L. Physico-mechanical experiments and discussions of the phænomena observable in that casual product of art the hand granade, prince Rupert's drop, or glass tear

Mr. John Snart

To cite this article: Mr. John Snart (1805) L. Physico-mechanical experiments and discussions of the phænomena observable in that casual product of art the hand granade, prince Rupert's drop, or glass tear , Philosophical Magazine Series 1, 22:88, 334-339, DOI: [10.1080/14786440508562464](https://doi.org/10.1080/14786440508562464)

To link to this article: <http://dx.doi.org/10.1080/14786440508562464>

Published online: 18 May 2009.

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each other: they were found in the island Maria, which is not far from d'Entrecasteaux's channel, by Messrs. Peron and Lesueur, to whom we are indebted for almost the whole of the zoological riches brought to us from New Holland.

I have comprehended in the following table all the characters of the genus and species of these three animals.

HYDROMIS.

NAT. CHAR.—Incisor teeth two in each jaw; canine; two molar teeth in each row, furrowed on the side, and with a double excavation on the crown.

Feet pentadactyles; the anterior free, the posterior pal-
mated.

Tail round, and covered with short hair.

ESSENT. CHAR.—*Hind-feet palmated. Tail round.*

I. Species. HYDROMIS COYPOU. *Hydromis coypus*
(Plate VI.)

Hair chestnut brown on the back, red on the flanks, and
bright brown under the belly,

Coypou. Molina's Hist. Nat. du Chili, p. 255. French Translation,
Mus coypus. Gm. Syst. Nat.

Quoiuya. D'Azzara, Hist. des Quad. du Paraguay, tom ii. p. 1.

COUNTRY.—Chili, Paraguay, Tucuman.

II. Species. YELLOW-BELLIED HYDROMIS. *Hydro-
mis chrysogaster* (Plate VIII.)

Hair chestnut brown above, orange below.

COUNTRY.—One of the islands in d'Entrecasteaux's chan-
nel.

III. Species. WHITE-BELLIED HYDROMIS. *Hydro-
mis leucogaster.* (Plate VII.)

Hair brown above, white below.

COUNTRY.—The island Maria.

**L. Physico-mechanical Experiments and Discussions of the
Phænomena observable in that casual Product of Art
the Hand Grenade, Prince Rupert's Drop, or Glass
Tear. By Mr. JOHN SNART, Optician.**

ALTHOUGH the subject of this paper is very inconsiderable
in itself, being, as was said above, "the casual and easy
product of art;" yet as it tends, in my humble opinion, to
develop some very obscure and important phænomena in
nature as well as the arts, I shall not take an operose route
to apologize for offering my explanation of it to the public;
because every accurate account of the *arcano naturæ*, &c.

is always sufficient to justify itself, and consequently does not need any apology. I therefore proceed.

The pyrometer long ago has demonstrated to the satisfaction of every one in the least acquainted therewith, that all bodies, whether in a fluid or solid state, expand by heat, and contract by cold, and from a very obvious cause; viz. because the particles of that fluid element, (fire,) by insinuating themselves between the component parts of such bodies, not only fill the most minute interstices, and pervade every pore with the greatest facility, but absolutely disunite or separate the constituent particles themselves, and thereby make them, in the aggregate, of a greater volume; and ultimately render such substances (if capable of fusion) a fluid, or running mass: in which state such substances occupy their greatest possible extension,—unless they were volatilized, or changed into vapour.

Thus much for the laws of fusion themselves. The application and inferences from them are quite appropriate.

It is while the greatest possible degree of expansion of the vitreous matter exists, that the portion which forms this molten tear or drop I am about to treat of, is separated and made. In fact, its fusion is the radical consequence of its extreme rarefaction, or expansion, being physically and mechanically superinduced thereby. For, by the introduction of the accumulated igneous particles, a separation of the once continuous particles of the glass takes place, until the attraction of cohesion entirely ceases, and fluidity eventually ensues.

