S_{1000} = 7·48547 08605 50344 91265 65182 04333 90017 65216 79169 70880
36657 73626 74995 76993 49165 20244 09599 34437 41184 50813
96798 01438 22544 03715 81484 21958 84703 40431 40398 43368
92966 39178 33827 35905 57913 00071 54692 68403 25933 79804
87809 56515 86955 67800 24804 71415 08712 32350 00711 42865
21027 95267 06455

$\log_e 1000$ = 6·90775 52789 82137 05205 39743 64053 09262 28033 04465 88631
89280 99983 70290 27178 29032 05744 07079 91615 26879 48950
25903 35212 68587 45900 22857 63952 48420 26999 88621 07296
34506 84487 21624 97666 40425 31399 68447 86995 95585 18051
59268 96133 19788 65384 90098 66686 30946 59660 23963 10024
23212 72982 31056

E = ·57721 56649 01532 86060 65120 90082 40243 10421 59335 93992
35988 05767 23488 48677 26777 66467 09369 47063 29174 67495
14631 44724 98070 82480 96050 40144 86542 83622 41739 97644
92353 62535 00333 74293 73377 37673 94279 25952 58247 09491
60087 35203 94816 56708 53233 15177 66115 28621 19950 15079
84793 74508 56961

It will be seen that the two values found for E agree to 263 places of decimals, which supplies another independent verification of the value obtained for $\log_e 2$.

February 14, 1878.

Sir JOSEPH HOOKER, K.C.S.I., President, in the Chair.

The Right Hon. William Henry Smith and the Right Hon. Sir William Henry Gregory, whose certificates had been suspended as required by the Statutes, were balloted for and elected Fellows of the Society.

The Presents received were laid on the table and thanks ordered for them.

The following Papers were read:—

I. "Concerning the Effects on the Heart of Alternate Stimulation of the Vagi." By ARTHUR GAMGEE, M.D., F.R.S., Brackenbury Professor of Physiology in Owens College, and JOHN PRIESTLEY, Assistant Lecturer in Physiology in Owens College. Received December 15, 1877.

In 1869, A. B. Meyer* observed that it was impossible to stop the heart in dogs and rabbits continuously by stimulation of the vagus

* A. B. Meyer "Das Hemmungsnervensystem des Herzens." (Abstract by Schiffer, "Centralblatt," 1869, No. 14, p. 216.)

nerve, even when the nerves were alternately stimulated so as to relieve one another.

In 1875, Tarchanoff and Puelma* stated, "Si l'on excite longtemps *un* des pneumogastriques du chien avec des courants forts jusqu'à épuiser complétement son action sur le cœur, ce qui se manifeste par le retour de ses battements et si l'on passe *immédiatement à l'excitation de l'autre*, on n'obtient plus d'arrêt du cœur, et même on n'observe aucune altération de son activité : et pourtant le nerf excité en dernier lieu n'est alors, on le conçoit, nullement épuisé." From this experiment they concluded, "que chacun des pneumogastriques met en jeu tout l'appareil modérateur situé dans les parois du cœur ; et qu'une fois cet appareil épuisé par l'excitation d'un pneumogastrique, il ne peut être mis en activité par l'excitation de l'autre."

In 1876, Tarchanoff† published observations on the frog, in which he states that the behaviour of the frog's heart to vagus-stimulation is quite different, in respect of the mutual influence of the two nerves, from the behaviour of the heart of dogs or rabbits: "J'ai vu alors que si l'on attend pour exciter le second pneumogastrique que le premier ait été épuisé par l'excitation, l'arrêt du cœur s'obtient de la façon la plus nette ;" and he concludes "Que chez les mammifères les deux nerfs aboutissent à un appareil modérateur commun, tandis que chez la grenouille chaque nerf aboutit à un appareil indépendant."

Between the publication of Tarchanoff and Puelma's note and the publication of Tarchanoff's later observations on the frog, the authors of this paper undertook to check Tarchanoff and Puelma's statement respecting mammals, and to extend the method of experiment to frogs. In the case of mammals, dogs and rabbits were used. They were rendered insensible by chloroform or ether, or subcutaneous injections of hydrochlorate of morphia. Their vagi were exposed in the neck and divided; and the peripheral ends loosely tied by ligatures. Arrangements were made to rapidly shunt an induced, interrupted current from a Du Bois-Reymond's induction coil, from one vagus into the other, the peripheral ends of the nerves being laid over fine platinum electrodes for the purpose. In all the experiments save one a Daniell cell was used to induce the currents. A cannula was placed in the femoral artery (in one case in the carotid artery) and connected with a kymograph, which wrote upon a moving sheet of paper.

In the case of frogs, the brain, and sometimes the spinal cord, were destroyed by pithing; a stout glass rod was thrust down the gullet;

* Jean Tarchanoff et G. Puelma, "Note sur l'effet de l'excitation alternative des deux pneumogastriques sur l'arrêt du cœur." "Archives de Physiologie," serie II, tome II, 1875.

† M. de Tarchanoff, "Innervation de l'appareil modérateur du cœur chez la Grenouille." Marey's "Physiologie Expérimentale," II Année, 1876, p. 289.

