- Agnates (lampreys) and insects meet by the river banks
- Chimerization happens yielding the first gnathostomes, the placoderms for instance. Theses animals mutate into cartilaginous fishes, the chondrichtians
- Some chondrichtyans mutate into osteichthyes
- Some osteichthyes turn into sarcopterigyans – lungfish,coelacanth – and others into practically all the other kinds of fishes
- Los sarcopterygians probably give the quadrupeds.
- After the chimerization the hexapods continue their evolution and change into all kinds of 'improved' insects presenting many traits homologous and analogous to those of the gnathostomes.

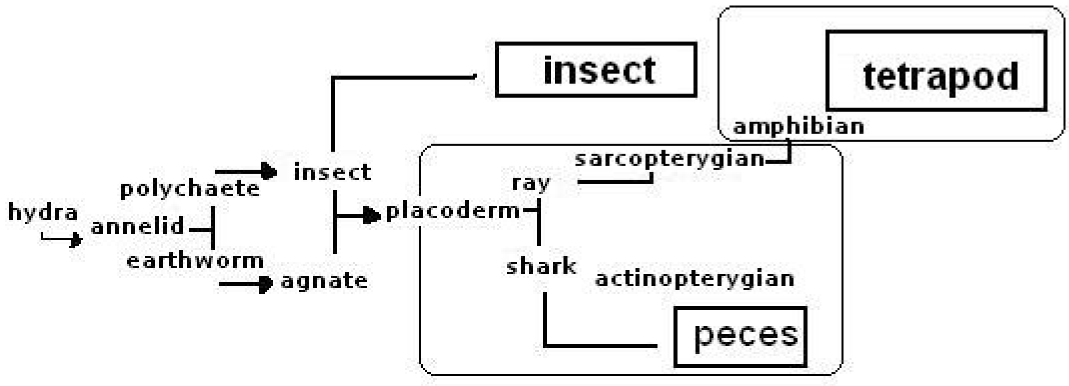

Fig. 7 - Insects mutate into insects and gnathostomes. The placoderms yield elasmobranches with the ray having more segments in her fins than the shark. Among the sarcopterygians, some show appendages that are more legs than fins. The separation between 'fishes' and tetrapods starts right from the early gnathostomes, then one branch wipes off the tools of aerial live, and then, soon after, a new branch brings them back to full expression.

Chimerization is the simplest explanation of the many coincidences between insects and gnathostomes.
It is an evolutionary process observed in bacteria and plants. Why couldn´t it be also used by the animal world?

The gnathostome is pulled towards water by its chordate ancestry and towards dry earth by its insect genetic stock. This is the advantage of its tetraploidy. It gives this taxon a large variety of programs to choose from without having to reinvent the wheel, besides combining the strength of both lines whenever there is no conflict between the two drives.

Comparing the opinions

We established the next table as follows. We gave some observations a total value of 5. These 5 points are then distributed between both columns in proportion with the support they give to the corresponding observation.

This table shows that the present hypothesis has at least the same weight as the traditional one.
They are two opinions, and since one of them has the status of theory, then the other should have it also.

We shall talk of the Theory of Chimerization.

	Current theory	Present hypothesis
All new traits appearing at the same time	1	4
Thalidomide effect	1	4
Middle ear ossicles	1	4
Abdomen localization	1	4
Nothing vital posterior al anus	3	3
Jaws, pharynx, tongue	2	3
Jaws and lateral appendages appear at the same time	1	4
Insects, lampreys and first gnathostomes present at the same place at the same time.	3	3
Tetraploidy due to chimerization	1	4
Insect genes in gnathostomes but not in agnates.	2	3
Myelin in insects and gnathostomes, not in lamprey.	2	3
Insects HOX in gnathostomes, not in lamprey.	1	4
Abdominal breathing in insects and mammals	2	3
Internal reproduction in insects, early gnathostomes, reptiles and mammals	2	3
TOTAL	21	50

Table 2 : weight of some traits. The total weight of each factor is 5. Adding the content of each column, it is clear that the current theory cannot be eliminated, but that the oresent hypothesis has a higher probability of toping it. The reader can verify this conclusion changing the values to fit what he feels is more honest.

