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## XXIII. *Obſervations upon Animals, commonly called Amphibious by Authors. Preſented by Dr.* Parſons, *F. R. S.*

Read June 26, 1766. THE following remarks, which I have the honour to lay before this learned Society, were occaſioned by a converſation that paſſed between me and a gentleman well acquainted with natural hiſtory, however miſtaken in the ſubject before us. His opinion was, that amphibious animals lived more in the water than on the land: but I believe the contrary will appear by the ſequel of this treatiſe.

If we conſider the words ἄμφι and βίος, from which the term amphibious is derived; we ſhould underſtand that animals, having this title, ſhould be capable of living as well by land or in the air, as by water, or of dwelling in either conſtantly at will; but it will be difficult to find any animal that can fulfil this definition, as being equally qualified for either; and in claſſing creatures of this kind, authors are much divided and ſometimes miſtaken.

Now if any natural hiſtorian ſhould deduce his diſtinction of this claſs, from the ſtructure or characteriſtic of any part of the animal, I think he would be a little out of the way; becauſe the term comprehends nothing but what regards its living in both air and water at diſcretion; however, ſince the word

amphibious is adopted by the writers of the hiſtory of animals, let us retain it ſtill, and examine ſome of this claſs, and, by conſidering their natural œconomy reſpectively, endeavour to range them according to that ſtandard in the following manner. They are ſuch as:

1. Enjoy their chief functions by land, but occaſionally go into the water.

2. Such as chiefly inhabit the water, but occaſionally go a ſhore. Of the latter there are but very few ſpecies. And although none of the winged tribe are to be ranged under this claſs, yet as many of them remain long upon the water, in ſearch of their proper food, we ſhall enumerate ſome peculiar advantages, which have been allowed to ſeveral of them by the bountiful wiſdom of the Creator, in order to render them the more able to obtain it; and this will make one curious part of my preſent purpoſe, not generally known.

The diſpute mentioned between my friend and me, turned upon the claſs of the phocæ, which conſiſts of a very numerous tribe of different ſpecies: I ſhall therefore endeavour to ſhew that none of them can live chiefly in the waters, but that their chief enjoyment of the functions of life is on ſhore.

Theſe animals are really quadrupeds; but, as their chief food is fiſh, they are under a neceſſity of going out to ſea to hunt their prey, and to great diſtances from ſhore; taking care that, how ever great the diſtance, rocks or ſmall iſlands are at hand, as reſting places when they are tired, or their bodies become too much macerated in the water; and they return to the places of their uſual reſort to ſleep, copulate, and bring

bring forth their young, for the following reaſons, viz. It is well known that the only eſſential difference (as to the general ſtructure of the heart) between amphibious and meer land animals, or ſuch as never go into the water, is that in the former the oval hole remains always open. Now, in ſuch as are without this hole, if they were to be immerſed in water for but a little time, reſpiration would ceaſe, and the animal muſt die; becauſe a great part of the maſs of blood paſſes from the heart, by the pulmonary artery, through the lungs, and by the pulmonary veins returns to the heart; while the aorta is carrying the greater part of the maſs to the head and extremities, &c.

Now the blood paſſes through the lungs in a continual uninterrupted ſtream, while reſpiration is gentle and moderate; but when it is violent, then the circulation is interrupted, for inſpiration and expiration are now carried to their extent; and in this ſtate the blood cannot paſs through the lungs either during the total inſpiration or total expiration of the air in breathing; for in the former caſe the inflation compreſſes the returning veins, and in the latter, by the collapſion of the lungs, theſe veins are interrupted alſo, ſo that it is only between theſe two violent actions that the blood can paſs: and hence it is that the lives of animals are ſhortened, and their health impaired, when they are ſubjected to frequent violent reſpiration; and thus it is that in animals who have once breathed, they muſt continue to reſpire ever after; for life is at an end when that ceaſes.

There are three neceſſary and principal uſes of reſpiration in all land animals, and in theſe kinds that are counted amphibious; the firſt is that of promoting

the circulation of the blood through the whole body and extremities; in real fiſhes, the force of the heart is alone capable of ſending the blood to every part, as they are not furniſhed with limbs or extremities; but in the others mentioned, being all furniſhed with extremities, reſpiration is an aſſiſtant force to the arteries in ſending blood to the extremities, which, being ſo remote from the heart, have need of ſuch aſſiſtance; otherwiſe the circulation would be very languid in theſe parts; thus we ſee, that in perſons ſubject to aſthmatic complaints, the circulation grows languid, the legs grow cold and oedematous, and other parts ſuffer by the defect in reſpiration.

A ſecond uſe of breathing is that, in inſpiration, the variety of particles of different qualities, which float always in the air, might be drawn into the lungs, to be inſinuated into the maſs of blood, being highly neceſſary to contemperate and cool the agitated maſs, and to contribute refined pabulum to the finer parts of it, which, meeting with the daily ſupply of chyle, ſerves to aſſimilate and more intimately mix the maſs, and render its conſtitution the fitter for ſupporting the life of the animal. Therefore it is, that valetudinarians, by changing foul or unwholeſome air for a free, good, open air, often recover from lingring diſeaſes.

