An experimental inquiry into the physiological action of ergot of rye / by Samuuel Wright.

AN

EXPERIMENTAL INQUIRY

INTO THE

PHYSIOLOGICAL ACTION OF ERGOT OF RYE.

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(From the Edin. Med. and Surg. Journal, No. 141.*)*

Whether ergotted grain were known to the ancients is a matter of doubt. It is said to have been mentioned by Theophrastus, Virgil, Ovid, and Pliny ;* but I think it very probable that they were not acquainted with any other forms of the disease than smut and mildew. The "luxuries segetum" of Theophrastus and Pliny has been supposed to imply ergot, though the evidence in its favour I have never been able clearly to ascertain. We are, however, certain that it has been extensively known during the last two centuries, described as chiefly affecting rye, and recog-

* Spicæ quædam binos ordines habent, quædam plures usque ad senos. Grano ipsi aliquot differentiæ, longius, leviusque, aut brevius, aut rotundius, candidius, nigrius, vel cui *purpura* est.—Plinii, Nat. Hist. lib. 18, c. 18.

nized by various names, according to the languages in which it may have been expressed.

Germ. Mutterkorn, Afterkorn, Schwarzkorn, Halmensporn, Aetzroggen, &c.—*Fr.* Seigle ergoté, Bled cornu, Clou de seigle, Mère de seigle, Bled avorté, Bled farouche, Have, or Rachitique, Calcar, Chambucle, Ebrun, Faux seigle, Seigle cornu, or corrumpu, Seigle à eperon, or ergotisé, Seigle ivré, Seigle noir, Argot, &c.—*Ital.* Grano allogliato, Segala allogliata.—*Polon.* Paniec. *Russ.* Spornick.—*Angl.* Ergot, Ergotted, Horned, or Spurred Rye.*—*Lat.* Clavus secalinus, Secalis mater, Ergota, &c. "A Cl. Candolle, qui illud inter fungos computat, vocatur Sclerotium clavus; eandem ob causam a Doct. Münchhausen, Clavaria solida. Doct. Robert, ob vires partum promoventes, illud nuncupat Secale Puerperale, vel Melanophyma secalinum; (nigra in Secali semina.")

Ergot is a disease to which rye is more liable than any other grain, though Tillet observed it in wheat near Rheims;† and the author of the Journal Encyclopédique says that he has repeatedly seen the oat so deteriorated.‡ Nor is it uncommon for barley to become ergotted in Scotland.

This disease has also been noticed in the

Phalaris canariensis	Arundo arenaria
——— aquatica	——— cinnoides
Panicum miliaceum	Elymus arenarius
Phleum pratense	——— Europæus
Poa fluitans	Triticum spelta
Festuca duriuscula	——— junceum
Alopecurus pratensis	——— repens
——— geniculatus	Holcus avenaceus
Aira cristata	——— lanatus
Agrostis stolonifera	Dactylis glomerata§

By Curtis in the *Festuca fluitans*, and by others in the *Avena elatior*,‖ and in the family of palms.¶.

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* From its supposed resemblance to the spur of a cock or a horn.

"Deep-rooted mould, and Ergot's *horn* uncouth."—
(Darwin's Bot. Garden, Canto 4.)

"Denominationis origo facili negotio explicatur: secale enim appellatur, quod vulgo observatur in secali cereali; *cornutum*, figura, quod semina hoc vitio degenerata ad calcaris vel cornu similitudinem accedunt; quoad significationem ergo nihil differunt nomina: secale corniculatum, calcaratum, frumentum, cornutum, et alia, quæ passim reperimus."—(Rudolph Padiera, Med. Diss. De Secali Cornuto, Cap. i.)

† Dissertation sur la cause qui corrompt et noircit les grains du blé dans les epis, et sur les moyens de prévenir les accidens.—Bordeaux, 1755, 4to.

‡ Journ. Encyclop. Juin 1771. p. 209.

§ Rust's Magazin für die gesammte Heilkunde, 25, 8.

‖ Lond. Med. and Phys. Journ. 1817, Vol. xxxviii. p. 334.

¶ Aymen.—It may be observed, that Tissot states, on the authority of Haller, that the ergot affects only rye, and two or three other alpine plants of the grass kind.—(See Philosophical Transactions for 1765, Vol. lv. p. 110.)

SECTION I.—*Physical Characters of Ergot of Rye.*

Ergot, when ripe, displays itself in the form of a dark-coloured substance,* which, in the place of sound grain, resides in the glume, exceeding it variously in length, and, if abundant, rendering the ear very conspicuous from the peculiarity of its hue. Some of the grains are composed of sound and diseased portions; the ergotted part, varying from one-third to one-half, is always within the husk.† It is rare to find all the pickles of an ear ergotted, the fewer so corrupted the more luxuriant they are. And conversely, when numerous, they are small in size, sometimes not exceeding the diameter or length of a sound grain.‡ The number of ergots in each ear is usually from four to five, though sometimes there will be ten or twelve. If only two or three be present, the sound grains upon the same ear are observed to be larger than usual; the whole plant is also more vigorous and healthy. But when the ergots are numerous, the grains not actually diseased have a very unhealthy appearance; they look shrunken, and are covered at their superior extremity with a black powder.§

It is chiefly produced upon low lands, more frequently on the borders than in the middle of a field, and generally in hot summers when there is plenty of rain. Spring wheat is also more liable to it than that sown in the winter season.‖

Ergot of rye is triangular in form, occasionally round, but oftener angulated, retaining the original longitudinal depression of the sound grain, to which are generally added two or three others, running from one extremity to the opposite. Its length is from six to ten lines; though often much greater. I have seen it eighteen lines in extent; and Aymen says that he has preserved in his herbarium a specimen, the length of which is equal to twenty-six lines. It is from one to three lines in diameter, generally smooth,

* Tissot says that it is sometimes green.—(Traité des Nerfs, et de leurs Maladies, Vol. vi. p. 218.)—When growing it is usually of a deep-green colour, gradually changes to a light pink, and when matured becomes purple, from the action of atmospheric air upon its oil.

† Dissertation by Oliver Prescott, A. M. Read before the Massachuset's Med. Soc. June 2, 1813.

‡ This is only the case with rye. Ergot of wheat, whether sparing or abundant, is always found to be short and thick.

§ Tessier, Traité des Maladies des Grains. 8vo, Paris, 1783, p. 421.

‖ We hence see the appropriateness of Virgil's allusion.

"Multi ante occasum Maiæ cæpere: sed illos
Expectata seges vanis elusit aristis."—Georg. lib. i. 225–6.

Columella also remarks—It was an old proverb amongst farmers, that an early sowing often deceives our expectations, but seldom a late one.

The growth of ergot is very rapid when compared with that of the sound grain. Philippart in his "Traité Organographique et Physiologico-agricole sur l'Ergot, &c. dans le Cereal," says that he observed some particular plants of rye whilst passing a certain corn-field, which plants had no appearance of ergot, but in ten or twelve days afterwards they had full-sized ergots on them.

of a violet-brown or brownish-purple colour, and curved towards the extremities, which are commonly tapering. To the naked eye its surface appears uniform, but when viewed through a microscope it is found to be sprinkled over with sparkling white dots, translucent and angular. Sometimes it is entirely covered with a grayish mealy powder, arising from the puncture of an insect, which transfers some portion of the substance of the grain to the surface.

It is firm, hard, and fragile when dry; soft, flexible, and tough when moist; emitting in the former instance, a heavy mawkish smell, in the latter, the odour of mouldiness.

It breaks with a clear transverse fracture, and the newly separated parts have a bright almond-like structure, over which is shed a faint blush of pink. When split longitudinally, little scales or lamellæ are often found, covering oblong cavities, each cavity usually terminating in a *cul de sac*, being rarely continued to the surface. These little canals are branched, and filled with a grayish dust, interspersed with a number of shining granules.

Ergot of rye has a nauseous acrid taste, leaving in the mouth a slight, but disagreeable sensation of warmth.* When kept in a moist atmosphere, it becomes soft, enlarges slightly, and is extensively preyed upon by insects; the outer covering acquires an intense blackness, and the active property of the drug is gradually impaired and lost. It is said that after having been twice subjected to dampness and dried again, it is no longer punctured by insects, but remains permanently enlarged. If reduced to powder before exposure to moist air, it very readily grows damp, and spoils much sooner than when exposed in the whole state, being in a few days completely covered with animalculæ. Roll sulphur has been suggested as a preservative; but I have never been able to discover the least advantage in its employment. Camphor has also been advised, and with much more propriety, for if intermixed with even powdered ergot, it completely prevents the formation of animalculæ; but the particles become moist, semi-pellucid, and mouldy, the activity of the substance at the same time diminishing. It is, however, best preserved in a warm dry place, after having been wrapped in absorbent paper, and secured in a well-stoppered bottle.

As it is important to distinguish between a good and a bad specimen, it may be observed, that if the ergot be clear and smooth upon the surface, not powdery, of a deep purple colour—neither totally black nor light brown, having a full strong odour, breaking clearly,† exhibiting a pink blush interiorly, unpunctur-

* Zimmermann, von der Erfahrung, Th. 2, p. 242, and Trommsdorff, Neues Journal der Pharmacie, Bd. 2, St. 1, p. 94, deny that it has any taste.

† It is necessary that the sample should be broken, and perhaps, that it should be tested, for Dr O'Shaughnessy once analysed a specimen of alleged ergot, which

ed by insects, burning with a clear jetting flame, and being of less specific gravity than water, its activity may be trusted.*

Section II.—*Chemical Characteristics and Composition of Ergot of Rye.*

When moderately heated, ergot becomes light-coloured, loses its natural smell, and acquires the odour of roasted wheat, at the same time greatly diminishing in activity. Flour, which contains as much as one-third of ergot, rises without any difficulty when made into paste, though when baked, the bread is dry and brittle. When ergot alone is made into bread, it does not ferment, remains sad, or heavy, and crumbles when handled.†

When ergot is boiled in water, it forms, if the preparation be concentrated, a deep claret-coloured solution, having the odour of ergot, and embodying its active principle. Continued boiling weakens the medicinal activity of the solution, and will, if sufficiently continued, render it inert. The cuticle does not peel off by maceration, nor can boiling, however protracted, separate it; but its colour is transferred to the interior of the grain, giving it a deep-red tinge. The solution obtained by boiling exhibits a white pellicle upon its surface, when cool, which is the oil of ergot altered by heat and moisture, and in this condition looks like common fatty matter.

An infusion of ergot is thus affected by reagents. Litmus paper indicates the presence of a free acid. Caustic potassa renders it a fawn colour in a few minutes; flakiness succeeds, which terminates in a light brown precipitate.‡ Caustic ammonia gives a bulky precipitate of a light pink colour. Lime-water, a light blue deposit. Carbonates of soda and potassa, no immediate effect, but in a few minutes there is a deposition of a grayish-pink colour. The strong acids afford a yellowish flaky coagulum. Io-

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proved to be nothing more than plaster of Paris artfully coloured. (Lancet, 1830–31. Vol. i. p. 638.) And I have several times observed the ergot to be adulterated with common paste; a fraud, I suspect, of very frequent occurrence, though not of very easy detection; for the process of baking generally modifies the starch, so that it can scarcely be indicated by iodine. The best way of testing it is to powder the suspected sample, and, after moistening with water, to triturate it gently with iodine, when, if a blue colour results, an impurity may be credited. If this process be not satisfactory, the specimen may be digested in ether; if the ergot be genuine, a yellowish oily solution will result; if impure, little change will take place.

* The lightness of ergot depends upon the presence of its oil, which reduces its weight considerably below that of sound rye: hence the ergotted ears stand upright, those, on the contrary, not diseased, bend down from their greater weight. A measure that holds fourteen pounds of rye, holds only nine pounds of ergot.

† I may here state, that in giving ergotted bread to dogs, they have invariably been less affected by it, than when a similar quantity of ergot has been administered in an uncombined state.

‡ The action of caustic potassa upon an aqueous solution of ergot, prepared without heat, is somewhat different. When first added, it gives the liquid a greenish tinge, and a curdy precipitate falls. If an acid be then dropped in, the precipitate is redissolved, and the original colour restored.

dine darkens its colour merely. Iodide of potassium, no change. Persulphate of iron, no change. Nitrate and acetate of lead form a bulky precipitate of a dirty violet colour, which is slow in falling. Protochloride of tin gives an abundant precipitate of a light-yellow colour. Chloride of gold, a yellowish deposit. Infusion of galls, a brown coagulum, which dissolves on being agitated. Alcohol occasions a slight opacity. Sulphuric ether when agitated with it forms a solution, which, on standing, separates into three strata,—the lowest, consisting of the aqueous solution, the middle one, of oil dissolved in ether, and the upper one, of pure ether.