Now, at this instant of extreme excitation it is, that, with a sudden and forcible jirk, the artist ejaculates or throws it forth to be suddenly quenched in cold water; when it is evident, that the parts which first came into contact with the water will become cooled and indurated first,—which is the exterior surface. And this stratum (if I may so speak, and suppose the whole composed of a number of strata) having taken its form and dimensions, no internal mutation or exertion it is capable of can either alter or lessen its form. But as all bodies, as was said before, must contract in cooling, the interior parts (contrary to gradual cooling) must give way: they therefore become vacuous, of necessity. And because the central parts cannot coalesce, they being the last which feel the refrigerating quality of the water, they remain longest in a fluid state: and as there is not a sufficient quantity of matter, when cooled, to occupy all the space it did when in an ignited or rarefied state, the parts which are most fluid, being most easy to move, and

finding they cannot fill the whole space, by close union, on account of their paucity, make the best junction they can, by taking a lateral course, and a vacuum is the result of unavoidable necessity.

And such a vacuum as cannot be produced by any other means that we know of ;—a vacuum only assailable by that subtle agent that knows no impediment,

But walks alike through solid gates of brass,
Or bars of steel, or doors of molten glass ;
This *primum mobile* all forms pervades ;
Our ev'ry act depends upon its aid.

It is true, the same event happens to other bodies, upon being brought into a state of fusion and suddenly quenched, as to glass. Thus, if a bar of steel be overheated in our attempts to harden it, we see upon breaking it that the interior parts have changed their position, and formed themselves into a kind of irregular crystals, for the same reasons : yet, as no substance but glass is so generally impermeable to all agents, except fire, the result is not so satisfactory as when this material is used ; because, on account of its diaphanous nature, or transparency, the appearances are more ocular, consequently less doubtful. For here, without analogy or hypothetical inference, our senses are called to witness the most complete vacuum in nature ; and, as far as relatés to heterogeneous effluvia, quite perfect.

A vacuum not of the Boylean kind, where that air which is driven out is ejected by means of that which remains behind ; but of the Torricellian kind, yet infinitely more perfect : the very formation of which precludes the possibility of the most subtle agent in nature (except fire) insinuating one particle of its substance therein. And, were it possible that we could make this vacuum subservient to our experiments on the mechanical pressure of the air, (whether incumbent or lateral,) I am persuaded, from what I have herein discovered, that we should have a greater result than (the maximum allowed) 14 or 15 lbs. per inch for its energy. The excess of which energy would be in a direct ratio to the perfection of this vacuum, in comparison with that of the barometer : and those of the air-pump cannot stand one moment in competition, for the reason assigned above.

And yet so well grounded were the antient philosophers "in all space being occupied by some agent or other," that they have, as it were, anticipated us in our most modern discovery ; for it was one of the dogmata of the Peripatetic or Aristotelian schools, "that Nature abhorred a vacuum."

uum." And although I will not take upon me to justify all their decisions, or even this dogma itself upon their principle; yet as this seems the *ne plus ultra* of human means to procure one, and which, after all, appears not to be absolutely so, I think their assertion is not remote enough from truth to justify a rash contradiction on our part, or to arraign the profundity of their knowledge. But to return: How great must be the velocity, how great the mechanical collision, to rend asunder with such force so well compacted a substance as the glass of which these grenades are made, even after making every reasonable allowance for its want of annealing, which no doubt increases its fragility, while it hardens the surface! There must be something more than mere mechanical influx, or consequent collision, to rend asunder and reduce to powder an impregnable mass, which is capable of resisting the weight of many tons, sustaining the force of a large vice, or the rude strokes of a hammer (after allowing for the geometric resistance on the external attack, and the want of the same in the internal force) used in breaking them, before this phenomenon will be satisfactorily explained.

And without giving a more elaborate definition than the thing is obviously susceptible of, I conceive this cause to be electricity: and that, in the formation of the drop, after the caloric particles have pervaded the glass and subsided, this matter, like a lambent flame, attaches to and lines the interior surface or cavities, as in the Leyden jar; and by this hermetic accident (for it is not properly art) may remain prisoner for many centuries; but yet, though pent up, (being perfectly insulated) is not diminished: therefore, upon opening the conduit pipe of communication in the tail, the affinity the inclosed effluvium has with that in the air, our hands, or whatever else breaks them, causes that violent detonation, and the destruction thereof considered therewith to take place, and the force of the explosion is (*cæteris paribus*) in a compound, direct, ratio with the capacity of the cavities, and the strength of materials.