And a third principal uſe of reſpiration is, to promote the exhibition of a voice in animals; which all thoſe that live on the land do according to their ſpecific natures.

From theſe conſiderations it appears, beyond contradiction, that the phocæ of every kind are under an abſolute neceſſity of making the land their principal reſidence; but there is another very convincing argument

argument why they reſide on ſhore the greateſt part of their time, and that is, that the fleſh of theſe creatures is analogous to that of other land animals; and therefore, by over-long maceration, added to the fatigue of their chacing their prey, they would ſuffer ſuch a relaxation as would deſtroy them. It is well known that animals, which have lain long under water, are reduced to a very lax and even putrid ſtate; and the phoca muſt baſk in the air on ſhore; for while the ſolids are at reſt, they acquire their former degree of tenſion, and the vigour of the animal is reſtored; and while he has an uninterrupted placid reſpiration, his blood is refreſhed by the new ſupply of air, as I have explained it above, and he is rendered fit for his next cruiſe: for action waſtes the moſt exalted fluids of the body, more or leſs, according to its duration and violence; and the reſtorative reſt muſt continue a longer or ſhorter time, according to the quantity of the previous fatigue.

Let us now examine by what power theſe animals are capable of remaining longer under water than land animals.

All theſe have the oval hole open, between the right and left auricles of the heart, and, in many, the canalis arterioſus alſo: and while the phoca remains under water, which he may continue an hour or two more or leſs, his reſpiration is ſtopped, and the blood, not finding the paſſage through the pulmonary artery free, ruſhes through the hole from the right to the left auricle, and partly through the arterial canal, being a ſhort paſſage to the aorta, and thence to every part of the body, maintaining the circulation: but, upon riſing

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to come aſhore, the blood finds its paſſage again through the lungs the moment he reſpires.

Thus the fœtus in utero, during his confinement, having the lungs compreſſed, and conſequently the pulmonary arteries and veins impervious, has the circulation of the blood carried on through the oval hole and the arterial canal; now ſo far the phoca in the water and the fœtus in utero are analogous; but they differ in other material circumſtances: one is, that the fœtus, having never reſpired, remains ſufficiently nouriſhed by the maternal blood circulating through him, and continues to grow till the time of his birth, without any want of reſpiration during nine months confinement; the phoca, having reſpired the moment of his birth, cannot live very long without it, for the reaſons given before; and this hole and canal would be cloſed in them, as it is in land animals, if the dam did not, very ſoon after the birth of the cub, carry him into the water to teach him, ſo very frequently; by which practice theſe paſſages are kept open during life; otherwiſe they would not be capable of attaining the food deſigned for them by providence.

Another difference is, that the phoca, as I ſaid before, would be relaxed by maceration in remaining too long in the water; whereas the fœtus in utero ſuffers no injury from continuing its full number of months in the fluid he ſwims in: the reaſon is; that water is a powerful ſolvent, and penetrates the pores of the ſkins of land animals, and in time can diſſolve them; whereas the liquor amnii is an inſipid ſoft fluid, impregnated with particles more or leſs mucilaginous, and utterly incapable of making the leaſt alteration in the cutis of the fœtus.

Otters, beavers, and ſome kinds of rats, go occaſionally into the waters for their prey, but cannot remain very long under water; I have often gone to ſhoot otters, and watched all their motions; I have ſeen one of them go ſoftly from a bank into the river, and dive down, and in about two minutes riſe, at ten or fifteen yards from the place he went in, with a midling ſalmon in his mouth, which he brought on ſhore; I ſhot him, and ſaved the fiſh whole. Now, as all fœtuſes have theſe paſſages open, if a whelp of a true water-ſpaniel was, immediately after its birth, ſerved as the phoca does her cubs, immerſed in water, to ſtop reſpiration for a little time every day, I make no doubt but the hole and canal would be kept open, and the dog be made capable of remaining as long under water as the phoca.

Frogs, how capable ſoever of remaining in the water, yet cannot avoid living on land, for they reſpire; and if, as I have often done, a frog be thrown into a river, he makes to the ſhore as faſt as he can.

The lizard kind, ſuch as may be called water lizards, or lacertæ aquaticæ, all are obliged to come to land and depoſite their eggs, reſt, and ſleep; even the crocodiles, who dwell much in rivers, ſleep and lay their eggs on ſhore; and, while in the water, are compelled to riſe to the ſurface to breathe; yet, from the texture of his ſcaley covering, he is capable of remaining in the water longer by far than any ſpecies of the phocæ, whoſe ſkin is analogous to that of a horſe or cow.

The hippopotamus, who wades into the lakes or rivers, is a quadruped, and remains under the water a conſiderable

conſiderable time; yet his chief reſidence is upon land, and he muſt come on ſhore for reſpiration.