Alkalized water, when boiled upon ergot, forms a saponaceous solution, in which the greater part of the colouring matter prevails. Alcohol removes the active principle of ergot, with a very small portion of its colouring matter. Ethers, sulphuret of carbon, naphtha, and the essential oils also separate its active principle, but leave the pigment untouched. Water, therefore, pure or alkalized, is the best solvent of the colouring matter.

This colouring matter is capable of being fixed as a dye; for, if wool or silk, prepared by digestion in sulphate of alumina, be dipped into a solution of ergot, it becomes beautifully tinged with a hue, varying from a light pink to a deep violet.*

Chemical Composition.—Ergot of rye has been analysed by Vauquelin, † Bonvoisin, ‡ Pettenkofer, § Winkler, ‖ Keyl, ¶ Robert, ** and others.

Vauquelin obtained a pale yellow pigment, soluble in alcohol; a white oil of a sweetish taste; a violet-coloured pigment, insoluble in alcohol; an acid, resembling the phosphoric; and a vegeto-animal matter, which easily putrefied, and afforded a thick oil and ammonia by distillation.

Pettenkofer, in addition to these constituents, obtained a reddish-yellow resin, phosphates, and a little acetic acid.

Winkler found gum, osmazome, salts of soda and ammonia, a modified fecula, in union with colouring matter, a thick, rancid, slightly acrid oil, and a thick reddish fluid, which had a highly disagreeable empyreumatic odour, a nauseous, sweetish, and slightly acrid taste—composed chiefly of resin, extractive, and colouring matter.

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* Vauquelin, Annales de Chimie et de Physique, Tom. iii. p. 337.

† Buchner's Repertor. für die d. Pharmacie, Th. 3, and Bulletins de la Soc. Philomatique, 1817, 58.

‡ Gehlen's Journ. d. Chimie, Th. 6. 1806. § Buchner's Repert. 3. 65.

‖ Rust's Magazin. Bd. 25. Hft. 1, p. 47–49.

¶ De Secali Cornuto, etc. Diss. Ber. 1823.

** Rust's Magazin, Bd. 25, Hft. 1, p. 41, sqq.

Keyl obtained similar results, but was unable to find either hydrocyanic acid or morphia, both of which were said to be present.

Bonvoisin concluded from his experiments, that the constitution of ergot is highly favourable to decomposition; and further imagined, that, by its putrescency, it acted upon the animal body, occasioning a dissolution of its several parts.

Robert inferred from his researches, that the acid which Vauquelin had supposed to be phosphoric, was none other than hydrocyanic, for the liquor obtained by the distillation of ergot readily killed insects, and gave out a strong narcotic odour, which occasioned dizziness. He also imagined that it contained some specific poison, hardly to be detected by chemical means.

Winkler obtained an acid, the certain nature of which he was unable to prove, but he denied the presence of hydrocyanic acid. He also found amylum, osmazome, saline matter, and chlorophylle; a thick oil, similar to what he had obtained from *Artemisia vulgaris*, and a pigment, analogous to that in the lichen, *Roccella tinctoria*.

According to the researches of Maas, a German chemist, ergot contains no amylum, but consists for the most part of gluten, a colouring matter, resin, fixed oil, and an alkaline principle, apparently combined with acetic acid. The alkali he believes to be either ammonia or a peculiar alkaloid. He says he could never find a trace of hydrocyanic or phosphoric acid, morphia, or narcotine.*

The most elaborate analysis yet given is by Wiggers,† whose results are as follow;—

A thick white oil,	35,0006
White fatty matter,	1,0456
Cerine,	0,7578
Fungin,	46,1862
Ergotine,	1,2466
Osmazome,	7,7645
Sugar,	1,5530
Gum extractive and colouring matter,	2,3250
Vegetable albumen,	1,4600
Phosphoric acid and phosphate of potass,	4,4221
Phosphate of lime and traces of iron,	0,2922
Silica,	0,1394

I have read attentively the analysis of Wiggers, which is detailed in the "Journal De Pharmacie," but I must confess that I think many of his supposed constituents are products, and not educts. This appears to me especially the case in reference to

* Quoted in the Lancet, 1829–30, Vol. ii. p. 187.
† Journal de Pharmacie, Tom. xviii. 525.

the cerine and sugar, both of which were probably formed by the solutions of ergot standing for some time. When we consider the liability of vegetable solutions to alter by exposure, and the facility with which new substances are produced, we may easily imagine that some of these constituents were formed during the analytical process; and were not originally present in the ergot. The vegetable albumen I have never been able to discover by any of the means usually employed for its detection, and if the analysis of Wiggers be accurate, my own must either be imperfect, or the specimens of ergot which I examined were peculiarly simple in composition. The following is the analytical process which I have adopted.

To determine the nature of the free acid, the character of which was suspected by Vauquelin, and erroneously represented by Mr Battley,* I prepared a strong infusion of ergot—200 grains to two ounces of water, and submitted it to slow distillation until two-thirds had passed over. The distilled liquid showed no traces whatever of acidity, but the residual portion was more strongly acid than before concentration. Being satisfied from the fixedness of the acid, that it was neither hydrochloric nor hydrocyanic, I proceeded to demonstrate its nature by filtering through charcoal to remove the colouring matter, and then dividing it into two equal parts. To one of them was added a solution of nitrate of silver, when immediately a yellow precipitate fell, which, when moistened with sulphuric acid, and subjected on charcoal to the flame of a blowpipe, tinged it green. The other portion was acidified with strong acetic acid, and acetate of baryta subsequently added.† The solution was then filtered, slowly evaporated to one-half, and exactly neutralized with ammonia.‡ On adding acetate of lead, a copious precipitate was obtained. The precipitate on being fused on the outer flame of the blowpipe, was in distinct crystals on cooling. Another portion, after having had a drop of sulphuric acid added to it, on being exposed to the inner flame on charcoal, tinged it green.

These experiments, which were many times repeated, and with the same results, appear to justify the inference that the free acid contained in ergot of rye is phosphoric acid. The further analysis of ergot I prosecuted in the following manner.

Any proposed quantity of it is to be reduced to a very fine

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* London Med. Gazette, 1830–31, Vol. vii. p. 681.

† The object here, was to remove any traces of sulphuric acid, and the acetic acid was added to prevent the phosphate of baryta subsiding along with the sulphate; the latter readily precipitating from an acid solution, the former only from a neutral one.

‡ The fluid was concentrated with the intention of removing as much of the acetic acid as possible; for acetate of ammonia is capable of retaining phosphate of baryta in solution.

powder, and acted upon by sulphuric ether in successive additions, until nothing more that is soluble in that menstruum is taken up.* Each of the ethereal solutions, after separation and evaporation, furnishes a determinate quantity of oily matter, and the whole collectively weighed, give the proportion of that constituent to the ergot used.

The residuary grain is then to be carefully dried, so that all the remaining ether may be expelled, or the next solution will include the colouring matter. When thoroughly dry, it is to be treated with distilled water, until everything soluble in that liquid is removed. The solution thus obtained comprises the mucilage and osmazome.† By evaporating to dryness, and acting upon the residue with strong alcohol, the osmazome is separated and the gum left. The latter is then to be weighed, and its quantity noted, and after evaporating the alcoholic solution to dryness, the proportion of osmazome is similarly defined.

The grain is next to be boiled in two or three successive measures of strong alcohol, and each filtered whilst hot. The solutions, after intermixture and evaporation, give the gluten contained.

The residue is now to be boiled in dilute nitric or hydrochloric acid to dissolve the fungin. This, after the liquid shall have been filtered, may be precipitated in a gelatinous form by the addition of tincture of galls, or an alkali.

The colouring matter next requires to be removed, and its separation is a work equally protracted and difficult. The remaining solid matter of the grain must be boiled in successive portions of *liq. potassæ*, until the whole of the colouring material is ex-

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* It is necessary that the ether be very pure, and that no water be present, or a complex solution will be formed.

The resin spoken of by many, I have never been able to detect; and as this substance is soluble in ether, it should if present, be furnished along with the oil which is taken up by that solvent. None, however, is afforded in this process, or in any of the succeeding ones, and I am disposed to believe that the alleged resin is nothing more than inspissated oil; for a specimen of ergot which I examined after it had been for some time exposed to atmospheric air and warmth, displayed traces of resinous matter, although a sample from the same packet, examined prior to its exposure, gave no such indications.

The fatty matter, cerine? &c. I have never been able to find. They are probably nothing more than oil, modified by warmth and moisture.

† It is remarkable that this substance, which is so essential a constituent of muscle, should be found prevalent in vegetable matter. But ergot is not the only one of the vegetable tribes which contains it. It is found in the *Agaricus campestris* and *Agaricus pseudo-aurantiacus*; in the rhizome of ginger. (Morin, Journ. Pharm. 10, 252, 9, 258.); in dyer's broom, (Cadet Gassicourt, Journ. Pharm. 10, 434); and in the matter secreted by the bracteas of the female hop; (Payen et Chevallier, Journ. Chim. Med. ii. 577). I have continued the old term osmazome, though I am aware that such a substance is not recognized by modern chemists; inasmuch as late experiments in organic analysis have resolved it into various primitive constituents. But as the animal matter which forms the basis of osmazome has not yet been clearly described, I have thought it most prudent to retain the original expression.

tracted. But the potash takes up also the fecula,* which needs a subsequent removal. For this purpose, the potash solutions are to be neutralized with an acid, evaporated to dryness, and acted upon by *liq. ammoniæ*, which has the property of removing the colouring matter in this state, though before it would be unaffected by it. The ammoniacal liquid after evaporation leaves a definable proportion of colouring material.

The fecula is purified from the potash salt by continued washings with distilled water, and after having been dried, is to be added to the portion not taken up by the *liq. potassæ*, and carefully weighed.

To determine the proportion of earthy and saline matters, 100 of ergot are to be completely burned in a covered platinum crucible, and the residue tested in the usual way. It has scarcely ever exceeded three grains, one of which has usually been silica, and the other two, phosphates of soda and lime.

My analysis has furnished me with the following constituents and their proportions.

Thick white oil, - - -	31.00 grains.
Osmazome, - - - -	5.50
Mucilage, - - - -	9.00
Gluten, - - - -	7.00
Fungin, - - - -	11.40
Colouring matter, - - -	3.50
Fecula, - - - -	26.00
Salts, - - - - -	3.10
Loss, - - - - -	3.50
	100.00 grains.

Ergot appears to differ from sound rye, chiefly in the presence of oil, osmazome, and fungin.† I am inclined to consider the formation of the oil as in some degree dependent upon an altered condition of the farina, arising from some peculiar change which we cannot express, but which, in the absence of a better term, may be denominated fermentation. It may seem extraordinary that so remarkable a substance should be thus produced; but the fact of its formation is demonstrated by its presence, and when we remember that "unconscious particles of matter take their stations, and severally range themselves in an order so as to become collectively plants or animals," we can easily conceive it possible for a change so

* I use the word fecula for want of a better term, for, as before stated, this substance, unlike starch, does not give a blue colour with iodine, nor is it souble in dilute nitric acid.

† Rye, according to the analysis of Einhof, gives albumen, 3.27; gluten, 9.48; mucilage, 11.19; amidine, 61.09; saccharine matter, 3.27; woody fibre, 6.38; loss, 5.42, (Dict. de Mat. Med. Tome vi. p. 278.)

apparently intricate and complicated as this, under certain disposing circumstances, readily to ensue.

Section III.—*Natural History of Ergot of Rye.*

An explanation of the manner in which ergot is formed has been very extensively and variously attempted. Some theories have undoubtedly a greater share of probability than others, but, from the uncertainty and difficulty of experiment, it is a subject which will probably ever remain open to discussion. Lentinus* says, " scarabaceum solstitialem clavi genitorem eapropter habendum censuit, quod pluviosa anni tempestate greges ejus spicas oppugnent seminumque recentium succos imbibant, quo facto inebriati, quasi decidant et e seminum plagis scaturiat humor lacteus, qui aëre inspissatus et nigrescens, secale cornutum fingat."