Thus is it, when a vacuum is induced of necessity, and of materials which, while they are extremely friable on the one hand, are impervious to both influx and efflux on the other; (hence the want of these appearances in breaking steel, &c.) and void of every other occupant than this elastic vapour, which is generated in their first formation, which, like seed in the womb, seems to be the very germ or rudiment of elementary fire, and only waits the invitation of excitation to manifest itself: and whenever this excita-

tion is begun, how irresistible are the effects produced by it! I believe nothing in nature (if small things might be compared with great) is more analogous to an earthquake than the bursting of one of these little tears of glass, or more like it in its cause; for both arise from a sudden combustion of a latent and inflammable principle contained in their interior parts; and both alike cause a derangement of the parts which heretofore formed their orbicular prisons.

To ascertain whether they were charged *plus* or *minus**, I placed them in an insulated situation, on a large flint glass condensing receiver; and with a hammer of the same kind of glass (both being well excited) I broke some of them at the small end: but, contrary to my expectation, the result was the same as if broken in my hand.

I next placed some of them on a table, which I knew to be a good conductor, and with my glass mallet or hammer I broke several more with precisely the same effect.

I also broke some with a conducting, *i. e.* a common hammer, upon the excited receiver, but there was no difference in the effect: for all the means I made use of (however varied) were productive of the same appearances as when broken in my hand, or by the collision of a conducting substance, while they were placed upon another conductor.

And now, having varied the experiment by all the means I could devise, except I had tried the air-pump, (which I could not do, as I had not got an open receiver,) I began to doubt whether electricity had any share in this phænomenon or not, and to conclude the effect must be purely mechanical (for I would not call it a *lusus naturæ*); when what compensated all my trouble, and put the matter past doubt, was this:

I darkened the room entirely, having previously furnished myself with a clear strong glass receiver to prevent the accident of the pieces flying into my eyes; then directing these organs of vision by the feet, I broke several in this inclosure, where they uniformly produced a bright corruscation like lightning; which, together with the more than mechanical snap they make upon breaking, quite satisfied

* To those who are unacquainted with the history of electricity, it may be needful to observe, that the terms *plus* and *minus*, + —; positive and negative; vitreous and resinous; are not six different electrical qualities; but three sets of equivalent terms, in different systems of the same science, indicative of the two or contrary principles which reciprocally attract each other, and cause what is called the *electric shock*. There are also other terms by way of designating the same principles, as *terrene* and *atmospheric*; but these are not so common.

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me that it was not the mere mechanical collision of the air striking the internal surface which so forcibly rends them asunder, but a compound effect of that and electrical affinity together; which, being corroborated by so many actual experiments, makes me believe the phenomenon of these little philosophical ænigmas is nearly expiored. And although I would not say the subject is entirely exhausted, yet this solution has so satisfied my mind, that I cannot think it any longer a desideratum.

I remain, sir,

Your obliged servant at command,

Tooley-street,
Sept. 14, 1805.

JOHN SNART.

P. S. Since the publication of my paper in the 86th number of the Philosophical Magazine, from a comparison of the creature therein described with what I have met with in Dr. Shaw's work, I am inclined to think it is a *larva* of the genus *dytiscus*, of the order *coleoptera*. It might not improperly be denominated *ranamalgus*, or frog-sucker.

LI. *Twenty-third Communication from Dr. THORNTON.*

To Mr. Tilloch.

DEAR SIR,

Sept. 14, 1805.
No. 1, Hinde-street, Manchester-square.

PERMIT me the honour of continuing, in your excellent magazine, facts confirming the propriety of employing pneumatic medicine.

Case of Consumption cured by Hydro-azotic Gas.

James Davis, æt. 25, living with Mr. Chambers, banker, Bond-street, as groom, had all the marked symptoms of a confirmed galloping consumption, violent cough, frequent pains in the side, shortness of breathing, the expectoration very copious, of an opaque appearance, night sweats constantly, wasted almost to a shadow, and extremely weak, arising from a cold proceeding from putting on a damp shirt, and being wet through, in March 1805. The violence of this disease had existed two months. He was recommended by Joseph Workman, who had been similarly affected, servant of captain Bond, also cured by the same plan. This patient inhaled the hydro-azotic gas, and he took at the same time tonic medicines, as bark, columbo, with myrrh, with occasional aperients; and, following