The teſtudo, or ſea-tortoiſe, though he goes out to ſea, and is often found far from land; yet, being a reſpiring animal, cannot remain long under water. He has indeed a power of rendering himſelf ſpecifically heavier or lighter than the water, and therefore can let himſelf down to avoid an enemy or a ſtorm; yet he is under a neceſſity of riſing frequently to breathe, for reaſons given before: and his moſt uſual ſituation, while at ſea, is upon the ſurface of the water, feeding upon the various ſubſtances that float in great abundance every where about him; theſe animals ſleep ſecurely upon the ſurface, but not under water, and can remain longer at ſea than any others of this claſs, except the crocodile, becauſe, as it is with the latter, his covering is not in danger of being too much macerated; yet they muſt go on ſhore to copulate and lay their eggs.

The conſideration of theſe is ſufficient to inform us of the nature of the firſt order of the claſs of amphibious animals; let us now ſee what is to be ſaid of the ſecond in our diviſion of them, which are ſuch as chiefly inhabit the waters, but occaſionally go on ſhore.

Theſe are but of two kinds: the eels and water-ſerpents, or ſnakes of every kind. It is their form that qualifies them for loco-motion on land, and they know their way back to the water at will; for by their ſtructure they have a ſtrong periſtaltic motion, by which they can go forward at a pretty good rate, whereas, all other kinds of fiſh, whether vertical or horizontal, are incapable of a voluntary loco-motion on

ſhore; and therefore, as ſoon as ſuch fiſh are brought out of the water, after having flounced a while, they lye motionleſs, and ſoon die.

Let us now examine into the reaſon why theſe vermicular fiſh, the eel and ſerpent kinds, can live a conſiderable time on land, and the vertical and horizontal kinds die almoſt immediately, when taken out of the water: and, in this reſearch, we ſhall come to know what analogy there is between land animals and thoſe of the waters. All land animals have lungs, and can live no longer than while theſe are inflated by the ambient air, and alternately compreſſed for its expulſion; that is, while reſpiration is duly carried on, by a regular inſpiration and expiration of air.

In like manner, the fiſh in general have, inſtead of lungs, gills, or branchiæ; and, as in land animals, the lungs have a large portion of the maſs of blood circulating through them, which muſt be ſtopped if the air has not a free ingreſs and egreſs into and from them; ſo, in fiſh, there is a great ſhare of blood veſſels that paſs through the branchiæ, and a great portion of their blood circulates through them, which muſt in like manner be totally ſtopped, if the branchiæ are not kept perpetually wet with water; ſo that, as the air is to the lungs, in land animals, a conſtant aſſiſtant to the circulation, ſo is the water to the branchiæ of thoſe of the rivers and ſeas; for when theſe are out of the water, the branchiæ very ſoon grow criſp and dry, the blood veſſels are ſhrunk, and the blood is obſtructed in its paſſage; ſo, when the former are immerſed in water, or otherwiſe prevented having reſpiration, the circulation ceaſes, and the animal dies.

Again, as land animals would be deſtroyed by too much maceration in water, ſo fiſhes would, on the other hand, be ruined by too much exſiccation; the latter being, from their general ſtructure and conſtitution, made fit to bear, and live in, the water; the former, by their conſtitution and forms, to breathe, and dwell, in the air.

But it may be aſked, why eels and water ſnakes are capable of living longer in the air than the other kinds of fiſh? this is anſwered, by conſidering the providential care of the great Creator for theſe and every one of his creatures: for, ſince they were capable of loco-motion by their form, which they need not be if they were never to go on ſhore, it ſeemed neceſſary that they ſhould be rendered capable of living a conſiderable time on ſhore, otherwiſe their loco-motion would be vain. How is this provided for? why in a moſt convenient manner; for this order of fiſhes have their branchiæ well covered from the external drying air, and are alſo furniſhed with a ſlimy mucus, which hinders their becoming criſp and dry for many hours, and their very ſkins always emit a mucous liquour, which keeps them ſupple and moiſt for a long time; whereas the branchiæ of other kinds of fiſh are much expoſed to the air, and want the ſlimy matter to keep them moiſt. Now, if, when any of theſe is brought out of the water, it was laid in a veſſel without water, he might be kept alive a conſiderable time, by only keeping the gills and ſurface of the ſkin conſtantly wet, even without any water to ſwim in.

Before I diſmiſs the firſt part of my diſcourſe, I muſt beg your patience, while I mention ſomething that relates to a family among the fiſh kinds, which is

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of a middle nature between the phocæ, and the real fiſhes of the ſea, in one peculiar reſpect. This is the claſs of the phocenæ, or porpeſſes, of which there are ſeveral ſpecies; and theſe have lungs, and therefore are forced to come up to the ſurface to breathe at very ſhort intervals; but, when brought on ſhore, have no progreſſive loco-motion. So that, having lungs, they reſemble the phocæ, and, in every other reſpect, the real fiſhes of the ſea.

Blaſius, in his Anatome Animalium, page 288, gives an account of one of theſe taken and brought on ſhore alive; the people let him lye, to ſee how long he could live out of the water; and he continued alive only about ſeven or eight hours, and exhibited a kind of hiſſing voice.

From what has been ſaid, it will, I hope, appear rational, that theſe are the only two orders, that can properly be deduced from the claſs of Amphibious animals; and that the genus's of either order are very few in the animal world.