Schreber † supposes the ergot to be formed by an insect, from having seen little cavities in its substance, containing insects and worms.

De Geer‡ and Ginnani§ favour the opinion of the insect origin of ergot, and compare its formation to that of gall-nuts. Duhamel and Ray entertain the same idea.

Parmentier thought that the disease originated in the covering of the grain ; and M. de Buffon‖ regarded ergot as an assemblage of animalculæ, having a similitude to eels.

De Münchausen¶ added ergot to the list of fungi, supposing it to hold a place intermediate between the species " clavaria and lycoperdon," wherefore " solidam clavariam appellavit."

Decandolle** considers it to be intimately allied to the fungi, and gives it the name of " sclerotium clavus."

Tessier†† and Zuckert‡‡ attribute its generation to the combined inimical action of the air, soil, and sun.

Roessig§§ supposes it to arise from a disordered condition of the whole internal structure of the plant.

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* Neues Hanöv. Magazin, 1804, i. p. 1.

† Oeconomische Schriften, Th. 12. p. 481, u. Th. 14, p. 362.

‡ Abhandl. d. Schwed. Acad. d. Wissenschaft. Th. 6.

§ Delle Mallatie del Grano in erba. Vesaro, 1759.

‖ Histoire Nat. Tome ii. and Sup. Tomé iv.

¶ Krumitz. Encyclop. Th. xcix. p. 289.

** Flore Francaise par Lamark et Decandolle. Paris, 1805–1816, Tome vi. Fries is also of opinion that it is a fungus, and more lately the question has been very ably treated by Mr Queckett, who proposes that it shall be considered as a new genus, with the title *Ergotata*, which will belong to the sub-order Coniomycetes of Fries, and to its division Mucedines. (Annals of Natural History, March 1839.)

†† Memoire sur la Maladie du Seigle, appelleé ergot. Paris, 1779. Traite des Maladies des Grains. Paris, 1783.

‡‡ Allgem. Abhandl. von d. Nahrungsmitt. Berl. 1775, p. 98.

§§ Abhandlung uber das Mutterkorn. Leipz. 1786.

Hube * imagines it to be dependent upon too small a quantity, and an undue spissitude of the juices of the plant.

Aymen † mentions as the occasional cause of ergot, the intermission of fecundation, or the coition of the sexual parts intercepted.

Robert,‡ supposing it to be produced by an impure state of the atmosphere, says its origin may be traced to the deformity of the seed, whereby the disease (finally) hangs upon a disturbance of the harmony of organization, and on the disproportion of nutriment.

The opinion of Robert respecting the formation of ergot is supported by the experiments of Willdenow, who proved that it may be artificially produced, by planting rye, during a wet and hot season, in a rich and moist soil, where it can be well watered.—"The causes, then, of this disease are chiefly to be found in heat, humid air, rich, moist soil, low situation, absence of winds, and an abundance of nutritive juices, badly assimilated. These conditions so change the vital process, that the plant is unable to produce a sound grain. More fruitful juices being received, they fill the vessels, distend them, and destroy their contractility. The power of averting and resisting injuries is lost; thickness and sizi-ness of the humours of secretion come on, the function also dies, and innutrition supervenes. It hence happens that a plant, the reproductive power of which has been so disturbed, is unable to mature its seeds—pro semine tuber, pro normali mixtione *dyscrasiam* exhibeat. These things considered, Robert places the disease which he supposes to be the cause of ergot, in an aberration of the formative tendency of vegetables, and in an alienation of lymphatic plasticity." (Rudolph Padiera, Diss. de Secali Cornuto, p. 15–16.)

It will be perceived that the causes to which Willdenow ascribes the formation of ergot, are somewhat resembling those to which Theophrastus imputes the production of rust and mildew.§

Schnieder attributed the generation of ergot, not to the humid state of the air, but to a viscous sweetish substance, which penetrates with the dew into the grain, and occasions in it a sort of

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* Der Landwirth, Th. 4. p. 493.

† Sur les Maladies des Blés. Memoires de Mathematique et de Physique, Tome iii. et iv.

‡ Rust's Magazin. Bd. 25. Hft. 1. p. 19. *sqq.*

§ "ἐρυσίβη δὲ σῆψίς τίς ἐστι τοῦ ἐφισταμένου ὑγροῦ· διὸ πολὺ μὲν ὕσαντος, οὐ γίνεται· καταπλύνεται γὰρ· ἐὰν δὲ ψεκάδες ἢ καὶ δρόσοι πλείους γένωνται, καὶ ὁ ἥλιος ἐπιλάβῃ καὶ ἄπνοια, τότε σήπεται· διὸ καὶ ἐν τοις εὔπνοις καὶ μετεώροις ἧττον· ἐν δὲ τοις κοίλοις καὶ δροσοβόλοις μᾶλλον· καὶ πανσελήνοις δὲ μᾶλλον· ὅτι συνεργεῖ καὶ ἡ τῆς σελήνης θερμότης· καὶ ὅλως ὁ ἀὴρ ὑγρότερος."
Theophrast. De Causis Plant. Lib. iv. cap. 15.

fermentation. He carefully observed its production, and discovered that, on the first and second day, the sweet matter was only adherent to the beard of the ear; on the third it descended into the husks; on the fourth it inclined a little further, and on the fifth it began to corrode the lateral parts, the bottom of the husk, and the grain itself. During other days, Schnieder saw the nourishing juice ferment with this matter, and produce a fungous substance which destroyed the grain of the rye. The seed was yet too small and too soft to resist the impression of this substance, which at last became more solid, dried up, and blackened.*

Tillet's theory of the origin of ergot, though highly improbable, is exceedingly interesting. He discovered that many ergots contained a worm, though not visible to the naked eye, yet which he believed to have sprung up and nourished itself there. He enclosed in a glass goblet, covered with parchment, a score of these ergots, in which he had observed some small insects. They increased in size, and consumed nearly the whole of the ergot. Four of these changed themselves into beautiful butterflies, the wings, legs, and *antennæ* of which were in some places covered with white spots, and in others with spots of a rich musk colour. The butterflies were of a small kind, and such as Tillet fancied he had seen on the surface of a tub of water which was exposed to the sun, and kept for watering a garden. From this discovery he drew the inference, that butterflies of the same species have inserted into these grains of rye, the eggs from which the caterpillars have subsequently arisen: and these grains, changed into ergot by some derangement in their organization, have served to nourish these caterpillars when converted into butterflies, and that they in their turn have become the cause of many ergots when labouring for the preservation of their young. Nevertheless, he says that he has found many ergots in which he could discover no trace of insects. Here he imagines that the caterpillars perished by some accident during the formation of the ergot.†

Read, a physician in the Military Hospital at Metz, says, that he has established by experiment, the inferences previously drawn by Tillet. He thinks that the butterfly piercing the grain at the time of its developement, that is, while the interior is yet soft and immature, excites there a sort of fermentation by the fluid which it deposits. This opinion has also been maintained by Fontana,‡ and supported by General Field, who imitated the action of the flies, by puncturing the sound grains, whilst soft and pulpy, with a needle, and obtained similar results. But he remarks, "under a good microscope I occasionally examined the ergot, and also the

* Renauldin, Dict. des Sciences Med. art. Ergot. † Ibid.
‡ Fontana, Lettre sur l'Ergot, Journ. de Phys. 7. 42.

grains of rye in every stage of decay, but was not able to discover in either the eggs or larvæ of any insect. I therefore conclude, that the puncture of the fly is for the purpose of extracting its food from the rye, and not for the deposition of its eggs.*

Wiggers adopts the theory of Decandolle respecting the formation of ergot, for he discovered that the white dust which is sprinkled over the surface of the spurs, will, if applied to the roots of a sound plant, generate the disease.†

On the contrary, Hertwig, a German physician, has concluded from a series of careful experiments, that the disease is incommunicable by contact. He surrounded the ear when in flower, with the powder of spurred rye, without in any degree affecting the healthiness of the plant or its grain.‡

My own experiments correspond in their results with those of Hertwig. I have sown rye in conjunction with ergot, both in powder and in substance, without the process of germination being either retarded or modified, or anything but a natural and healthy maturation resulting. I have regularly watered rye, from the sowing of the seed to its period of ripening, with a solution of ergot, but without producing a trace of the disease. Nor does the direct application of the powder of ergot to the ears of rye seem in any way to affect them. Indeed, a solution of ergot does not appear to have any influence upon vegetables. I have watered turnips, stocks, slips of currant trees, &c. for weeks together, without injuring them in the least.

Should the experiments of Wiggers be correct, they will materially tend to establish the theory which he suggests; but on comparing the small quantity of fungin, a harmless substance, with the prevalence of oil in the ergot, the presence of which requires a different explanation, I cannot help concluding that the hypotheses which ascribe the formation of this excrescence to atmospheric warmth and moisture, are the most accordant with circumstances, and the least liable to objection. Tessier has also rendered this idea more probable, by showing from careful and elaborate investigation, that the district of Sologne, which is more exuberant in the production of ergot than any other place, is thus peculiarly adapted to its production. And it is well known that nothing so soon produces ergot as a storm of rain falling upon rye situate in a hot latitude, and in a moist rich soil.§ Further, the grains are sometimes found to be only partially ergotted, one-half being

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* Annals of Philosophy, N. S. Vol. xi. p. 14.

† Inquisitio in Secale Cornutum, &c. Commentatio præmio regio ornata. Gottingæ, 1831.

‡ Lorinser, Beob. und Vers. über die Wirkung des Mutterkorns, 1824. Quoted in Robert's paper, 28.

§ Duncan's Med. Com. Vol. ix. p. 78.

sound and the other half diseased, which is a circumstance of insuperable objection and denial to the theory of fungous growth. And Virey has found remains of stigmata upon grains infected with the spur, and has proved that the genus Sclerotium, in which Decandolle places ergot, has a character widely different from it.* The ergot has also a form like that of rye, and its longitudinal furrow is scarcely ever wanting; a fact which, coupled with the shining appearance of its interior, renders very nugatory the hypothesis of its being a fungus.

This is perhaps the fittest place for notifying that a minute excrescence has been described as situated at one extremity of the ergot, to which its active properties have been referred. Léveillé, a French physician, published in 1827, a pamphlet in which he described it minutely. I do not think it a subject which is worth discussing; for were his opinions correct, the samples of ergot which reach us, entirely free as they are from this appendage, ought to be equally free from activity. I think there can be little doubt that the body which he denominates *Sphacelaria segetum* is a stigma altered by disease.†

Section IV.—*Toxicological History of Ergot of Rye.*

Spasmodic Ergotism.—According to the Abrégé Chronologique of Mezeray, the historian, the earliest mention we have of ergot is by Sigebert de Gremblour, who wrote upon it in 1096.‡ Others say that its first description was in 1596 by Wendelin-Thalius, a German physician, suggested by an epidemic which it caused in the kingdom of Hesse in that year, and respecting which a treatise was published in the following year in German. In this work, the epidemic is represented as characterized—1. by a peculiar stupidness of the patients, which continued until death; 2. those who escaped death had habitual ill-health, particularly in the months of January and February; 3. the disease was contagious; 4. the bodies rapidly decomposed; 5. the disease was not confined to the human species, for animals were affected, and their chief symptom was lethargy.

The same disease prevailed in Voightland during the years 1648, 1649, and 1675.

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* Lond. Med. and Phys. Journ. 1817. Vol. xxxviii. 334.

† See Experiment 10th.

‡ See Hildanus, Obs 69. cent. 2. N. C. Dec. 3. Ann. 4. Obs. 234, &c. Miscel. Nat. Cur. Cent. 5. Obs. 82, and Hoffmann, Vol. i. Part, 2, Cap. 9.

‖ In the "Recueil des Historien des Gaules, et de la France," Tom. xiii. p. 258, is the following passage, extracted from the works of Sigebert.—"1089. Annus pestilens maxime in occidentali parte Lotharingiæ, ubi multi sacro igne interiora consumente computrescentes, exesis membris instar carbonum nigrescentibus, aut miserabiliter moriuntur, aut manibus, ac pedibus putrefactis truncati, miserabiliori vitæ reservantur, multi vero nervorum contractione distorti tormentantur."