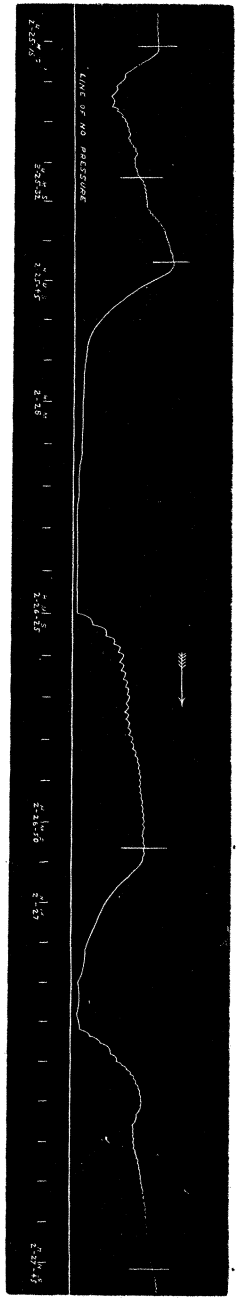
the vagi were exposed and placed each on a pair of fine platinum electrodes; and preparations were made for shunting an interrupted current, by means of a commutator, from one nerve into the other, just as in the case of mammals. Sometimes the heart was watched directly and notes made. At other times care was taken to register the heart's rate, the lapse of time and the moments of stimulation. The heart's rate was indicated by means of Marey's *Myographe du cœur*,* the time by an electromagnet and Ludwig's *Unterbrechungsuhr*, and the moments of stimulation by a marking key, each holding a pointed lever against a smoked revolving cylinder.

The general result of the experiments made by the authors of this paper, is the following: In all the animals hitherto examined (viz., dogs, rabbits and frogs), if one vagus be stimulated powerfully so as at first to arrest the heart, and if after the heart has recommenced to contract, the current be at once shunted to the other vagus, arrest again occurs: in some cases, however, on again reversing to the vagus first stimulated, no effect is produced. This result may be formulated as follows: Stimulation of one vagus never annuls, or even prejudices, the inhibiting powers of the other vagus, *unless when the inhibiting apparatus has been recently under stimulation for some time.* It would therefore seem that Tarchanoff, in asserting the mutual prejudicial action of vagus-stimulations in mammals, and denying it in frogs, has missed one half of the truth in the case of the former, and the other half in the case of the latter.

In illustration of their statement of results of experiments, the authors append a reduced kymographic tracing of a dog. The animal was a young terrier, and the experiment was made in the manner above described. The arterial cannula leading to the kymograph was introduced into the femoral artery.

The upper line is the tracing of the kymograph, the middle line is the line of no pressure, and the lower line is divided into intervals of five seconds. The tracing reads from left to right. Quite at the left of the figure a small portion of the normal tracing is represented. At 2h. 25m. 15s., a stimulus was thrown into the left vagus, the secondary coil being 6 c.m. from the primary. At once the heart stopped and the blood-pressure fell. The heart recommenced, and at 2h. 25m. 32s. the current was shut off from the nerve. It remained off about 10 seconds, and at the expiration of that interval the current was thrown into the right vagus. Again the heart stopped, and remained motionless until 2h. 26m. 25s., a period of 43 seconds, the current, of course, passing the whole of the time. The heart then began to beat, and the blood-pressure rose towards the normal rapidly. At 2h. 26m. 53s. the current was shunted out of the right vagus into the left, the nerve first stimulated, and once more the pulse ceased and

* See Marey's "Physiologie Expérimentale," II Année, 1876, p. 70.



....Excitation of left vagus, II coil at 6 c.m.

....Stop exciting.

....Reversed excitation to right vagus.

....Reversed to left vagus.

....Stop exciting.

(Tracing reduced by photography to about $\frac{2}{3}$.)

the pressure fell. At 2h. 27m. 15s. the pressure quickly rose, notwithstanding the continued stimulation; until at 2h. 27m. 45s. the current was broken and the experiment brought to a close.

It seems to the authors that the generally accepted theory of the connection of the vagus nerves with a common intermediate apparatus is fully competent to cover the facts established by A. B. Meyer, Tarchanoff and Puelma, and themselves. Each vagus abuts against a common nervous apparatus, through which every inhibitory stimulus must pass to reach the cardiac muscle. It is only necessary to suppose—and the supposition, as it will be shown, is not gratuitous—that the exhaustibility of the vagi is far greater than that of the common mechanism they lead to, in order to gain a consistent view of the facts. When one vagus is stimulated with a strong current, the heart, after a longer or shorter period of diastolic rest, gradually escapes from the inhibitory influence of the stimulus. This escape must not be supposed to be due to the gradual exhaustion of the whole inhibiting apparatus, but merely to that of the vagus which is stimulated. The heart escapes, not because its guard is enfeebled, but because the warrant for detention miscarries. On shunting the current into the other vagus, the intermediate apparatus is at once roused and the heart stopped.

