

V. *A General Idea of the Structure of the Internal Parts of Fish. Communicated by Dr. Charles Preston.*

FISH are not only different from other Animals' but likewise differ very much from one another, there being scarce a Species of them, that has not remarkable Differences: Not intending to enter into the several particularities, it shall suffice to observe the principal Matters wherein they differ from other Animals, of which the most considerable is their want of Lungs, and in their not Breathing; whereas all other Animals have Lungs both Terrestrial, Volatil, and Amphibious: And in Insects, the several Tracheæ that are spread throughout their whole Body serve them instead of Lungs. It is nevertheless necessary that something should supply this in fishes, which may have the same effect upon their Blood, as the Air has upon ours, by entering into our Lungs; that is to say, to divide and dissolve it, and render it fit for Circulation; otherwise it were in danger of Coagulating, would become moveless and stagnate. Now we find no part in Fish more proper to produce this effect than the Bronchiæ that lye like so many Leaves upon each other under their Gills; for they receive the Water in by the Mouth, and return it by the Gills, or receiving it in by the they throw it out by the Mouth.

It may be asked, *What this is that dissolves the Blood in the Bronchiæ?*

It is agreed upon by all, that the Water must necessarily contain this Body that produces the Effect; but they differ in asserting what it is. It cannot be Water alone,

alone, which is so far from dissolving the Blood, that it rather Coagulates it ; for it is found, that if an Injection of Water be made into the Lungs, the Blood will be Coagulated there, and the great coldness thereof permits us not to doubt of it ; neither is it likely to be a Salt contained in the Water that may cause it ; for it is not Marine Salt, since Fish live as well in Fresh Water as Salt ; nor is it a Nitrous Salt, since they live in places where there is not a jot of it ; it may yet be thought, that this Salt containing an Alkali, it mixes part thereof with the Blood of the Fishes that are in the Sea, which makes their Blood to be more dissolved and fluid than that of Fresh Water Fish ; and it is observed that Sea Fish are of a more cold Temperament than those in Fresh Waters are.

It seems then to be the Air that is contained in the Water, that dissolves the Blood in the Bronchiæ of Fish, as well as it does that in the Lungs of all other Animals. It cannot be doubted but that there is Air in all Water ; the Experiment of that famous Person of the Academy, Monsieur *Marolle* has put this past dispute : He set a Vessel of Water over the Fire, so to drive out the Air from it ; for the Bubbles that arise from hot Water, are only Air that breaks loose from it, enveloped with some watery Particles. This Water he put into the Air Pump, to draw out the Air from it ; and after that filled a Vial with it, within Two or Three Fingers of the top, which space he left full only of Air, and stopt the Vial well ; and by shaking it, the Water Imbibed the Air, so as to rise up and quite fill the Vial.

It may be objected, that if the Air in the Water were the cause of this effect, the Fish would live in the open Air. I shall only reply to this, that Fish have their Blood naturally less hot than ours, so that the natural
Heat

Heat of ours would be a Fever in them, and Mortal, wherefore we need not wonder they cannot live in the Air; for the Nitre of the pure Air is in too great a quantity, and too subtile, so that it dissolves their Blood too much, and makes it too Fluid; whereas the Nitre in the Water is more gross and in lesser proportion, whence it gives their Blood only a Fluidity requisite to keep it in its natural State: To prove that it is in the Bronchiæ that this division is performed, we need but observe their extraordinary redness above any other part of the Body, a Proof that the Blood is there more divided: Fish are found to dye in Water Frozen over, which happens plainly from their Communication with the outward Air, being hindered by the Ice.

The Heart of Fish is different from that of other Animals in its having but One Ventricle; for it has only the *Vena Cava* and the *Aorta* that open into it, having no Lungs; so that by the *Aorta* the Blood comes out of the Heart, which is branched into a Thousand Capillaries over the Bronchiæ, and is after re-united; which re-union is made under the Basis of the Cranium; and because the Blood, when once there, has no need of being forced higher upwards, they have no occasion for a second Ventricle for that purpose, as Terrestrial Animals have.

The Re-union of these Capillaries of the Bronchiæ being made, they form Two large Trunks, of which one proceeds towards the Head, and the other towards the lower parts.

Fish have a Diaphragm, but not for the same purpose as in other Animals that Breathe: it is always Strait and Tense, and Perpendicular on the Vertebrae, it hinders the fermenting Salts that exhale from the Inte-

times from coming to the Heart, which might cause some alteration there.