In 1693, it raged extensively in the Black Forest, and some severe cases of it are described by Wepfer.*

The Ephemerides Curiosor. Naturæ, Dec. 3d, report, that, in 1698, many persons in the Cantons of Germany were the subjects of transient intoxication, pains in the head, continued nausea, and considerable tumefaction of the face, all of which symptoms were regarded as the consequence of eating bread that contained ergotted rye.

In the years 1702, 1716, and 1717, this disease caused by bad rye, which contained nearly one-third of ergot, almost devastated Freybourg, and overran many of the Cantons of Lusatia, Saxony, and Sweden. The villages situate on marshy land were more unfortunate than others, and the cities were least visited by the disease. According to Videlius, the patients were attacked with spasms and convulsions, accompanied with violent pains, which were said to equal those of luxation, and to be similar in their type. These pains were intermittent, sometimes having intervals of two or three days, during which period the patients were capable of following their usual employment. After the cessation of the paroxysms, there generally came on a voracious appetite; in other instances the patients became lethargic, and when recovering from such state, gave respectively signs of stupidity, intoxication, and extreme lassitude, after which the fit subsided for a time. But there generally remained vertigo, *tinnitus aurium, nebulæ oculorum*, rigidity of the members, and excessive feebleness. The dissections showed extravasation of blood in the chest, and traces of inflammation in the lungs. The heart presented a remarkable flaccidity, the ventricles were usually empty, and "the blood-vessels seemed only to carry bile." The liver and spleen were commonly studded with gangrenous spots.

In 1722, Silesia, in 1723, the environs of Berlin, and in 1736, Wirtemburg in Bohemia, sustained the disastrous effects of ergotism. The symptoms of the first epidemic have been ably described by M. Vater,† and those of the last, with equal precision by J. A. Scrinc,‡ who alone saw 500 individuals the subjects of its virulence. He describes the disease as commencing with a disagreeable sensation in the feet, a tingling or itching; a violent cardialgia then came on; and the disease ascended to the hands and the head. The pains in a short time subsided, the head became heavy, and vertigo prevailed,—the eyes appearing to have a thick mist before them. The patient then complained of extreme heat, which was attended with diaphoresis. The fingers and

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* De Affect. Capitis, Obs. 109, p. 482.

† Dissertatio de Morbo Spasmodico. Siles. Wirtemburg, 1723.

‡ Satyr. Medicor. Siles. Specim. 3.

hands were so spasmodically contracted, that no ordinary force could straighten them, and the pain was described as equalling that of luxation, Some of the patients became totally blind, and others had double vision. The memory also failed, the conversation was wild and unintelligible, and the movements staggering and awkward. Some became maniacal, some melancholic, and others comatose. The disease was usually accompanied with opisthotonos, and an abundance of saliva tinged with blood, or coloured greenish-yellow, poured from the mouth. The tongue was frequently so much swollen as to impede articulation. The greater part of those who had epileptic fits died, and such as experienced sensations of coldness and rigidity in the limbs, consequent upon the subsidence of the itching, had less distension of the hands and feet. " This iliad of affections" was followed by excessive hunger, many had an insatiable appetite, and very few evinced any aversion to food. One had buboes in the neck, which discharged yellow purulent matter, accompanied with violent burning pains. Another had spots on his feet resembling the stings of fleas, and which remained during eight weeks. Some had the face extensively covered with these spots. The pulse, without one exception, was the same as in health. The disease continued for two, four, eight, and sometimes even for twelve weeks, with occasional intervals of repose. Of the 500 patients coming under the notice of Scrinc, 300 infants perished, considering as such, all under five years of age.

G. H. Burghard gives the following description of a convulsive epidemic which raged in the Canton of Silesia. * The patients were the subjects of excessive spasms, which convulsed the extremities, and the head, eyes, and lips in particular, attended with an aberration of reason which no medicines could restore. Rarely had the patients any remission until the third week, and the disease generally continued for two or three months with those who took no medicine, and who were not guarded in their manner of living. Those who had continued fever, and in whom profuse perspiration following the spasms prevailed, were most readily cured. Those who died, showed, previously to dissolution, a sort of paralysis, which degenerated into apoplexy. Females were more severely affected than men, and especially so during the period of menstruation. This being over, they complained of little except great debility, until the return of the menses, when the symptoms were much aggravated. Such as were fortunate enough to recover, laboured for some time under excessive debility, particularly of the joints, stiffness, and even immobility of the limbs, enfeebled intellect, &c.

In 1741, this disease raged in Germany. J. M. F. Müller gave

* Satyræ Medic. Specim.

a very elaborate description of it, in a dissertation which was discussed at Frankfort on the Oder. * This epidemic presented symptoms very closely allied to those described by Scrinc.

In 1756, M. Blohm of Altona gave a description of a similar epidemic, but without saying where it prevailed.†

Gangrenous Ergotism.—In 1630, the dry gangrene appeared in many parts of France, often producing very fatal effects. This epidemic Dr Thuillier attributed to the incautious use of ergot of rye.

In 1650, 1660, and 1664, it prevailed in Guyenne and Sologne districts, and, during the last year especially, at Montargis, of which a report has been given by M. Perault.‡ From his account, it appears, that, whilst travelling in Sologne, he had found, from the physicians and surgeons, that the rye was sometimes so corrupted, as to form a highly injurious bread, the use of which had brought on dry gangrene, followed by the loss of the limb, and without inflammation or fever. The Academy having learnt some years afterwards that similar accidents had happened at Montargis, requested Dodart, in 1674, to investigate the circumstances. It seemed from the report of this physician, that the use of ergotted bread had occasioned vertigos, malignant fevers, heaviness, and gangrene of the extremities. The last symptom was preceded by numbness of the legs, which members afterwards became painful, and swelled slightly, but did not evince any direct signs of inflammation. The skin, on the contrary, was cold and livid. The gangrene commenced in the centre of the member, and did not attack the cutaneous tissue until a long time afterwards, and they were consequently obliged to cut through the skin to discover the progress of the disease. Dodart further observed, that the poor only were the particular subjects of this distressing malady, and that the ergot occasioned it more certainly when new, than after having been kept for some time.

In 1695, John Conrad Brun or Brunner, saw in Augsburg a female whose fingers were withered, blackened, and sphacelated from having eaten bread containing ergot of rye. The surgeon who presented this female to Brunner, assured him that the patients in the environs were attacked with resembling symptoms, which were violent in proportion to the newness of the bread. He added, that some time before, he had amputated a foot which was gangrenous from the use of ergotted bread.

In 1709, a gangrenous epidemic prevailed in the Departments of Orleans and Blesse. Noel, surgeon at the Hotel Dieu, had to treat above fifty cases, incident to adults and infants. In one

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* Dissertatio de morbo epidemico, convuls. contagiis. experte. Franc. ad Oder. 1742.

† De Affectu Spasmod. vago Maligno. Erford, 1756.

‡ Journ. des Sav. 1676.

case only were the fingers attacked, in every other, the disease began in the toes, and, extending gradually, sometimes reached the top of the thigh.

In this epoch it was discovered that the internal use of ergotted bread had horribly mutilated a peasant at Blois, the particulars of whose case are described by M. de Fontenelle in the following terms. A peasant was attacked most severely. Gangrene caused first the separation of all the toes of one foot; then those of the other; next both legs and both thighs were successively detached, leaving only bones. At the time of writing the account, the cavities of the iliac bones began to be filled with good fleshy granulations.*

Noel declares that, in the year 1709, the rye of Sologne contained nearly one-third of ergot; that, as soon as the inhabitants of the country had eaten of this unwholesome bread, they became inebriated, and this was followed by gangrene; but in Beauce, where there was little or no ergot, these accidents were not common.

In the same year, (1709), from the excessive coldness of the season, this malady, ascribed to an intermixture of ergot with the bread, raged in the canton of Lucerne, and reappeared in 1715 and 1716 at the same time as in the cantons of Zurich and Berne. Of this epidemic, Langius has given the following description;— "It began with excessive lassitude, unaccompanied by any febrile action. Soon, the cold attacked the extremities, which became painful and rigid, as they are after a long immersion in cold water: the wrinkles were so marked, that even the veins could not be distinguished; benumbed, and almost insensible, the limbs were with difficulty moved. They were internally tortured with acute pain, increased either by the heat of a room or of a bed, and which did not subside until the patient had been long exposed to a low temperature. These pains extended by degrees to the hands, arms, and shoulders; and from the feet to the legs and thighs, until the parts affected became dry, sphacelated, and attacked. Some victims of this plague found in their gloves or stockings, one or two of the digital phalanges separated by gangrene. Throughout the progress of the disease, the other organs of the body were in a healthy condition, except, that, as the pain increased, the patients experienced slight febrile heat, afterwards a copious sweat, which extended from the top of the head to the pit of the stomach, and lastly, a disturbed sleep, agitated by frightful dreams, particularly after warm food. This affection, tortured with equal severity all its victims; but those with whose food ergot had been sparingly mixed, were only affected with a feeling of weight in the head, and drowsiness, to which often succeeded transient intoxication."

* Hist. de l'Acad. Roy. 1710, 81.

Du Hamel, on the authority of Mulcaille, in the Memoires de l'Academie Royale des Sciences, anneé 1748, has described a fatal epidemic which in 1747 raged in Sologne, destroying the greater number of its inhabitants.

Salerne, a physician at Orleans, and Corresponding Member of the Academie Royale des Sciences de Paris, gave also, in 1748, to that Academy, an interesting memoir on the diseases produced by ergotted rye.* From his report it appears, that about the middle of August, in the year preceding, he commenced treating in the Hotel Dieu, patients threatened, or attacked with gangrene, more than two-thirds of whom were men. A child, ten years old, lost both its thighs, which were detached from their articulations without any hemorrhage. Its brother lost the leg and thigh of one side, and the leg of the other. Both died in twenty-eight days from the commencement of the disease. In every case, amputation rather accelerated than retarded dissolution. Of more than 120 patients, operated on or not, but 4 or 5 escaped. During the time that he gave his memoir, he had three or four cases in which the feet fell off, yet the appetites of the sufferers were not diminished. He saw one man, about forty-five years old, who, eighteen years before, lost the left hand and wrist ; he had a large, hard, and tense belly, his right hand was numbed, but he had a creeping sensation in it. Most of his symptoms were relieved, except the numbness, but he returned to the hospital shortly afterwards, his disease being aggravated. Salerne observed that most of the patients were dull and stupid, scarcely able to describe or to define their sufferings ; the skin was generally yellow ; the face and the conjunctiva being more decidedly tinged than the other parts : the belly was hard, tense, and stretched ; emaciation rapidly came on, nevertheless the alvine and urinary evacuations were regular and copious, the latter being natural, the former coherent and imperfectly digested, until within three or four weeks of death, when diarrhœa supervened, not unfrequently accompanied with colic pains ; the appetite was usually good, and the sleep natural ; the pulse was hard, but often imperceptible, although the vessels appeared swollen and distended, and the blood, whether emitted from a large or a small orifice, was slimy in its consistence, and tardy in its escape.

In 1749, there prevailed in Bethune, a disease very closely resembling gangrenous ergotism, and which had every appearance of having originated from the same cause.

In August 1764, the dry gangrene made destructive ravages in the environs of Arras and Douai. The disease, according to the report of Read, † was announced by sharp lancinating pains in the

* Mem. de Mathemat, et de Phys. Tome ii. 55. † Traité du Seigle Ergote. 82.

extremities, little swelling or local inflammation being present, but general fever commonly prevailing. This first stage lasted from ten to fifteen days. In the second period, which continued during eight or ten days, the pains commonly ceased, and the extremities became numbed; the limbs were then greatly reduced in temperature, but were not relieved by the application of external warmth. The third stage manifested itself by the developement of blisters, quickly succeeded by gangrene of the toes, which made rapid progress, extending over the whole surface of the foot, stretching to the leg, and sometimes even reaching the middle of the thigh. During the third period, the feet, legs, and hands detached themselves from their articulations, and the pulse was generally small and hard. Read saw two children, twelve months after their attack, begging at Valenciennes; the youngest had lost one leg and both feet, the other had lost only a leg. Two eminent physicians, Larsé and Taranget, commissioned by the state of Artois to institute means best calculated to prevent the spread of the disease, ascribed its entire origination to the use of bread contaminated with ergot.

Dr Vetillart, who, in 1770, published a work upon the treatment of gangrenous ergotism, gives the following example of its virulence.

