The anatomy and physiology of the perforating instruments of Pholas dactylus : being notes read before the Brighton and Sussex Natural History Society, on the 11th November, 1858, and 10th February, 1859 / by John Robertson.

To Isaby Hogg Esqun
with the Author's
best compliments.

THE

ANATOMY AND PHYSIOLOGY

OF THE

PERFORATING INSTRUMENTS

OF

PHOLAS DACTYLUS:

Being Notes read before the Brighton and Sussex Natural History Society, on the 11th November, 1858, and 10th February, 1859.

By

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1859.

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PHOLAS DACTYLUS.

The Brighton eye-witnesses of the perforating processes of Pholas Dactylus in the summer of 1851, and in the autumn of 1858, have been sufficiently numerous to establish any fact which can be proved by human testimony. They have observed semi-rotations and ejections which are found on investigation to be raspings and squirtings. The winter is not a favorable season for these observations, but from the number of naturalists who now know how to chip the Pholades uninjured out of the rocks and set them in lumps of chalk placed in sea-water pans or tanks, the perforating processes will soon be seen by all who are willing to take the trouble to look at them.

PHOLADES IN CROSSING CRYPTS.

Early in November, 1858, I supplied an intelligent lady, resident in Lansdowne Place, Brighton, with a number of pholades, chiefly of the pholas candida, and pholas dactylus, kinds, which were lodged in lumps of chalk. They worked satisfactorily, rasping and ejecting, up till Christmas. But she observed two of them, which by their borings were approaching each other, and bye and bye, they had rasped away the partition which divided their crypts. The fair observer becoming intensely interested in their proceedings, and curious to know what they would do, watched them very closely. A contest then began between the rival mollusks which had crossed each other's paths, and the contest ended by the stronger boring right through the weaker pholas.

I have rarely seen a pholas perform a complete rotation, and I have seen half, or rather quarter rotations and oscillations executed by only a single valve working at a time. With regard to the ejections, I have seen chalky nodules issuing from the anal siphon, but this is an observation which I have made but rarely; what I have most frequently seen being squirtings or puffings out of chalk dust from the gill siphon.

The study of the movements excites curiosity respecting the instruments which perform them. But a preliminary remark ought to be made on the hardness of chalk. Judging of the hardness of chalk from

lumps cast ashore by the sea and baked by the sun, naturalists have misjudged the chalk rocks which are perforated by the gastrochenes and pholades. Chalk rocks which are generally submerged can be cut with a strong knife nearly as easily as cheese. Such are the rocks which are perforated in the vicinity of Brighton by three or four varieties of the pholas, parva, bakeri or candida, and dactylus, by means of their rasping and squirting instruments.

I shall begin by describing Pholas Dactylus as a rasp. The instruments composing this rasp are the teeth, the lever, the motor or fulcrum, the muscles and the spring.

1 The Teeth.

If you take up one of the valves of Pholas Dactylus and pass your finger along the outside of the valve from the siphonal gape to the pedal gape you will be sensible of passing along asperities differing in acuteness from the roughness of a file to the sharpness of a rasp. The apparent insufficiency of the rasping teeth of the Pholades for the rude task of perforating chalk, gneiss and wood, sandstone and limestone, suggested to M. Fleureau de Bellevue the notion of a chemical solvent which he thought he had discovered in the thin brown mud with which the Pholas lines and lubricates the sides of its crypt to make it more agreeable to its siphonal tube. Believing in the insufficiency of the teeth, M. Deshayes made them of no account, as there are many shell-fish found in crypts in rocks

which are destitute of teeth for rasping, and ascribed all perforations of the shell-fish to a gland containing a secretion capable of corroding rocks and timber. M. Caillaud made a simple experiment to test the strength of the teeth of Pholas Dactylus, accounts of which he published in the Journal de Conchyliologie in 1850 and 1851 simultaneously with the publication of my observations of the raspings of the animals themselves in Brighton. M. Caillaud made grooves in chalk and limestone rocks by rasping them under water with a number of pholas shells, taking fresh shells as he wore out the teeth, and using a considerable number of shells.