Conclusion

As he separates what comes from the chordate from the remaining characteristics of the gnathostome, Shimeld skips the question: where does that rest come from?
Table 1. establishes the apparent link between gnathostomes and insects. The most plausible explanation for the simultaneous coming to be of all these traits, in the transition between agnate and gnathostome, is that all that the improvement achieved by the evolution of the arthropod into the insect has been added in bulk to the legacy of the lamprey, or vice versa, an event whose likelihood is quantified in the last table.

The present theory doesn't deny the chordate ascendancy, but it allows filling the blanks underlined by Shimeld.
The exceptional form of mutation described in this new theory changes nothing but a limited number of conclusions about the links between the animals. It changes them for the mouth pieces, the limbs and the cerebellum, i.e. all the cranial and appendicular apparatus, but little more
.

From the first gnathostome onwards, insects and gnathostomes evolve independently, in parallel.
Little after the assembly of the gnathostome, the vertebrates branched into fishes and tetrapods. These branches drifted apart.
The union of the advances of both insects and agnates gave the new group a great advantage over its ancestors. On one hand advantage in hunting and moving about, on the other hand computing advantage with the presence of two computers allowing for a direct observation of the sensory stimuli, and an abstract study and representation of the world and of these signals.
We, humans are conscious of the abstract, virtual representation created by the chordate brain, an image based on memory, imagination and the stimuli received from the insect brain, as well as the sympathetic and parasympathetic nervous systems.[ ]Man,Worm and Ant, Bruno Leclercq, Authorhouse, 2003.

Was there a unique chimera? Or else several gnathostomes? The progress of genetics may solve that question. It is possible that some of the early gnathostome did not present Anadromy? We don't think it likely.

- An anadromous taxon can mutate in all other forms
- The most primitive fishes all have the anatomy of freshwater vertebrates – i.e. all fins are ventral –
- The earliest fossils are found on the seashores where the skeleton of anadromous fishes can be expected to drift and participate with all the sediment to the advance of land over sea.

How did the first gnathostomes reproduce? Were there gnathostomes of complementary sexes? Parthenogenesis? Clonation?
If there was parthenogenesis, where does the Y chromosome come from?

The large variety of genes that separate the different kinds of fish, the question of the Y chromosome, the number of pair ventral appendages of the acanthodian and probability makes us believe that there was probably more than a single occurrence of chimerization.

There are more arguments 'pro' the hypothesis of chimerization of lampreys and insects than there are in favor of the exclusive chordate inheritance theory, that which has prevailed for the last two centuries. This changes the hypothesis into a theory.

Unlike most other theories of evolution, the step described can be tested in laboratories. If tests were to reproduce it, we would have the first concrete, experimental proof of one of the steps of evolution.

It is interesting to note the influence of the biotope on evolution. The agnates stopped evolving a long time ago. The arthropods that appeared at about the same time continued to improve and adapt for a long time.
On the other hand, the gnathostomes split into two groups, those of water and those of land, with the first group ending its evolution long before the second one.

We observe a parallel between agnates and fishes, and another between insects and quadrupeds. The first group lives in a continuous media, the other in a discrete one.
Solid matter presents the animals with a wider range of problems, and thus a need or an opportunity for a greater variety of forms to encounter a matching niche, together with a reason for corresponding improvement of the nervous system.
The terrestrial gnathostome surpasses the terrestrial insect and continues to evolve for a longer time as an effect of its parallel computing, of its two brains.
As it was living in a discrete world the terrestrial gnathostome continued its evolution, unlike that of the dolphin, a solid world presenting such a wide array of physical problems that it favored the limbs, and then the invention of techniques and tools first imagined in the continuous, virtual world of the telencephalon, and then made and tested in the discrete world of dry matter.

Efficient responses are stored, learned in the cerebellum for fast, learned reflex responses. Creation, invention is generated in the telencephalon, apart from the concrete. It is then tested in the concrete world. The availability of two separate computers makes it possible without stopping to watch the real world for preys and predators.

This article links psychology, neurology and evolution.

Bibliography

Between copies and translations the proper location of the references has been lost. The present list is thus nothing more than acknowledgement. For references in-situ, the internet links are correct.