A poor man of Noyen in Maine, seeing a farmer sifting his rye, begged permission to carry away the refuse to make bread of it. The farmer represented to him that this bread might be detrimental to him; but necessity prevailed over fear. The poor man ground these siftings, consisting mostly of ergot, and made bread of the flour. In the course of one month this unfortunate person, his wife, and two children perished wretchedly. A third at the breast, and which had eaten panado of this flour, escaped death, but it was deaf, dumb, and deprived of two legs.

MM. Model,* Schlegel,† and Parmentier,‡ having stated their disbelief in the noxious properties of ergot, and especially in its tendency to produce gangrene, Tessier submitted a second paper to the Societé Roy. de Med., Tome ii. 587; experimentally illustrative of his previous views, and confirmatory of the popular belief in the injurious effects of this diseased grain.§ These experiments were instituted to answer the sceptical inquiries of the age in which he lived, though more than a century antecedently.

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* Recreat. Chim. † Journ. Encyclop. Juin 1771.

‡ Addit. Aux récréat. Chim. du Model.

§ His experiments are in favour of the notion, that ergot is actually destructive of animal life; and that gangrene in various external organs is consequent upon its protracted use. His views upon spasmodic and gangrenous ergotism are amply confirmed by M. Hoffman, (Path. gener., part 2, cap. 9.)

Dr Thuillier affirmed that he had given ergot to many animals, all of which perished from its effects.* But the memoir which Dr Salerne presented to the Academy in 1748 is perhaps equal to any one written prior or subsequent to it. This physician intermixed some ergot with appropriate food, intending to feed with it a young pig, which was lively, and in good health. As he refused on the first day to take his food, they were compelled to make him swallow it with a spoon; but at the end of five days he took it readily, so that during one month he swallowed daily three pints of the mash. At the commencement of the trial, he thrived perceptibly, but so soon as they took away the bran, only with the intention of giving him more barley, in which there was one-third of ergot, he ceased to grow. At least his belly only augmented, which eventually became large and hard. At the end of five days his legs began to redden and inflame, exuding a greenish fluid of a disagreeable odour, which grew rapidly worse. The parts under the belly blackened, the tail and ears dropped, but the alvine and urinary dejections were ordinary in quantity and natural in kind. After having eaten in the space of a month, two bushels of rye, (Orleans measure,) containing one-third of ergot, he was put upon pure bran, in the form of a tepid mash; but this change of food failed to re-establish him; the poison had accomplished its effect, and although the animal at first appeared a little better, he was evidently the subject of pain and uneasiness; his walk was unsteady and tottering, and the powers of life gradually declined, until their final termination in death. On opening the body, part of the mesentery, the jejunum, and especially the ileum, were found inflamed. The acute margin of the liver presented two large dark-coloured spots. Under the throat, and in the legs, were some unhealthy open tumours, from which exuded a reddish puriform discharge. There was no gangrene of the feet.

This physician learned from a lady, whose charitableness was often exercised in attendance upon those who were suffering from the diseases consequent upon eating ergotted bread, that the dogs to which she had given some of this bread the day before, would not leave the yard, and that two days afterwards, a couple of them were found dead. The others would also have died had the poisonous food been continued, the ill effects of which ceased only after many days use of good and nutritious diet. This lady further asserted, that the ears and feet of a pig had fallen off, from eating twenty-four bushels of barley, which had a notable intermixture of ergot.

Dr Read fed during five days a pig three months old, with er-

* Journ. des. Savans pour l'anneé 1676.

got mixed in his mash. The animal did not go out of the stye, his eyes were suffused with tears, and an acrid serous humour poured from his ears. On the 17th day, dry gangrene had attacked the left ear, which fell off on the day following, and on the 19th the animal died. Upon examination, the abdominal viscera were found in a swollen state, and a gangrenous spot, an inch in diameter, was discovered upon the liver. This physician further states that he made a strong decoction of ergotted rye, which he mixed with an equal quantity of syrup, and that flies died in two or three minutes after tasting it. *

Spurred Indian corn is said to produce similar diseases to those occasioned by spurred rye.—Christison on Poisons, p. 836, 3d edition.†

Though the authors, who have respectively detailed the diseases consequent upon the alimentary use of ergot, have ably illustrated the natural, statistical, and medical history of the substance, so as not to require me to dwell longer on these heads, yet it is somewhat incumbent upon me, in connecting together these interesting and valuable records, to determine, if possible, their verity of character, to divest the narratives of any admixture of exaggeration, and to give upon the pages of a work amenable to the judicature of established science, results as satisfactory as common experiment and inference can supply. Notwithstanding that most of the diseases regarded as the effects of ergot have been so proved, I am decidedly of opinion, that in numerous instances these diseases have had origins widely different and distinct. In many of the provinces where spasms and gangrene have prevailed, ergot has been sparingly, and in others, not at all produced. In some instances, the season of the year in which these diseases have prevailed, renders it extremely improbable that ergot, admitting its use, could have retained sufficient activity to qualify the virulence which history and tradition have ascribed to it; and in others, the very sparing employment of bread supposed to contain it, would require to produce such notable effects, even a greater degree of activity on the part of the drug, than its toxico-

* I have repeated this experiment scores of times, but have not in one instance found any deadly consequences. I think Dr Read must have been a very fortunate experimenter.

† Gallinæ quæ illud Maïs peladero comedunt, sæpissime ova gignunt testis orbata. Primo intuitu difficile est intellectu, inquit Roulin, qua ratione illa nutrimenti species effectum exserere possit in formationem carbonatis calcis, quo vulgo ovum est incrustatum;—attamen ex eo satis bene res mihi videtur explicanda, si statuamus, triticum illud cornutum hoc in casu excitare partum præcocem et intempestivum; verbo, illud contractionibus eo ducere organa ovis producendis destinata, ut ovum ab ovario separent antequam illi occasio fuerit et tempus, terrestri involucro se obtegendi. (Specimen Medicum Inaugurale, de Secali Cornuto, auctore G. Ter. Horst., p. 19–20.)

logical history will authorize us in effecting. As a proof of the difficulty experienced in determining the etiology of dry gangrene, we repeatedly see it confounded with other diseases, widely different in their cause, but having a remarkable similitude in their appearance, viz. the "mal des ardens," and the "ignis sacer," called also, "feu sacré," "feu St Antonie," and "feu d'enfer"—both modifications of erysipelas, but commonly having a gangrenous termination. The latter appears to have been first observed in Paris in 947. It is said to have attacked all parts of the body, destroying the patient with the most torturing and afflicting pains. About the year 1000, this disease prevailed in Lorrain. It was characterized by a sense of burning heat, the affected parts subsequently becoming gangrenous.

Sigebert de Gremblour states, that, in 1089, the *feu sacré* ravaged the eastern part of Lorrain. In some instances the limbs dropped off, in others, the patients suffered only from contractions of such parts. In the epidemic of Dauphiné in 1089, its visitancy gave rise to the formation of the order of Saint Anthony; and tradition states, that one of the sufferers lived several days with his head and trunk only remaining, all the limbs having separated.

Again, we are not justified in concluding that the diseases, when they occurred in those instances where ergotted rye was used, were solely in consequence of the deleterious impression of the grain itself. The bread was poor, and sometimes almost innutritive, hardly, indeed, calculated to sustain the physical energies of the peasantry, compelled to subsist upon such crude and unwholesome aliment. And when we consider the fearful train of diseases which defective nourishment induces, we need not hesitate to infer, that, in many instances, the supposed ergotism was occasioned, as M. Gassoud observes, by the people "in order to avoid actual famine, being compelled to live upon a sort of bread made of the meal of acorns, of grape stones, of the roots of fern, and other such crude and innutritious substances."

To prove the succession of pestilence to famine it is scarcely necessary to quote the apothegm, "pestis post famem." The records of history furnish proofs which abundantly substantiate the notion.

"He that abideth in this city shall die by the sword, and by the *famine*, and by the *pestilence*."*

In the year of Rome 300, a fearful pestilence was the melancholy effect of previous famine.†

About the year 407 or 408, near the close of the reign of Arcadius, a plague, consequent upon famine, is said to have prevailed in every quarter. Nicephorus, in his description, affirms that al-

* Jeremiah, ch. xxi. v. 9. † Livy, lib. iii. 32.

most all Europe perished. " Pasa de oleto e Europe"—and very considerably of Asia and Africa.

In 590, the severest drought ever known visited Italy, lasting from January to September. A famine was the result, and a deadly plague succeeded. Of this pestilence died Pope Pelagius.*

In 987, an unfavourable season caused a sad dearth in the harvest. The subsequent scarcity of provisions caused a multitude of diseases—malignant fevers prevailed, and the cattle died of fluxes.†

In 1084, there was a famine, which was succeeded by a severe pestilence. The latter destroyed the whole of the army of the Emperor Henry at Rome. In the following year, the defective crops in England caused a great mortality amongst cattle.

The epidemic of 1596, which is by one party regarded as the sole offspring of ergotted rye, is, by a very high authority also declared to have been caused by famine.‡

In the year 1600, pestilence raged in almost every part of Europe. Many of the symptoms were precisely those of ergotism. The patients were senseless, the hair fell off, livid spots appeared, and the limbs mortified. But we have no mention of ergot.§

In the description given by Gregorius Horstius of the epidemic febrile disease, accompanied by spasmodic convulsive symptoms, in which, or in epileptic fits, the patients died, no allusion whatever is made to ergot. Bad bread is simply notified amongst other sorts of crude and unwholesome diet. " Causas hujus affectus quoad attinet, ex ægrotantium relatione scire licet, quoad externa causa communiter in alimento, ad nutriendum minus idoneo et improportionato, consistat, dum pauperis rebus ad vitam necessariis destituti, panem impurum et male coctum longo tempore, in summâ famis urgentiâ, devorant, interdum etiam poma acerba et austera, fungosque et similia deglutitientes, sese eduliis crudis, immaturis, et astringentibus ingurgitant, de quorum depravatâ concoctione cruditates abortæ."‖

A similar report of this epidemic is made by Sennertus in his chapter, " De febre maligno cum spasmo." And upon reading the allusion which Wepfer makes to the epidemic that raged in the Black Forest in 1693, I do not find the least mention of ergot, nor does that learned author appear to have been at all acquainted with it. Camerarius also positively asserts that the dry gangrene was frequently observed in the extremities of persons who had certainly not eaten any ergotted rye.¶

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* Webster on Epidemic Diseases, Vol. i. p. 146.
† Brompton, Angl. Scrip. 878. ‡ Short on Air, Vol. i.
§ Webster, Vol. i. p. 273.
‖ Greg. Horst Opera, Vol. ii. lib. viii. obs. 22.
¶ Acad. Nat. Curios. Cent. 4, obs. 82.

Admitting, however, that these are cases still unsettled and disputable, we have recorded a very remarkable instance of gangrene having a strong similitude to that induced by ergot, but certainly not arising from it. And the only cause which can be assigned is that of imperfect nutrition, from the unwholesomeness and impurity of the bread. This case occurred in the year 1762, in the family of J. Downing, residing at the village of Watisham, the particulars of which are given by Bones, * Wollaston, † and Parsons.‡ From their reports, it appears, that the father, mother, and six infants were seized with violent pains in the feet, legs, and thighs, the other parts not suffering materially. The affected limbs grew black, gangrenous, and fell off. The father, most triflingly attacked, was fortunate enough not to lose a limb. A child four months old died before any of the members separated. The mother, three girls, and two boys, lost collectively seven legs and four feet. The Rev. Mr Bones, minister of the parish, in answer to questions put by Dr Baker, states, that they made their bread the summer before, of what is there called clog wheat, for they had no rye. The grain was damaged, it had been laid, gathered, and thrashed separately; it was not mildewed or grown, but discoloured, and smaller than the rest. It made bad bread, and worse puddings.§

These facts I have submitted, not to invalidate what so many have attempted to establish, the destructive nature of ergotted rye, but to show the probability of spasmodic and gangrenous ergotism having in many instances arisen from food imperfectly nu-

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* Philosoph. Transac. Vol. lii. Nos. 84 and 85. † Ibid. Nos. 83 and 98.

‡ Med. Museum, Tom. i. p. 442, Tom. ii. p. 449.