2. The Lever.

If you look inside the valves of Pholas Dactylus you will see just under the hinge a small structure like a tiny spoon. This is the lever. It is placed inside near the sharpest rasping teeth. The levers, each projecting from its valve, penetrate profoundly into the muscles of the mantle and foot, which playing upon them direct and govern the movements of the teeth.

3. The Muscles.

The muscles which surround the levers branch off from them fanwise after encircling them. After clasping the levers tight, they radiate away from them as wing-shaped muscles, passing into the muscles of the foot and mantle. The muscular system of Pholas Dactylus is just an apparatus for forcing the external teeth

against the sides of the crypts and for guiding their gratings by pressing upon the internal levers. The most important and least understood parts of this machinery are the fulcrum and spring.

4. The Fulcrum.

The fulcrum is the instrument called the foot. In some kindred bivalves this muscular instrument is an organ of locomotion; but in Pholas Dactylus it is an instrument of rotation. It issues through a hole in the mantle and through the pedal gape, and presses against the sides of the crypt. Its disk is in the shape of a rose-leaf and it is formed of a network of muscles. It has a remarkable expansibility, being capable of lessening or widening its spread thrice over. When the muscles of this rose-leaf-like disk expand, the teeth penetrate the rock, and when they retract, the teeth cease to grate it.

The Spring.

5. The expansibility of the foot or disk is due to the spring. This is the hyaline or crystalline stylet of the comparative anatomists. With teeth to pierce the chalk; with levers to guide them; with muscles to work upon them; with a fulcrum to rest upon the side of the hole and with a highly expansible disk or foot, it is easy to see how the Pholas was created a rasp, and how its instinct interpreting its structure, it bores its hole and home by its raspings.

But as a rasp it could only fill up its crypt with pulverized stone. It requires instruments to get rid

of the chalk powder. These instruments compose its structure as a syringe. A syringe consists of a tube, a cylinder and a piston. The siphons are the tube, the mantle is the cylinder and the foot is the piston of Pholas Dactylus, viewed as a syringe. When the chalk dust falls from the teeth, it is collected into the mantle, and suspended in the water, is pushed upwards by the tiny hairs or cilia which line the gills and siphons. The fact is ascertained by taking Pholades, who have been rasping some time, and examining them before they have ejected the chalk dust. The chalk powder is then found in the cylinder of the syringe. When a sufficient quantity has been collected, a sudden swelling and spreading of the foot, makes it, acting as a piston, force the water, air and chalk in the cylinder up through the tube. I have seen, sometimes, squirtings or spurtings two feet high. This expansibility of the foot which is important to the Pholas, as a rasp, is still more important to it as a squirt, for without it the shell-fish could not eject the dust it grinds down into its crypt.

The analysis of the Pholas as a rasp and as a syringe conducts us always to the instrument which explains the expansibility of the foot, fulcrum or piston.

And now we enter a new and virgin field. The perforation of the Pholades by mechanical raspings and squirtings, rejected by the British Association, in 1851, accepted by the French authorities, in 1853, and by the British, in 1856, is now a well established and undisputed fact of science. But I am about to

submit to you an account of an instrument, the anatomy of which has hitherto been imperfectly known and the physiology entirely unknown. The fact is that the anatomy of what I call the spring of Pholas Dactylus has been so erroniously described in every respect that the state of science might be summed up into a vague knowledge of its existence, ignorance of its position, and nature, and a solitary, and unsatisfactory conjecture respecting its functions.