1. Sebastian M. Shimeld* and Peter W. H. Holland* PNAS | April 25, 2000 | vol. 97 | no. 9 | 4449-4452
2. Christiane Nüsslein-Volhard : Nobel Lecture: The Identification Of Genes Controlling Development In Flies And Fishes, December 8, 1995 at Stockholm Concert Hall, Stockholm, Sweden http://gos.sbc.edu/n/nv/nv.html
3. Janvier , Philippe. 1997. Gnathostomata. Jawed Vertebrates. Version 01 January 1997 (under construction). http://tolweb.org/Gnathostomata/14843/1997.01.01
4. cda.morris.umn.edu/~meeklesr/compbrainnotes.html - 12k
5. Shigeru Kuratani* Shigehiro Kuraku Yasunori Murakami **Lamprey** as an Evo-Devo Model: Lessons From Comparative Embryology and Molecular Phylogenetics Genesis,34(3): 175-83. (2002)
6. http://bugs.bio.usyd.edu.au/Entomology/externalmorphology/imagepages/mouth_master.html
7. Newman C.G. Clinics of perinatology, 1986, Sept. 13(3), 555-73
8. **H.Rouvière, A.Delmas.** *Anatomía humana*; descriptiva, topográfica y funcional. Tomo I. Masson. 9na edición. 1996
9. http://www.ucmp.berkeley.edu/ordovician/ordolife.html
10. Bruno Leclercq ;Yoga, corps et pensée: (1967) Ed. de l'Homme, Montréal, Que. Canada
11. Bruno Leclercq : Man, Worm and Ant,(2002) Authorhouse Ed,
12. Kuratani S, Nobusada Y, Horigome N, Shigetani Y.Embryology of the lamprey and evolution of the vertebrate jaw: insights from molecular and developmental perspectives. Philos Trans R Soc Lond B Biol Sci. ;356(1414):1615-32. (2001)
13. Andrew *G.* Clark and Lei Wang: Molecular Population Genetics of Drosophila Immune System Genes, Genetic society of America, *Institute of Molecular Evolutionary Genetics, Department of Biology, Pennsylvania State University,* 1997
14. Bullock, T.H., Moore, J.K. and Fields, D. Evolution of myelin Sheath: both lamprey and hagfish lack myelin. Neurosc. Lett. 48, 145-148(1984)
15. **I. García-Verdugo,‡§ F. Sánchez-Barbero,‡§ F. U. Bosch,‖ W. Steinhilber,‖ and C. Casals*§** *Biochemistry 42* (32), pp 9532-9542, **2003**
16. Dietmar Schwarz[1], Benjamin M. Matta[1,2], Nicole L. Shakir-Botteri[1] & Bruce A. McPheron[1] : Host shift to an invasive plant triggers rapid animal hybrid speciation, Nature 436, 546-549 (28 July 2005)
17. Rebecca F. Furlong [1] and PETER W. H. HOLLAND [2] * Polyploidy in vertebrate ancestry: Ohno and beyond: Biological Journal of the Linnean Society **Volume 82 Issue 4, Pages 425 – 430**
18. Kuratani S. : Cephalic neural crest cells and the evolution of craniofacial structures in vertebrates: morphological and embryological significance of the

premandibular-mandibular boundary. Zoology (Jena). 2005;108(1):13-25. (2005)

19. Yasunori Murakami[1,2,*,‡], Michio Ogasawara[3,*], Fumiaki Sugahara[1], Shigeki Hirano[4], Nori Satoh[3] andShigeru Kuratani[1,2:]Identification and expression of the lamprey *Pax6* gene: evolutionary origin of the segmented brain of vertebrates ;*Development* 128, 3521-3531 (2001)
20. J.A. Long, K. Trinajstic, G.C. Young & T. Senden Live birth in the Devonian period. *Nature***453**: 650-653(2008)
21. LABANDEIRA C. C. [(1)] ; PHILLIPS T. L. ; (Ann. Entomol. Soc. Am.) , vol. 89, nº2, pp. 157-183 (6 p.1/4) (1996)
22. Michael S. Engel[1] & David A. Grimaldi: New light shed on the oldest insect *Nature* **427**, 627-630 (2004)