§ See Gentleman's Magazine for 1763, Vol. xxxii. p. 492.—Besides there are other seeds which have a tendency to induce diseases similar to gangrenous and spasmodic ergotism, and which in many instances have been intermixed with the grain, the farmer unknowing of their banefulness. Amongst these, perhaps the most remarkable is the *Raphanus raphanistrum*, which grew in vast abundance amongst the barley in the kingdom of Sweden during the years 1746 and 1754, when a disease precisely similar to spasmodic ergotism prevailed. And Linnæus, to discover its physiological influence, gave some of it to fowls, which, in consequence, suffered from strong and painful convulsions. He hence denominated the disease Raphania, (Amæn. Academ, Vol. vi.) which term has since been employed by Dr Cullen, who, however, wisely questions whether it be the same as the *Necrosis ustilaginea*, by which Sauvages has denominated ergotism. (See Cullen, Nosol. Meth. Gen. 52. Sauvages, Nosol. Meth. class 10, gen. 39.)

And Dr Tytler has shown that degenerated rice is capable of producing diseases very similar to those of ergotism, both spasmodic and gangrenous. He fed a healthy young goat with ouse rice, which diminished its appetite, caused excessive thirst, weakness, stupidity, watery eyes, and apparent suffering. The animal died in forty-two hours from the commencement. The only morbid appearance of moment was an "erythematic inflammation," extending from the stomach to the intestines.

In several instances the effects of this degenerated rice upon the human subject were very serious. (Remarks on Morbus Oryzeus, 4820, 8vo, p. 80.)

And Dr Peddie of Edinburgh has kindly furnished me with a pamphlet which he published, illustrative of a case of dropsy and gangrene occurring in a family from eating unsound potatoes. (See Edin. Med. and Surg. Journal, No. 115.)

tritive, as well as actually poisonous. And, therefore, to endeavour to lessen the popular prejudice which has so long presided over its history, by showing, that the maladies recognized as its production, have, in the greater number of instances, been the conjoined offspring of deteriorated grain and defective nutriment, I have been led to this train of reasoning from the fact of my own experiments by no means corresponding in remarkableness with those reported by the continental writers upon the same subject. And, without enlarging further upon matters at all problematical, I shall proceed to a faithful detail of my own experiments, from which will be attempted to be drawn whatever inferences are most correspondent with their character and kind.

Section V.—*Physiological action of Ergot of Rye, illustrated by Experiments.*

These experiments I have divided into two classes; 1*st*, the immediate injection of ergot into the system by the arteries and veins; and *2dly*, its mediate introduction by the stomach, skin, and rectum. The former will be subdivided into three orders, comprising solutions of different degrees of strength, which will be particularized in each respective trial. The latter will form two subdivisions, embracing large and single doses, to determine the direct effects of the drug; and small continued ones, to illustrate its eventual or remote influence upon the animal system.

Injection of Ergot into the Veins.—Expt. I.—Three-quarters of an ounce* of ergot of rye were infused in three ounces of water, † slowly evaporated until only half an ounce remained, which, after filtration, was injected into the right external jugular of a bull-terrier bitch, weighing seventeen pounds. She cried and struggled violently on receiving it, the urine flowing in a full stream, the pupil dilating immediately, the pulsations of the heart being too rapid to be counted. In four minutes its action was much diminished in force and frequency, and general muscular flaccidity prevailed, with slight quivering of the whole frame. In another minute the heart again beat with singular rapidity and force, during which complete opisthotonos came on. After the lapse of another minute and a half, she cried in a plaintive tone, the heart beat slowly and laboriously, the breathing was remark-

* Whenever the word ounce is used throughout this treatise, it implies an ounce apothecaries' weight.

† My mode of preparing this solution, whether for physiological or obstetrical purposes, consists in mixing the ergot, previously reduced to a fine powder, with cold water, and slowly heating it until near the boiling point. At the temperature of about 200° it is maintained for a few minutes, then poured into a strainer, and forcibly squeezed whilst hot. As the active principle of ergot is volatile, its aqueous solution should never be allowed to boil.

ably slow and profound, and under these symptoms the animal died, in exactly nine minutes from the period of injection.

Autopsy.—All the muscles of voluntary motion retracted from the knife. The heart was firm and rigid, but insensible to galvanism, whether transmitted, or from a closed circuit. The right cavities contained venous, and the left ventricle, arterial blood. The lungs had a natural appearance, but the trachea was lined with abundance of frothy mucus. The intestines were contracting vermicularly when exposed, and, as well as the stomach, had a natural appearance throughout. The other abdominal viscera were apparently healthy. The mouth was very livid and frothy; the pupil was dilated, and the conjunctiva reddened. The *dura mater* was slightly injected, but the other membranes of the brain and its substance exhibited nothing remarkable. The spinal chord was exposed throughout its whole extent, but it displayed no evidences of alteration.

Expt. II.—I intended to inject a strong solution of an ounce of ergot into the jugular vein of a shepherd's dog, weighing twenty-four pounds; but when the first syringeful had passed, which did not contain above half the quantity, excessive spasmodic action ensued, with dilatation of the pupil and discharge of feces. In three-quarters of a minute the convulsions had ceased, and there was only to be observed the most perfect helplessness and flaccidity of the limbs, with a quick and feeble pulse. This state continued through the further period of half a minute, when very slight tremor of the muscles of the hind and fore-legs succeeded, accompanied with a drawing down of the lower jaw, and perfect emprosthotonos. The motion of the heart was now very slow and intermittent; the emprosthotonos, with an occasional convulsive sigh, continued until four minutes and a half from the commencement, when all signs of life were gone.

Autopsy.—The pectoral muscles contracted remarkably when cut. The heart was quite still, but, after having been incised, began to pulsate, and continued to do so for sixteen minutes. Its right cavities contained venous, and its left ones arterial blood. The thoracic and abdominal viscera were natural. The brain was slightly injected upon the surface only. The spinal chord exhibited nothing remarkable. This experiment was witnessed by Mr Walker, Surgeon, of Bulwell.

To determine whether these results were at all influenced by the mere presence of foreign matter in so concentrated a form, without respect to any poisonous quality, I tried the following experiment, which satisfactorily proves that vegetable substances, not directly poisonous, may, with perfect safety, be injected into the animal system; and that the results in the two preceding trials

were dependent upon an active inherent property of the ergot, not characteristic of sound rye.

Expt. III.—Three-quarters of an ounce of healthy rye were bruised, and then boiled for some time in three ounces of water. The solution was then well squeezed through a coarse strainer, and when cool, injected into the jugular vein of a spaniel bitch, weighing sixteen pounds. With the exception of a slight increase in the action of the heart, and hurried respiration, she appeared to be unaffected by it. The wound healed readily, and during the three remaining weeks that she was allowed to live, no signs of injury appeared. This experiment I repeated, with similar results, in the presence of Mr Walker.

Expt. IV.—Three drachms of ergot were infused in as many ounces of water, evaporated to one ounce and a half, and when tepid, the liquid was slowly injected into the right jugular vein of a terrier dog, weighing fourteen pounds. Its introduction was almost immediately followed by heavy and laborious breathing, with increased action of the heart, its beats amounting to about 100 in a minute. The pupil was dilated at first, but soon contracted again. In ten minutes, he cried out wildly, and violent convulsions of the whole frame succeeded at intervals. Five more minutes passed over, his breathing continuing to be heavy and laborious, the action of the heart being quick and violent. He was perfectly unconscious, the eye was fixed and insensible to the touch, feeling, indeed, was quite gone; for punctures made in different parts of the body furnished no indications of suffering. In twenty minutes the heart began to falter, respiration diminished in frequency until it became unobservable, and in this state he continued without any alteration, until two hours and a quarter from the first injection, when life became wholly extinct.

Autopsy.—All the voluntary muscles were sensible to galvanism, as also the auricles, but not the ventricles of the heart. The latter organ was flaccid, containing venous blood in all its cavities. The lungs were dark-coloured and engorged, and the bladder was excessively distended with urine. The other viscera were natural. The membranes of the brain were slightly injected, and both lateral ventricles contained a little serous fluid, slightly coloured. A similar effusion was found upon the surface of the brain. I could discover nothing unusual in the spinal chord.

Expt. IV.—A solution furnished by half an ounce of ergot in three ounces of water, was slowly injected into the femoral vein of a large bull-terrier bitch, weighing twenty-three pounds. About half an ounce of the fluid was propelled at once, to each of which injections the system answered by very increased arterial action, and quick, hurried respiration. The first injection also produced violent convulsive movement of the whole body, but the hind-legs

were chiefly affected. The urine and feces flowed abundantly, and the animal cried in a plaintive and agonized tone. The convulsions lasted for about three minutes, when the dog became still, the whole frame relaxed, being totally insensible to pain. The pupil was dilated and motionless, the action of the heart scarcely audible, the respiration slow and profound. In eight minutes, the pulsations of the heart became distinct, and the respiration was hurried and difficult. In four minutes more sensibility returned to the anterior part of the body, and the animal stirred its fore-legs; the posterior extremities remained motionless and insensible. The pupils were excessively dilated, and the eyes glared hideously. Sight and hearing were, however, restored; for the dog watched my movements, and was startled by a sudden or loud noise. At this period the body was cold; in a short time the sensibility of the fore legs was again lost, the eye became fixed and glazed, the motions of the heart were feeble and quivering, and a rattling in the throat announced the period of dissolution. A little diluted spirit was now (half an hour from the commencement) poured down its throat, which seemed to operate as by enchantment. In a few seconds, the breathing became free, the motions of the heart were accelerated, the energies of the system were revived, and, as if invested with new life and vigour, the animal in a minute or two was upon its legs, followed me when called, but whined piteously from the wounds on its surface of which it was now sensible. The fore legs were moved with perfect freedom, the hind ones were not fairly lifted, but dragged along. It thus continued for about quarter of an hour, when paralysis again returned, and increasing progressively, terminated the function of animal life in exactly one hour and thirty-five minutes from the first injection.

Upon this experiment I may remark, that I have often succeeded in averting for a time the effects of an injection of ergot, by the exhibition of continued doses of stimuli; but I have never thus recovered an animal, to which a strong solution of ergot had been given, although its influence has certainly been modified. When weaker solutions have been employed, I am persuaded that this treatment has considerably facilitated resistance of the poison.

Expt. VI.—Five drachms of ergot were infused in four ounces of water, and the liquid when cool was rapidly injected into the left external jugular of a bull-bitch, weighing twenty-two pounds. Soon after its introduction the heart beat violently, sometimes intermitting, and again leaping excessively. The breathing was heavy, and considerably accelerated, the pupils widely dilated, and in about four minutes and a half the power of voluntary motion was completely lost. The abdominal muscles were violently convulsed, the urine and feces at the same time passing abun-

dantly. After the fecal evacuation, the tail began tremulously to move, and, increasing in force, at last waved rapidly from side to side. In seven minutes from the first injection, the *sphincter ani* contracted powerfully, and there was every appearance of severe tenesmus, which symptom was greatly augmented by touching the hind-legs or tail. The pupil was still dilated, the eye fixed and motionless, and, as well as every other part of the body, apparently insensible to pain. Even the hind-legs, which were convulsed slightly when touched, were freely incised without occasioning any symptoms of torture. In fifteen minutes, stertor came on, and there was a copious discharge of mucus from the nose. The heart was beating slowly, the pupils were contracted, and all the muscles except the *sphincter ani* were flaccid and powerless. In half an hour the animal had a copious bloody evacuation, accompanied with severe and protracted tenesmus. In forty minutes, the abdominal muscles became relaxed, the contractions of the *sphincter ani* ceased, and the tail in spasmodic movement made a complete circuit towards the back, in which position it continued, fixed in the most unyielding rigidity until death, which followed in three-quarters of an hour afterwards, the animal having survived the injection one hour and twenty-five minutes.

Autopsy.—The stomach was remarkably distended with air, and its mucous surface was coloured from the presence of deeply injected blood-vessels. Spots of a darker hue variegated its pyloric extremity. The intestines were in vermicular motion, and when opened, exhibited a deep-claret colour throughout their entire mucous surface. The tinge was deepened towards the rectum, at the extremity of which it was nearly black. The latter bowel contained an appreciable quantity of bloody mucus. The bladder was empty, and with all the other abdominal organs, natural in appearance. The heart was flaccid, containing dark blood in all its cavities. The lungs displayed no particular traces of engorgement, but were much darker than usual. The membranes of the brain were reddened from injected vessels, the lateral ventricles contained a little bloody serum, but the substance of the brain, as also the spinal chord, was in every respect natural. This experiment was performed in the presence of Mr Bowker, surgeon.