The anatomists have called it the glassy stylet. It has been drawn in the books of comparative anatomy incorrectly, since the days of Poli. Siebold and Stannius, say:—"As yet nobody has succeeded in ascertaining the use of this body." In June 1851 I sent a letter to a number of well-known naturalists, which was afterwards published in the *Brighton Herald*, the *Zoologist*, the *Naturalist*, and *Jameson's New Edinburgh Philosophical Journal:* and in which I observed that,—"there is in the foot a gelatinous spring or style, which even when taken out has great elasticity and which seems the mainspring of the motions of Pholas Dactylus." Among the letters I received in reply was one from Mr. Owen, in which he said he thought the stylet was "in the stomach and was used in pounding up the alimentary matters." This guess is reproduced in *Woodward's Fossil and Recent Shells*, at page 29:—"In the *aplysia*, which is a vegetable-feeder, the gizzard is armed with numerous small plates or spines. The stomach of some bivalves contains an instrument called the 'crystalline stylet'

which is conjectured to have a similar use." M. Emile Blanchard, although he explained and illustrated my observations on the perforations in his "Organization du Regne Animal," and notwithstanding the explanations I gave him, says: "It is moreover proved that there often exists near the pylore a long cœcum containing a crystalline stalk, which is still called the hyaline style, and which if the cœcum is wanting, may be found in the intestine itself, 'only the function of that part is not even suspected'—seulement le rôle de cette partie n'est pas même soupçonné."

This instrument exists in Solen, Arca, Mactra, Donax, Cardium, Tellina, Anadonta, Unio, Mya, and other bivalves which may be described generally as burrowing shell-fish. I have dissected individuals of these species, and satisfied myself that the glassy stalk performs the functions of an extensor spring in all of them. But it is my present business to shew you this fact in the instance of Pholas Dactylus.

This instrument is a glassy spring. In colour it so nearly resembles glass that if at any time it has dropped into a tumbler of water I have had to pour out the water to find it. Some of my friends who have seen the casualty have insisted upon it that it had dissolved. In form it might be described as a cylindrical model of a cricket-bat about an inch long. It lies along the sole of the foot. A slight cut along the rose-leaf like surface will make it start out. It is like disengaging the mainspring of a watch. This instru-

ment is not lodged in the stomach, and I can account for such an error respecting its position only by remembering how such fine membranes are contracted and destroyed by spirit. A body so elastic could not be held in the stomach without a set of muscles to control it. On the contrary, it lies in a case or sheath of encircling muscles. The seat containing the base of the glassy spring, is a cup held in by the border muscle of the foot; and the socket containing the apex is a corneous hood controled by the retractile muscles of the case, and traversed by the dorsal muscles. The small end of the spring is spiral, and the flaps or wings of the hood-like socket, lap over it and clasp it. Ordinarily the moment it is released by the cutting of the encircling or retractile muscles the spiral apex of the spring starts out of the hood-like socket which is drawn down and aside by the retracting muscle; but I have several times uncovered the socket whilst still containing the apex. This socket has hitherto escaped the researches of the anatomists, for none of them mention it.

The microscopic structure of the glassy spring explains its elasticity. It consists of at least three cylinders, enclosed the one in the other. Each of these crystal cylinders consists of spiral fibres. The cylinders are easily peeled off, and the fibres can be uncoiled, although both the peeling and the uncoiling are trials of skill and patience. When the glassy spring is under a microscope of low power, the spiral fibres present a lovely appearance of cross streaking

and lines of beauty. Shakspeare did not know these elastic fibres when describing the coach of queen Mab, or he might have mentioned them as springs used by the coach-makers of the fairies.

To sum up, teeth, levers, muscles, and a fulcrum or motor-foot containing a spring, make the Pholas a rasp; tubes, a cylinder, and a piston, moved by a spring, make the Pholas a syringe. The more minutely the instruments are examined, the more exactly these facts are established. But for the present I feel I ought to conclude by saying that I would apologize for occupying so much of your time, if I had troubled you with a guess or conjecture, reasoning or theory of mine. I have however only been translating into words what the movements reveal respecting the instruments, and what the instruments say of themselves; and it is the Pholas Dactylus which has been telling its own story.