Their Stomach is Membranous ; for Fish swallow down other smaller Fish whole, and sometimes Earth ; wherefore 'tis needful to have a power of Contracting and Straitning it self, forceably to break to pieces the hard matters contained therein. Their Intestines make several great windings about ; a sign the Fermentation is but slow therein, which is made up by the length of the Intestines.

The Liver has much the same Situation as in other Animals, as also the Spleen has ; they are provided of a Gall Bladder, a *Ductus Choledochus* and *Pancreas*, or rather Two little Bags fastned to the Ventricle for the same use : As to the rest of the Parts, Fish have usually many *Pancreas*'s, so that in some there have been told Forty Four ; they have Kidneys, Bladder, &c.

They have the Ovary near the Vertebres of the Loins ; the Eggs come forth at a passage below the *Anus*, and the Male has a like *Ductus* or Hole, by which they eject their Seed upon that of the Female to impregnate the Eggs, which the Male sometimes changes the Colour of as he passes over them, when he casts his Seed upon them after they are laid.

Fish have on the Vertebre of the Loins a Bladder, very large in proportion to their Bulk, which serves not for their Digestion, as Dr. *Needham* was of Opinion, for there is no *Ductus* found from this Bladder, leading to the Stomach ; and if sometimes such a *Ductus* may be found, it permits the Liquor Syringed into it, to pass from the Stomach to the Bladder, but not at all the other way from the
Bladder

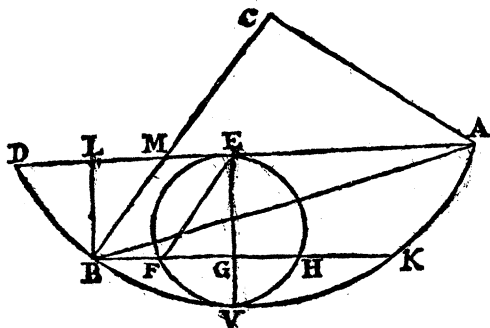
Bladder to the Stomach, which shews that Opinion not right. There is more reason to believe its use is by dilating it self, to render the Fish lighter, as occasion serves, for Swimming: So that when this Bladder is dilated, or the Air contained therein weighs less than an equal quantity of Water; if it be dilated a little, the Fish weighs as much as so much Water; and if it be compressed, the Fish weighs more than an equal quantity of Water; for the Air Compressed, weighs more than when 'tis Dilated. 'Tis a Rule in Hydrostaticks, that a Body that weighs more than its equal Bulk of Water must sink to the bottom; if it weighs less it will rise to the top; if it weighs exactly equal to so much Water, it will stay where-ever 'tis placed. Now the Air of the Bladder, by being Compressed or Dilated, by means of the Muscles of the Fish, causes the Fish to be more or less heavy. That it is this Bladder that makes the Fish Swim is plain; for if it be by any means burst, so that it cannot be Extended, the Fish can no more raise it self in the Water, but keeps continually at the bottom. The Fins and Tail assist them in their passage through the Water, whether they will; but the Dilatation of the Air in the Bladder makes them capable of Swimming after the same manner, as the Dilating of the Lungs and Thorax of a Man bears him up in the Water. Flat Fish, such as Soles, have none of this Bladder; for they are able, by reason of their Breadth, to keep themselves up in the Water. Cray-fish, and other Shell-fish want it likewise,

for the most part, for they creep only at the bottom of the Water; there are many Fish have them double.

VI. De Ratione Temporis quo grave labitur per rectam data duo puncta conjungentem, ad Tempus brevissimum quo, vi gravitatis, transit ab horum uno ad alterum per arcum Cycloidis.

Theorema.

S I in Cycloide AVD cujus basis AD est horizonti parallela, Vertice V deorsum spectante, ex A ducatur utcumque recta AB cycloidi occurrens in B, ex quo ducatur recta BC curvæ Cycloidis BD in B normalis, ad quam ex A demittatur perpendicularis recta AC. Dico Tempus quo grave è quiete cadens ex A, vi suæ gravitatis decurrit rectam AB, esse ad Tempus quo percurrit Curvam AVB, sicut recta AB ad rectam AC.



Per B ducatur BL parallela Cycloidis axi VE; & BK, basi AD parallela, occurrens axi in G, & circulo super Diametrum EV descripto in F & H, Cycloidi denique in K. Ducatur recta EF, quæ ex Cycloidis natura parallela