Expt. VII.—Three drachms of ergot were infused in four ounces of water, and by careful evaporation the quantity was reduced to three ounces. This measure was slowly injected into the left external jugular of a bull-terrier dog, weighing twenty-five pounds. The animal bore the introduction of the whole quantity without exhibiting any signs of suffering, or even of physical disturbance, very slight acceleration of the pulse excepted. There

was neither spasm nor convulsive motion of any kind. In the lapse of ten minutes every limb was flaccid and powerless; the breathing was natural, and the dog lay, giving no indications of pain, but was in the most complete state of paralysis. The hind-legs were totally insensible, and the susceptibility of the fore extremities was very trifling. The pupil was slightly contracted, insensible to light, and the eye was scarcely affected when touched. In this state he continued for half an hour, when reaction came on, and sensibility was in some degree restored. He rose upon his fore-legs, but, on attempting to support himself on the hind ones, fell. In a sitting posture, then, he crawled a few yards, using only the anterior part of the body, the posterior extremities being scarcely moved. In three-quarters of an hour the limbs again became weak and useless. The body grew cold, and the pulsations of the heart were indistinct and fluttering. The respirations gradually diminished in force and frequency, until they became imperceptible; and the feeble action of the heart, with an occasional sigh, was the only indication of life's continuance. Eventually, however, the heart ceased to beat, the termination of its functions marking the intervention of two hours and eighteen minutes between the commencement of the experiment and its close.

Autopsy.—The muscles of the posterior extremities were only very slightly affected by galvanism; the anterior part of the body was more susceptible, yet it was evident that irritability was in a great measure exhausted. The heart was uninfluenced by stimuli, flaccid in its texture, containing venous blood in the right cavities, and in the left ventricle arterial blood. The lungs had a natural appearance, but the trachea contained much frothy mucus. The stomach was distended with flatus, as also the bladder with urine, but nothing unusual was discovered in any of the abdominal viscera. The membranes of the brain, its substance, and the spinal chord, were in every respect natural. This experiment was witnessed by Mr John Wright, surgeon.

Expt. VIII.—Two drachms and a-half of ergot were infused for some time in two ounces of water, and the solution when tepid, was injected into the right external jugular of a terrier dog, weighing eleven pounds. The whole of the liquid was passed without any evidence of injury, but in about six minutes the dog was in a state of complete paralysis, voluntary motion being entirely suspended, and sensibility lost in every part except the head, face, and neck. The pupil was not affected, nor did the sight appear to be at all diminished. In twenty minutes, the sensibility of the eye began to decline, and its glassy fixed state indicated the mischief that was impending. The heart was almost unaffected until the lapse of half an hour, when its pulsations became slow and feeble, the respirations at the same time diminished in force and

frequency. In forty-five minutes the animal was quite cold, the heart and lungs continuing their functions in a body apparently dead. The dog remained in this state through the further period of half an hour, having survived the experiment one hour and a quarter.

Autopsy.—Muscular irritability was very slight. The heart was soft and flabby, containing in its right cavities venous blood, the blood on the left side being much darker than arterial. The mouth was very livid and frothy. A most careful examination was made of every other part of the body without the discovery of anything unusual. This experiment was performed in the presence of Mr Henry Taylor, surgeon.

In repeating these experiments, I discovered in two instances, that the paralytic state of the hind-legs may be considerably relieved by a stimulant injection. The dogs were quite unable to stir their hind-legs, when an enema of spirit in one instance, and of dilute ammonia in the other, restored for nearly an hour their motility, and for a much longer period their sensibility. Both, however, subsequently died.

*Injection of Ergot into the Arteries.**—*Expt.* IX. Half an ounce of ergot was infused in three ounces of water, and the solution, after a reduction to two ounces, was carefully injected into the right carotid artery of a fine bull-dog, weighing thirty-eight pounds. Upon receiving the first syringeful he cried loudly, and struggled with convulsive violence. The pupils immediately contracted, but in a few minutes dilated again. Each injection produced similar effects, and when the whole quantity had passed, the pupil remained contracted, and abundance of froth issued from the mouth. In five minutes, the heart's action, which a short time before had been hurried, became slow and heavy; the pupil was at this time so contracted as to be scarcely discernible. The breathing was stertorous, and scarcely any part of the body was susceptible of pain. Respiration gradually became more slow and profound, until thirty-five minutes had elapsed from the commencement, when life was terminated. Sensibility of the body in this experiment was not materially influenced until twenty minutes from the first injection.

Autopsy.—All the muscles readily retracted from the knife. The heart was tolerably firm in its texture, the auricles were remarkably sensible to galvanism, but the ventricles, before and after the evacuation of their contents, were unaffected by it. All the cavities of the heart contained dark blood. The lungs were

* Without giving a separate detail, I may observe, that I have injected a pretty strong solution of sound rye into the arteries, without producing any effect, except contraction of the pupil and tendency to sleep.

engorged, and the trachea contained much frothy mucus. All the abdominal viscera were natural, except the gastro-colic-omentum, between the folds of which was a large quantity of extravasated blood. All the mesenteric veins were highly turgid. The *dura mater* and *pia mater* were diffusely reddened from minute injection; the vessels upon the surface of the brain were congested; and the substance of this organ exhibited throughout its structure many distinct traces of extravasation. The ventricles contained only as much serum as was requisite for the lubrication of their inner surfaces. I could discover nothing unusual in the spinal chord. This experiment was performed in the presence of Dr John Percy.

Expt. X.—A solution furnished by half an ounce of ergot* infused in four ounces of water, and carefully evaporated until only an ounce and a-half remained, was injected into the left carotid artery of a bull-terrier bitch weighing seventeen pounds. As the fluid passed, and before it was wholly transmitted, she yelled vehemently, and was the subject of strong convulsions. The pupil contracted instantly; the heart beat with increased activity, and the respiration was hurried and difficult. The urine flowed copiously, and the feces were discharged with severe tenesmus. Complete paralysis, with total loss of sensibility, resulted in less than a minute. In four minutes and a-half she fetched a deep sigh, the jaw was drawn down, and partial emprosthotonos appeared for a few seconds, when suddenly the muscles were relaxed; and the animal was dead.

Autopsy.—The appearances were almost identical with those in the last experiment, the effusion of blood in the abdomen excepted.

Expt. XI.—Three drachms of ergot were infused in three ounces of water, and the solution obtained was rapidly injected into the left carotid artery of a shepherd's dog weighing twenty-three pounds. The greater part of the fluid passed without producing any marked symptoms; but whilst the last syringeful was discharging, slight convulsions came on, with deep sighing and accelerated motion of the heart. In five minutes after the injection had been completed, hiccup prevailed, and the animal vomited a good deal of bilious matter. Afterwards, general twitching of the whole frame appeared, not amounting to convulsion, but having somewhat the character of rigor. All the hairs along

* The ergot in this instance, as in several others, had been well washed with cold water, to discover whether any diminution of activity would be the consequence. The results need no comment.

This mode of inquiry was suggested by the reports made upon the influence of the "sphacelus," which, when removed by washing, has been said to leave the ergot totally inert.

the spine became erect, and stood at right angles with the skin. The tail moved tremulously for some time, and then described a curve towards the back. In fifteen minutes from the commencement, paralysis of the hind-legs came on, but during a further period of twenty minutes, neither the motility nor the sensibility of the anterior part of the body was impaired. The pupil dilated without previously contracting, and it was not until ten minutes before death, that the eye was insensible to external impressions. Very little alteration was observed in the motions of the heart, though the respiration was much slower than usual. The skin for half an hour prior to dissolution was quite cold, and remarkably loose. No further symptoms occurred worthy to be particularized, until the death of the animal, which happened in two hours and forty-five minutes from the first injection.

Autopsy.—Excepting the presence of venous blood in the left cavities of the heart, there was no appearance meriting notice. The brain even was natural, and its membranes were but slightly marked by a few solitary vessels.

Paralysis that results from an injection of ergot into the animal system, is not always accompanied with a loss of feeling. In two instances where I have injected it by the veins, there has resulted an extraordinary increase of sensibility, so much so, that even touching the hairs at the extremity of the tail caused the animals to cry out in agony; a breeze of air produced the same effect; and again, without any apparent reason, there was a convulsive start, and a yell at the moment, expressive of acute suffering. Both these animals recovered.

In other cases, I have injected mild solutions of ergot into the arteries and veins, without producing any sensible effects whatever, —neither increase nor decrease of sensibility, no paralysis or stupor; and yet death has resulted in ten, fourteen, or twenty hours. The autopsies have failed to disclose any morbid appearances except the presence of dark blood in the left ventricle, and slight congestion in the lungs; circumstances attributable to the fact, that the respiration has diminished in a ratio disproportionate to the decrease of the action of the heart.

On the contrary, I have injected mild solutions of ergot into the arteries and veins without destroying the animals, though they have invariably looked meagre and sickly, and have never regained their previous strength or liveliness.*

Inferences.—These experiments are of so plain and pointed a nature, as to require little enlargement in verbal explanation. They appear to justify the following conclusions.

* Dr Mackenzie informs me that he has injected a solution furnished by two drachms of ergot, into the femoral vein of a dog without any bad effects; the chief symptom being hurried respiration.

1. That solutions of ergot injected into the arteries and veins affect chiefly the brain and the nervous system.

2. Both may be influenced together, coma, more or less perfect, and paralysis appearing at once; or the spinal chord may be first affected, paralysis immediately resulting, and the brain participate subsequently, the comatose period being much delayed.

3. Its effects differ according to the strength of the solution employed. In a concentrated form it appears to paralyze the system instantly, no resistance to its effects being discernible. A milder preparation causes for a time, great excitement, the nervous energy is roused, but sinks eventually under the influence of the poison. A much diluted solution, on the contrary, produces at first no apparent effect, but seems, by a very progressive sedative action, to deprive the system of its energy, and so to exhaust it of life.

4. Its effects are produced more speedily when introduced by the arteries than by the veins. The brain then appears to be first affected, and the spinal chord subsequently; and in some instances, as in Experiment IX. stupor to a considerable extent may prevail, and yet the sensibility of the extremities be little impaired.

Ergot also appears to exert a deleterious influence upon the system through the medium of absorption, and its activity seems to be correspondent with the relative absorbent power of varied tissues, or with the sensibility of different membranes.

Expt. XII. Three ounces of a very strong infusion of ergot were injected into the peritoneal cavity of a mongrel dog. It produced but little impression for some time; but in the course of two hours he looked drowsy, his hind-legs failed, and eventually became paralytic, his fore ones were only affected with slight weakness. He frothed considerably at the mouth, and whined as if in pain. Death followed in about eleven hours from the commencement.

Autopsy.—The peritoneum was extensively, but not deeply inflamed, the blush was most conspicuous where the syringe had been introduced, no doubt from the local irritation caused by the instrument.

This experiment may not at first appear to be conclusive, and to a considerable extent it is not satisfactory;—the difficulty being to draw a distinctive line between the mechanical influence and the physiological effects of the drug. My object, however, in this investigation was not to discover whether the ergot would occasion death when injected into the cavity of the peritoneum; but I wished to know how the animal system would be affected through such a medium. That the results did not depend upon simple mechanical irritation, I proved from a comparative experiment,

which consisted in injecting into the peritoneal cavity of another dog, a strong solution of sound rye. No stupor, frothing at the mouth, or paralysis resulted. The animal appeared to suffer exquisite pain, and died on the following day, above thirty hours having intervened between the commencement of the experiment and its close. The peritoneum was much more extensively inflamed in this instance than in the former.

But I have injected strong solutions of ergot into the cavity of the pleura without any injury following it. The animals have generally survived the operation for two or three days, and the inflammatory state, ever apparent, has prevented my drawing any satisfactory inferences.

Its injection into the cellular tissue of animals, which experiment I have often tried, has invariably led to the formation of purulent matter; in some instances circumscribed within a cavity, bounded by parietes apparently formed of solid purulent matter, easily broken down, and feeling to the touch like soft cheese. In other instances it has been diffused throughout a great extent of tissue, burrowing amongst the neighbouring muscles, and forming a number of cavities, communicating finally with one common cyst.

The purulent matter thus formed has always been of a very offensive, and apparently unhealthy kind.