Pholas Martesia Striata.

Several years ago Mr. Hollis presented to this society a very interesting oaken pile which had been twenty years under water in the harbour of Kingston, Jamaica. In it there are a number of specimens of the Pholas Martesia striata of Leech.

Now the globular Pholades present some difficulties to the student of the means of perforation used by these mollusks. The first specimens of them which I had an opportunity of studying, came from the Island of France.

For a long time I could not explain how it was possible for them to perforate with the instruments used by Pholas Dactylus.

The foot of Pholas Striata is completely closed in within the shell; the valves having apparently no opening by which the foot can reach the side of the hole. The motor of the rotatory machine is without a fulcrum. How then was I to account for the perforations? Many and many a day I gazed for hours at these specimens in their case, in the Museum of Natural History, in Paris, and discovered nothing but headaches.

Upon the 11th September, 1856, M. Valenciennes having had the kindness to place the specimens at my disposal, in his laboratory, the difficulty vanished in a couple of hours, for the young have the needful opening for the action of the foot.

When this species need a home they can bore one. The hole once bored and the home prepared, the adult Pholas, whose future business is the reproduction of its species, protects its foot from contact with the wood or stone, by secreting a sort of operculum, or lid, in two parts, which shuts up the pedal aperture.

The lever then wastes away. In the shells of the young, whose business is perforation, a strong band strengthens the valves at the juncture of the part of the valve which has asperities, with the part which has not; and the tiny spoon-like lever is very long; the hinge moreover being furnished with a pair of salient levers. In the young, everything announces

the perforator, while in the old, the machinery or perforating instruments are in a state of atrophy, and the whole animal is inclosed by the valves and operculum.

Pholas Candida, Brighton	and	Pholas Bakeri, East Indies.

Is this Brighton shell a dwarf form of the East Indian shell? For myself I incline to the affirmative opinion. Blainville seems to have proved that not a few of our European shells are only dwarf varieties of tropical mollusks and in the specimens before us there is no striking difference except difference of size. There is a wide field of labour open to the naturalist of the present day in verifying the received species, making allowances for the differences of appearance due to the influences of climate and temperature. Botanists have long ago remarked the plants of cold regions upon the cold heights of mountains, and zoologists are beginning to make similar observations. For example, the common snail, helix arbustorum, of Siberia, is found upon the shrubs near the snows of Mont Blanc. Without studying the animals themselves, we cannot decide beyond a doubt from the shells merely, respecting the identity of mollusks described in books as different species, but it is well to study the animals of our locality and record our doubts and suspicions as notes and queries.

NOTES.

[NOTE I.]

Brighton, 1st June, 1851.

Having, while residing here, opportunities of studying the Pholas Dactylus, I have endeavoured during the last six months, to discover how this mollusc makes its hole or crypt in the chalk; by a chemical solvent? by absorption? by ciliary currents? or by rotatory motion?

My observations, dissections, and experiments, set at rest all controversy in my own mind. Between twenty and thirty of these creatures have been at work in lumps of chalk in sea water in a finger glass and a pan, at my window, for the last three months.

The Pholas Dactylus makes its hole by grating the chalk by its rasp-like valves, licking it up when pulverised, with its foot, forcing it up through its principal or branchial siphon, and squirting it out in oblong nodules. The crypt protects the Pholas from conferve, which, when they get at it, grow not merely outside, but even within the lips of the valves, preventing the action of the siphons.

In the foot there is a gelatinous spring or style, which even when taken out has great elasticity, and which seems the mainspring of the motions of the Pholas Dactylus.

[NOTE II.]