So much greater are the enduring powers of the intermediate apparatus that, even in the mammal, where, presumedly, they are more easily exhausted than in the frog, the intermediate apparatus seems capable of tiring out relay after relay of reinvigorated vagi. Indeed, it would appear to be next to impossible, by the most careful and judicious alternate stimulation of the vagi, to cause exhaustion of the intermediate apparatus; for, after stimulating the vagi alternately a few times, the interval during which each vagus can hold the heart in check becomes too brief for the recovery of the resting vagus. Nevertheless, when this stage has been reached, it is always possible (in the frog) at once to stop the heart by applying an induced, interrupted current to the *sinus venosus*, even if the current so applied be weaker than that passing previously through the vagus nerves.

But, although the authors believe that the intermediate apparatus can, in health, easily wear out the organised attacks of the vagi, particularly in the case of frogs, yet they think it not improbable that, in conditions unfavourable to the restorative processes, the intermediate apparatus may occasionally succumb to successive vagus-stimulations, especially in the case of mammals. They are, however, convinced that the latter alternative very rarely occurs.

The assumption of such enormous powers of endurance for the intermediate mechanism is not gratuitous. As long ago as 1869, A. B. Meyer* pointed out that the heart of the frog could be inhibited

* A. B. Meyer, *loc. cit.*

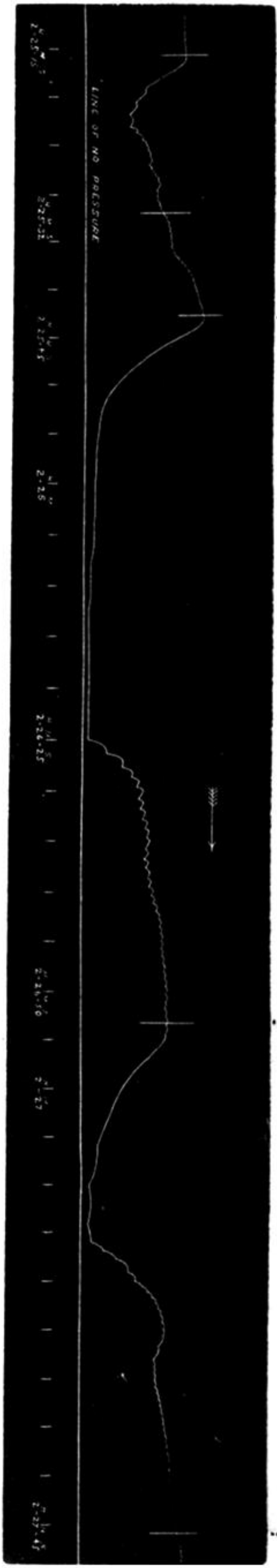
for hours by carefully applying interrupted currents to the *sinus venosus;* and although the authors of this paper, in repeating the experiment, have sometimes failed to inhibit indefinitely—as did also Meyer—they have always found it possible to stop the heart for very long intervals by stimulating the *sinus venosus;* even with weaker currents than had just before sufficed to exhaust simultaneously the inhibiting powers of both vagi.

II. "On Schulze's Mode of Intercepting the Germinal Matter of the Air." By JOHN TYNDALL, F.R.S., Professor of Natural Philosophy in the Royal Institution. Received December 17, 1877.

In "Poggendorf's Annalen" for 1836, Franz Schulze described an experiment which has attained considerable celebrity. He placed in a flask a mixture of vegetable and animal matters and water; through the cork of the flask two glass tubes passed air-tight, each being bent at a right angle above the cork. He boiled the infusion; and while steam issued from the two glass tubes, he attached to each of them a group of Liebig's bulbs, one group being filled with solution of caustic potash, and the other with concentrated sulphuric acid. Applying his mouth on the potash side, he sucked air daily through the sulphuric acid into the flask. But, though the process was continued from the end of May till the beginning of August, no life appeared.

In this experiment, the germs diffused in the atmosphere are supposed to have been destroyed by the sulphuric acid, and doubtless this was the case. Other experimenters, however, in repeating the experiment of Schulze, have failed to obtain his results. The experiments of Dr. Hughes Bennett are a case in point, to which I might add certain failures of my own. Schulze's success is, perhaps, in part to be ascribed to the purity of the air in which he worked; possibly, also, to extreme care in drawing the air into his flask; or, it may be, that the peculiar disposition of his experiment favoured him. Within the flask, as shown by his diagram, both his glass tubes terminated immediately under the cork, so that the air, entering by the one tube, was immediately sucked into the other, thus failing to mix completely with the general air of the flask.

At a very moderate rate of transfer, I found, in 1869, that germs could pass unscathed through caustic potash and sulphuric acid in succession. To render the experiment secure, the air-bubbles must pass so slowly through the sulphuric acid, that the floating matter, up to the very core of every bubble, must come into contact with the surrounding liquid. It must, of course, touch the acid before it can be destroyed.



....Excitation of left vagus, II coil at 6 c.m.

....Stop exciting.

....Reversed excitation to right vagus.

....Reversed to left vagus.

....Stop exciting.

(Tracing reduced by photography to about $\frac{1}{8}$.)