SECTION VI.—*Action of Ergot upon the Animal System, when given in large and single doses by the Stomach and Rectum.*

Expt. XIII.—An infusion of six drachms of ergot in four ounces of water, was evaporated to two-thirds, and then introduced by means of a gum-elastic catheter, into the stomach of a small terrier bitch, weighing ten pounds. In fifteen minutes after receiving it, she looked sickly, her eyes appeared heavy and red, and the contracted abdominal muscles, curved back, and prominent ribs, with an occasional hiccup, showed plainly the distress of the stomach and the prevalence of nausea. At this time the breathing was heavy and laborious, marked by an occasional deep inspiration, which was invariably accompanied with a shudder. At the end of twenty minutes, this tremor increased and prevailed during every inspiration, but none of the expirations were marked by it. In some instances it was considerably augmented, and nearly resembled convulsion, but this severity was only occasional. When twenty-five minutes had elapsed, she seemed inclined to doze, the eyes were heavy, and the conjunctiva reddened. When called, she raised her head, and looked very suppliantly, but refused to get upon her legs. In forty minutes she became very restless, whined much, and continually wandered about. No further symptoms of moment occurred until the lapse of three hours, when her hind-legs appear-

ed to be remarkably weak. She moved them with difficulty, dragging them after her, and, in turning abruptly, generally fell. The fore-legs participated in the affection but not so strikingly; nevertheless they appeared numbed, and she threw them carelessly about, as though unconscious of their touching the ground. This condition subsided in about nine hours, up to which time she had refused her food. On the following day, she displayed nothing peculiar, except debility, considerable thirst, and a disinclination to eat.

Expt. XIV.—In two days afterwards, I gave to the same dog a similar quantity of ergot prepared as before. Nothing remarkable occurred until the expiration of half an hour, when she looked wild and confused, displaying occasionally strong indications of cerebral excitement. The tremor upon inspiration, and the faltering step, characterized this, as they marked the previous experiment. At the end of an hour she seemed to labour under great nervous excitement, for the least noise caused her to start in fear. She evinced also great irritability, for when a dog, with which she had played, immediately before the administration of the drug, came near to her, she growled or snapped at him, being evidently annoyed by his presence. At the end of six hours these symptoms had subsided, but during that period she refused to eat, and passed urine copiously seven times. For three or four days subsequently, she remained listless and inactive, sleeping much and eating very sparingly.

Expt. XV.—Five drachms of ergot, reduced to a very fine powder, were infused in water, and the whole of it, without straining, was injected into the stomach of a terrier dog, weighing thirteen pounds. He appeared in a very few minutes to suffer uneasiness, his belly was drawn up, and he crouched as though in pain. In eight minutes after taking it he began to vomit, and continued to be distressingly agitated with nausea and retching for nearly a quarter of an hour, when these symptoms declined, and gave place to severe and protracted hiccup; this continued for above half an hour, when he fell asleep, and subsequently awoke, apparently little affected by the medicine.

Expt. XVI.—Twelve drachms of ergot, reduced to a very fine powder, were suspended in water, and then injected into the stomach of a mongrel dog, weighing twelve pounds. Immediately after its introduction the gullet was tied, to prevent the ejection of the dose. In five minutes, he made many ineffectual attempts to vomit, though the sickness was not so great as I anticipated. It continued for six or seven minutes, and then subsided. In fourteen minutes general tremor came on, and the dog was scarcely able to stand. He stared wildly about, and seemed to recognize nothing distinctly. He then staggered into a corner, falling seve-

ral times before reaching it, and in a few minutes began to doze. During sleep the limbs were twitched convulsively, the hind-legs were especially affected, and the abdominal muscles were in strong contraction. He snored loudly, and more than once I suspected a termination in coma. At the end of three hours he was somewhat easier, but hardly able to move. The eyes looked heavy, the conjunctiva reddened, and the mouth was filled with frothy saliva. The ligature was now relaxed, a further dose of twelve drachms of ergot was given, and the cord was tightened once more. This dose affected him much more than the former one, and in a few minutes after receiving it, he lay as if dying, moving his legs unconsciously in various directions. In a quarter of an hour he tried to vomit, and was evidently much agonized. He lay upon his side, occasionally fetching a deep sigh, and hiccupping severely; his look was remarkably wild, and the tremor upon inspiration excessive. After having been removed into a corner he fell asleep, snoring loudly, and frothing abundantly at the mouth. At the end of two hours and a half the ligature was removed, and the wound carefully sewed up. From the commencement he had passed no urine, but shortly after the removal of the cord, both urine and feces were evacuated involuntarily. In about six hours from the administration of the last dose, he ate three small pieces of bacon, and then refused whatever was offered to him. On the following day he was completely paralyzed in the hind-legs, and his command over the fore ones did not allow him even to crawl. He ate nothing during the day, but drank a good deal, and towards evening seemed to be a little relieved. On the second day he was able to stand, but when he attempted to walk he invariably fell, and was many minutes before he could rise again. He dozed almost continually, and was irritated by very trifling causes. His hearing now appeared to be nearly gone, for it required a great noise to startle him; his sight was also much diminished, and, indeed, I was several times of opinion that actual blindness had resulted. The sense of smell was totally lost, which was perhaps in some measure owing to the presence of an abundant and highly offensive mucus which poured from the nostrils. His victuals were obliged to be put into his mouth, for he could neither smell nor see them, and if left alone he must inevitably have been starved to death. Up to this day, I could discover no particular difference in the action of the heart, but it was now feeble and intermittent; the temperature of the body was much diminished, the nose perfectly dry, mouth parched, and in every particular he exhibited the most wretched picture of misery and suffering. On the third day profuse diarrhœa came on, after which the animal seemed a little better; his senses were more acute, and he was able to walk for a few yards. The wound in his neck discharged

a matter of the most offensive description imaginable, such as rendered the stable, though a large one, almost intolerable.

From this time he slowly improved, but he never regained his flesh or recovered his liveliness. His activity was gone, his faculties were enfeebled, and he displayed every unequivocal proof of physical decrepitude and decline.

Expt. XVII.—Twenty-four drachms of ergot in fine powder were infused in five ounces of water, and when tepid the whole mass was injected through a gum-elastic tube into the stomach of a terrier bitch, weighing fifteen pounds, the gullet being tied immediately afterwards. In about seven minutes she began to evince signs of uneasiness, whining piteously, and drawing up her legs. In twelve minutes she made the first effort to vomit, and continued to do so with evident indications of suffering for above quarter of an hour, when these symptoms were succeeded by calmness and lassitude. During the greater part of the time in which vomiting prevailed, she was lying on her belly, and was therefore not disturbed; but on the cessation of the sickness, it was found that she was unable to rise, and on being lifted upon her legs, she maintained the position with difficulty, and in a few seconds fell. The pupil was contracted, the conjunctiva reddened, an abundance of saliva issued from the mouth, and the breathing was slightly stertorous. In eighteen minutes further, spasmodic twitchings of the hind-legs came on, the abdominal muscles next, and those of the fore-legs subsequently participating. During the prevalence of this spasm hiccup appeared, which lasted for a short time, and on its cessation, the animal began to whine and exhibit other indications of pain and torture. At this time, three-quarters of an hour from the commencement, the heart became intermittent in its beats, and its pulsations, at first rapid, were slow and feeble. Urine and feces were abundantly evacuated, and slight emprosthotonos appeared, with desire to vomit. At the expiration of an hour these symptoms subsided, leaving the animal weak, flaccid, and motionless. She continued to froth at the mouth, the pupil remained contracted, the eye fixed, and, except when touched, not influenced by passing circumstances. In two hours and three-quarters from the commencement, the ligature was removed from the gullet. The extremities were now growing cold, the spasms had subsided, and nothing but slight tremor upon inspiration was discoverable. Respiration was very slowly performed, and insensibility much diminished; for when pricked she manifested no uneasiness, and a deep incision was required ere its influence was acknowledged with a groan. At the end of five hours, nothing of further importance having transpired, she was left for the night, and on entering the stable on the following morning she was found to be dying. The pupils were di-

lated, the action of the heart could not be felt, the body was perfectly cold, and equally insensible, and the only proof of vitality remaining was an occasional gasp, which was accompanied with a drawing down of the lower jaw. In rather more than an hour and a half afterwards she died, having survived the experiment nineteen hours and forty minutes.

Autopsy.—The body was opened immediately after death, but the muscles were not susceptible of galvanic influence. The heart contained blood in all its cavities, but the blood of the left side was of too dark a hue to indicate perfect arterialization. The substance of this organ was soft and flaccid, and the *venæ cavæ* for some distance beyond it were gorged with blood. The lungs were darker than natural, the trachea was lined with frothy mucus, and the bronchial ramifications were, in some instances, filled with it. The gullet exhibited nothing remarkable, but the lining membrane of the stomach was extensively reddened from minute injection, the loaded vessels being more conspicuous upon the summit of the rugæ than in their intervals. Only a small quantity of ergot was present in this organ, the greater part having passed into the intestines. The vermicular motion of the latter had ceased, and they contained abundance of bile. Feces were found in the rectum, and the bladder was full of urine. The uterus was natural. Upon removing the skull, the *dura mater* discovered a slight and diffusive injection, but distinctly less than the *pia mater*. The substance of the brain was little altered, and the left ventricle only contained a small quantity of serum. The spinal chord was natural throughout. This experiment was witnessed by Mr Henry Taylor.

Expt. XVIII.—Nine drachms of finely powdered ergot were, after slight infusion in three ounces and a half of water, injected, *en masse*, into the stomach of a rabbit, weighing five pounds and a half. There was no necessity to tie the gullet, as this drug, like most others, fails to induce sickness in such animals. At the end of half an hour it began to show signs of uneasiness, constantly turning about, and drawing together its legs as though pained. In about ten minutes this restlessness had subsided, and when an hour and a half had elapsed, the rabbit began to dose, twitching a little at the same time, particularly in the hind-legs and ears. He was watched for two hours longer, and nothing particular appearing, I left him for the night, and on the following morning found him well and lively.

Expt. XIX.—Sixteen drachms of ergot were, in a manner similar to the last, introduced into the stomach of a female rabbit, weighing four pounds and three quarters. The dose appeared to occasion a little uneasiness, indicated by a very frequent and somewhat peculiar change of position; but none other symptom

at all expressive of its influence could I discover until the termination of two hours and a quarter, when its fur was remarkably roughened, not having the softness of texture and uniformity of disposition characteristic of good health. This peculiarity of surface, unmarked, however, by any other symptom, continued until the following day, when its absence and a good appetite justified the inference that all indisposition had subsided.

Expt. XX.—Eleven drachms of ergot, after the customary infusion, were, without straining, injected into the rectum of a bull-terrier bitch, of about eighteen pounds weight. The enema was retained for twenty minutes, at the end of which time it was forcibly expelled with a small quantity of fecal matter, severe tenesmus succeeding. She then became uneasy, whined piteously, passed a little urine with apparent difficulty; the pupil dilating at first, and contracting subsequently. In a short time she foamed much at the mouth, twitchings were observed in the hind-legs, which in an hour afterwards were weakened and benumbed, their temperature, as also that of the body, being much reduced. On the following day she was quite well.

Expt. XXI.—Fifteen drachms of ergot were, in a manner similar to the last, given to a mongrel dog, weighing nine pounds and a half. The symptoms were almost identical with the preceding, except that he appeared to suffer considerably in passing urine, and in half an hour priapism came on, associated with hiccup. For two or three days this animal laboured under a dysenteric affection, and considerable weakness of the hind-legs.

From these experiments we may infer, that ergot is capable of exciting a local irritation upon the parts with which it comes into contact; determining when in the stomach nausea, vomiting, and hiccup; when in the rectum, tenesmus; and by sympathy, dysury and priapism.

Its influence upon the brain and spinal chord is well expressed, on the latter especially; but it is evident that a considerable dose is required for the developement of any active results.

It will also be observed that rabbits are much less influenced by the ergot than dogs; a circumstance perhaps attributable to two causes; 1*st*, vegetable diet being the one allotted to, and therefore best suiting them; and 2*dly*, because they are able to bear a much greater quantity of narcotics and other substances of that class than carnivorous animals; the influence of such medicines upon them being of course greatly modified by idiosyncrasy.

The next experiments are intended, according as they may apply, to confirm or render nugatory the long prevalent opinion in favour of the production of spasmodic ergotism and dry gangrene from the protracted use of ergot of rye.

(To be concluded in Next Number.)

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