Mr. J. Robertson wrote to say that the ideas emitted recently by M. Cailliaud upon the perforations of rocks by the Pholades, had been published by him previously, especially in a letter of June last, in the *New Edinburgh Magazine*, the *Naturalist*, the *Zoologist*, and he added that in August last he arrived in Paris with his Pholades still living, and that he had shown their stone to different persons, among others M Valenciennes. Mr. John Robertson has offered his assistance to the authorities of the Jardin des Plantes of Paris, and the Zoological Gardens of London, to make a permanent exhibition of per-

forating Pholades to the public. Such an exhibition would enable all the world to see with their own eyes the solution of what has been for many years the most keenly and constantly contested puzzle in natural history, besides displaying to the Parisians and the Londoners innumerable marine wonders.

[NOTE III.]

M. Cailliaud a prouvé d'abord que les valves des Pholades offraient assez de résistance pour creuser des pierres calcaires, et il a découvert ces animaux dans des roches qu'il regarde comme inattaquables par un acide.

Un Anglais, d'un autre côté, M. Robertson, qui s'est aussi occupé de la question, a fait porter ses observations *sur la Pholade même* travaillant à creuser son habitation, et il nous communique à ce sujet une notice intéressante que nous allons mettre sous les yeux de nos lecteurs, et qui viendra d'autant plus à propos que la commission de l'Académie des Sciences, qui ne s'est pas encore prononcée, trouvera dans les procédés employés par le naturaliste anglais les moyens de reprendre ses expériences, de les vérifier, et de résoudre enfin une question trop longtemps controversée.

NOTICE de M. Robertson *sur la perforation des pierres par le Pholas dactylus.*

Pholas dactylus est le nom donné à un Mollusque bivalve, et ce nom formé de deux mots grecs φωλεος (être caché) δακτῦλος (doigt), signifie, je le suppose, un animal ayant la forme d'un doigt et vivant dans un trou : il serait difficile de mieux résumer en deux mots, l'objet des observations que nous avons faites, et auxquelles M. Petit de la Saussaye veut bien donner une place dans son Journal.

Lorsqu'on se promène sur les rivages de la côte S. E. de l'Angleterre, on remarque des blocs de craie très singulièrement perforés : si l'on en demande la cause aux pêcheurs du Sussex, ils vous rèpondent que les trous sont creusés par le *Piddick*, animal très bon pour servir d'appat, et dont la coquille a la forme d'un doigt. Si, pour son instruction, l'investigateur a recours aux ouvrages scientifiques, il apprendra que la question de la perforation des pierres par notre Mollusque a été vivement controversée depuis plusieurs siècles, mais qu'elle n'a point encore étè résolue, et fort embarrassé, il se demandera aussi ; comment cela peut-il se faire ? est-ce par un dissolvant chimique, par l'absorption, par l'action de cils vibratiles, ou par des mouvements de rotation ?

Le champ de l'observation est hérissé de difficultés, et le fait qui nous occupe en est une preuve, mais nous croyons que le résultat de nos observations lèvera toute espéces de doutes relativement à cette question.

Pour découvrir la Pholade avec son animal, l'observateur doit la chercher parmi les roches calcaires qui se trouvent à peu près à moitié chemin entre les limites des hautes et des basses mers : en examinant avec soin, il remarquera de petits jets qui trahiront l'existence du Mollusque : s'il fait pénétrer une petite baguette à l'entrée du trou, l'animal manifestera de nouveau sa présence en rejetant de l'eau et du sable. Pour obtenir des exemplaires de Pholades intactes, le naturaliste qui veut en faire l'objet de ses observations doit enlever le calcaire autour du trou, à l'aide d'un marteau et d'un ciseau à froid, mais avec précaution, car le Mollusque pour ne pas être enlevé de sa demeure étendra son pied et son manteau jusqu'à faire éclater son dos, et par là nous ne parlons pas seulement des membranes qui couvrent les charnières, mais encore des muscles semblables à des dents, qui sont attachés intérieurement aux crochets de la coquille.

