in alcohol, a partial solution is formed, leaving an elastic substance, which is said to possess the properties of caoutchouc, but which becomes hard by exposure to the air.

The author has remarked, that the portion of mastic dissolved in the alcohol may be precipitated from it by water, and that this precipitate possesses the properties of a pure resin; but when a stream of oxymuriatic acid gas was passed through the solution, a tough elastic substance was thrown down, which became brittle when dry: this precipitate was soluble in boiling alcohol, but separated from it as the solution became cool. Its properties, therefore, approached in some measure to those of the original insoluble part.

On the Direction of the Radicle and Germen during the Vegetation of Seeds. *By* Thomas Andrew Knight, *Esq. F.R.S.* *In a Letter to the Right Hon. Sir* Joseph Banks, *K.B. P.R.S.* Read January 9, 1806. [*Phil. Trans.* 1806, *p.* 99.]

It is, Mr. Knight observes, very well known, that in whatever position a seed is placed to germinate, its radicle always makes an effort to descend towards the centre of the earth, whilst the elongated germen takes a precisely opposite direction: and it has been proved by Du Hamel, that if a seed, during its germination, be frequently inverted, the points, both of the radicle and germen, will return to their first direction. These opposite effects have, by some naturalists, been attributed to gravitation; and Mr. Knight conceived, that if they really proceeded from that cause, those effects would take place only whilst the seed remained at rest, in the same position with respect to the attraction of the earth, and that the operation of gravitation would be suspended by a constant and rapid change of position in the germinating seed, and might be counteracted by the agency of centrifugal force. In order to determine how far the above opinion was well founded, he made the following experiments:—

Having a strong rill of water passing through his garden, he contrived, by its means, to give motion, vertically, to a wheel of eleven inches diameter. Round the circumference of this wheel, several seeds of the garden-bean, which had been previously soaked in water, were bound in such a manner that their radicles were made to point in every direction. The wheel made rather more than 150 revolutions in a minute.

In a few days the seeds began to germinate, and Mr. Knight had the pleasure to see that the radicles, in whatever direction they were protruded, turned their points outwards from the circumference of the wheel, and in their subsequent growth receded still further from it. The germens, on the contrary, took the opposite direction; and in a few days their points met at the centre of the wheel. Three of these plants were suffered to remain on the wheel; their stems soon extended beyond its centre, but their points returned, and met again at the centre.

As Mr. Knight conceived that some slight objections might be urged against the conclusions he was inclined to draw from the above experiment, he repeated it in a different manner, by adding to his former apparatus another wheel, also of eleven inches diameter, which moved horizontally, and to which he could give different degrees of velocity. Round the circumference of this horizontal wheel, seeds of the garden-bean were bound, as in the former experiment, and the wheel was made to perform 250 revolutions in a minute. The effect produced by this motion soon became obvious; for the radicles now pointed downwards about ten degrees below the horizontal line of the wheel's motion, whilst the germens pointed the same number of degrees above it: but when the motion of the wheel was diminished to 80 revolutions in a minute, the radicles pointed about 45 degrees below the horizontal line, and the germen as much above it; the one always receding from the axis of the wheel, the other approaching to it.

The foregoing experiments, the author thinks, prove that the radicles of the germinating seeds are made to descend, and the germens to ascend, by some external cause, and not by any power inherent in vegetable life; and he sees little reason to doubt that gravitation is the principal if not the only agent employed in this case by nature. The radicle, he says, is increased in length only by parts successively added to its point; whereas the germen, on the contrary, is elongated by a general extension of its parts previously organized; and its vessels and fibres appear to extend themselves in proportion to the quantity of nutriment they receive. When the germen deviates from a perpendicular direction, the sap accumulates on its under side; and consequently, as the vessels and fibres on that side elongate more rapidly than those of the upper side, the point of the germen must always turn upwards. This increased elongation of the vessels and fibres of the under side produces also the most extensive effects in the subsequent growth of the trunks and branches of trees. The immediate effect of gravitation, Mr. Knight says, is to occasion the depression of the branches; but, by the above-mentioned increased longitudinal extension of the under side, their depression is prevented, and they are even enabled to raise themselves above their natural level.

It has, however, been objected by Du Hamel, that gravitation can have little influence on the germen when it points perpendicularly downwards. To obviate this objection, Mr. Knight made many experiments on the seeds of the horse-chestnut and of the bean. The result was, that the radicle of the bean, when made to point perpendicularly upwards, formed a considerable curvature in the course of a few hours. The germen was more sluggish; but, in spite of any efforts made by the author to prevent it, constantly changed its direction in less than twenty-four hours.

It may also, Mr. Knight says, be objected, that few of the branches of trees rise perpendicularly upwards, and that their roots always spread horizontally. Respecting the first of these objections, he ob-

serves, that luxuriant shoots, which abound in sap, constantly turn upwards, and endeavour to acquire a perpendicular direction; but that the feeble and more slender shoots grow in almost every direction, probably from their fibres being more dry, and their vessels less amply supplied with sap, so that they are less affected by gravitation. To the second objection, Mr. Knight answers, that the compression of the radicle, as it penetrates the soil, obstructs the motion of the sap, and occasions the generation of numerous lateral roots; and as their substance is less succulent than that of the radicle first emitted, they are less obedient to gravitation, and consequently extend horizontally in every direction. Respecting the tap-root of the oak, the author says he has examined at least 20,000 trees of that species, and never found one tree that possessed a tap-root; he therefore thinks he may be allowed to doubt the existence of such a root.

A third Series of Experiments on an artificial Substance, which possesses the principal characteristic Properties of Tannin; with some Remarks on Coal. *By* Charles Hatchett, *Esq. F.R.S.* Read January 16, 1806. [*Phil. Trans.* 1806, *p.* 109.]

Mr. Hatchett, in his former communications on this subject, gave some account of the effects produced by sulphuric acid upon turpentine, resin, and camphor. He now states the results of a variety of experiments made with that acid upon a great number of resins, balsams, gum-resins, and gums; from which it appears, that sulphuric acid almost immediately dissolved the resins, forming transparent brown solutions, which gradually became black; that the solutions of the balsams and of guaiacum were at first of a deep crimson colour, slightly inclining to brown; and that caoutchouc and elastic bitumen were not dissolved, but, after a long digestion, were only superficially carbonized.

Turpentine, common resin, elemi, tucamahaca, mastic, copaiba, copal, camphor, benzoin, the balsams of Tolu and of Peru, assafœtida, and amber, yielded a large proportion of the tanning substance; so also did oil of turpentine.

Asphaltum yielded only a small portion of that substance; and some slight traces of it were obtained from gum arabic and from gum tragacanth; but none was produced from guaiacum, dragon's blood, myrrh, gum ammoniac, olibanum, gamboge, caoutchouc, elastic bitumen, liquorice, and manna. Mr. Hatchett thinks, however, that some of these would have yielded it, had not the digestion with nitric acid been too long continued.

Olive oil was partly converted into the tanning substance; so also were linseed oil, wax, and animal fat. In the experiment with linseed oil, a portion was left undissolved: this portion appeared to retain many of the properties of an inspissated fat oil. In the experiment made with wax, a white substance was obtained, which was found to possess the properties of spermaceti. In that with animal fat (in which the kidney-fat of veal was employed), a great