Il faudra, préalablement, avoir détaché et préparé un fragment de la roche calcaire, dans lequel on aura trouvé déjà, ou pratiqué artificiellement, des trous d'un pouce et demi à deux pouces de profondeur, puis on choisira celles des Pholades qui ne seront pas endommagées, et on les placera dans les trous préparés pour elles : elles pourront ainsi être mises et transportées dans un bassin rempli d'eau de mer qu'on renouvellera deux fois par jour : il sera bon, avant ce renouvellement de provision, de les laisser pendant une demi-heure à découvert sans eau : le bassin doit rester dehors au grand air. Telles sont les dispositions que nous avons prises nous-même, et à la suite desquelles nous avons pu observer, au bout de quelques jours, comment procédait la Pholade : les premières que nous avons étudiées travaillaient à s'approprier un trou que nous avions grossièrement fait dans une roche calcaire.

La Pholade dactyle fait son trou en se servant de ses valves comme d'une râpe pour user la craie, qu'elle rejette avec son pied, quand elle est pulvérisée, la faisant passer par son siphon principal ou branchial, et la faisant jaillir en nodules oblongs. Par siphon principal nous entendons le siphon qui est du même côté que le pied, et non celui qui est du côté de la charnière : ces nodules crayeux sont rejetés par le grand siphon, tandis que les matières excrémentielles sont repoussées par le siphon plus petit (anal) en longs bourrelets tortillés de matières noires.

Ayant examiné la Pholade à l'œuvre, je n'ai jamais vu de rotation complète, mais l'animal faisant seulement faire un demi-tour à sa coquille, son pied se portant du côté de la char-

niére, puis retournant en arrière : souvent il tourne à droite et à gauche, et grattant par des mouvements oscillatoires, deux ou trois latéralement, deux ou trois en arrière et en avant : parfois il râpe d'un côté avec une seul valve. La craie pulvérisée est envoyée dans la cavité palléale par le pied : les nodules, formés dans le siphon, sont rejetés par des contractions spasmodiques. En résumé, les dents aiguës, les épines ou les pointes qui existent à la partie inférieure et la plus solide de la coquille agissent comme les aspérités d'une râpe sur les parois du trou, le pied repousse le sédiment calcaire, et le siphon branchial le pompe et le rejette.

Le pied de la Pholade a la forme d'une petite feuille de rosier : son pouvoir d'expansion et de contraction est d'environ les deux tiers de sa grandeur : il y a dans l'intérieur de ce pied un tissu élastique d'apparence gélatineuse, qui conserve même après la mort cette grande élasticité, à laquelle est dû le mouvement du pied.

La Pholade travaillant dans un trou sous l'eau, qui est un puissant dissolvant, ne paraît pas avoir besoin du secours d'un autre dissolvant.

On voit encore à l'intérieur de chaque valve ce qu'on appelle un cuilleron ; or, ces cuillerons placés dans la partie la plus solide de la coquille sont des leviers pour l'appareil musculaire placé au-dessus du pied, qui est la force motrice, le levier destiné à faire agir les aspérités du test sur la pierre.

Je n'ai rien vu qui ressemblât à des vaisseux absorbants dans le pied des Pholades, qui a du rapport avec celui du *Solen ensis*, et dont celui-ci se sert pour pénétrer dans le sable : cet organe ne paraîtrait être d'aucun usage s'il ne servait aux mouvements rotatoires : l'animal ne marche pas, et quand il s'est une fois creusé un trou confortable, à l'abri de ses ennemis, et où il peut faire agir ses siphons, il ne se dérange plus.

Ajoutons qu'en travaillant sous l'eau le Mollusque dont il s'agit obtient dans son opération une autre force, celle qu'exerce la pression de l'eau elle-même, force hydraulique qu'il ne faut pas oublier, et qui est très grande et proportionnée à la profondeur et étroitesse du trou.

De ce qui précède, et des observations que j'ai faites pendant plusieurs mois sur des Pholades travaillant sous mes yeux, je puis conclure que ces Mollusques emploient, pour pénétrer dans la pierre, l'action mécanique de leurs valves et de leurs siphons, aidés par l'eau comme dissolvant et comme force hydraulique, qu'en contractant et étendant subitement leur pied ils rejettent l'eau avec les sédiments calcaires, et que la Pholade est à la fois une râpe, une seringue, et un appareil hydraulique, ou la combinaison vivante de ces trois instruments, organisés de manière à

lui rendre facile la perforation des calcaires, des grés, du gneiss, du bois, etc.

Le trou des Pholades les protège, contre leurs ennemis et les met généralement à l'abri des conferves, qui lorsqu'elles tombent sur eux ne croissent pas seulement en dehors, mais aussi en dedans des bords des valves, ce qui nuit à l'action des siphons. Lorsqu'elle n'est pas exposée au soliel, la couleur de la coquille est bleue, mais l'exposition à la lumière et à l'air blanchit les valves du Mollusque mort ou vivant. Nous devons dire aussi que les coquilles des Pholades qui ont vécu pendant quelques semaines dans un vase n'ont pas la force et la vivacité de celles qui sont restées dans leur milieu normal, que leur coquille pâlit, qu'elles perdent successivement leur agilité, leur force, ainsi que l'énergie avec lesquelles elles se débarrassent ordinairement du sédiment calcaire et des excréments.

M. Rang, d'après des individus fossiles, a supposé que l'animal, lorsqu'il creuse sa demeure, déposait quelquefois une couche calcaire tubuleuse sur les parois intérieures de cette cavité, ce qui est exact. En effet, nous avons remarqué que le *Pholas Dactylus* revêt l'intérieur de sou trou de deux couches, d'abord de craie pulvérisée, et ensuite de matières excrémentielles, dans le but évident de rétrécir l'ouverture, et d'adoucir les bords pour le passage du siphon.

Tel est le résultat des observations que nous avons faites sur le travail des Pholades, pendant une période de temps assez longue, sur un assez grand nombre de sujets, et avec assez de soin pour que nous ne puissions conserver le moindre doute relativement à la solution de la question. Les naturalistes qui vinrent chez moi, à Brighton, partirent rarement sans avoir ètè témoins de quelqu'une de mes expériences, et le Dr. Mantell, qui avait adopté l'opinion de *l'agent chimique*, étant entouré de savants, avec mes Pholades sous les yeux, me demanda un jour : " Quelle est votre théorie, Monsieur Robertson ?" A quoi je répliquai : Je n'ai pas de théorie, examinez.—Le docteur, témoin, avec les assistants, du mouvement des valves et du jeu des siphons, s'écria bientôt: " *Mécaniquement après tout!*"

ROBERTSON.

NOTE IV.

Institut Impérial de France, Academie des Sciences.

Paris, le 2 Septembre, 1857.

Le Secrétaire Perpétuel de l'Académie.

Mon cher Monsieur Robertson,

Je me fais un vrai plaisir de vous rendre le temoignage que vous me demander.

J'ai vu des pierres perforées par des Pholades que vous aviez fait agir sous vos yeux. J'ai comparé ces perforations avec la structure de l'animal, qui m'était fort connue, et il m'a paru que cette structure respondait singuliérement bien du mécanisme que vous avez fait connaître. J'ai même été si frappé de la chose, et de tout ce qu'il y a d'ingénieux dans votre explication, que dans mes cours de 1853,' j'ai vu devoir consacrer une de mes lecons á la développer devant un auditoire qui l'applaudie.

J'ajoute ici qu'ayant eu l'honneur de vous voir souvent, depuis environ six années, soit à mes leçons, soit en particulier, mon temoignage pourrait s'étendre, beaucoup plus loin que vous ne me la demandez, car j'ai rarement rencontré, en qui que ce soit, un savoir aussi varié, aussi vaste, ni un esprit plus riche que ce que j'ai trouvé en vous. Vous honorera l'Université qui vous appellera.

Recevez, mon cher Monsieur Robertson, l'expression de ma plus haute estime avec mes sentiments dévoués.

FLOURENS.