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Grevillea,

A QUARTERLY RECORD OF CRYPTOGAMIC BOTANY AND ITS LITERATURE.

PERSONAL NOTICE.

Subscribers are requested to excuse delay in this number. The unfortunate, sudden, and severe illness of the Editor was the cause, and his temporary loss of the use of the right arm, added to the condition of the head, made it quite impossible to obviate the delay. It is hoped that he will be able to resume with the next number.

ON MIMICRY IN FUNGI.

By Charles B. Plowright.

The subject of mimicry in the various kingdoms of Nature is one of great interest, especially since the evolutionist has shown its importance to the well-being, or even perhaps almost to the existence of certain specific forms. It may be that the more striking manifestations of protective mimicry are to be found in the animal kingdom, but all mimicry is not protective, neither is it by any means confined to the animal kingdom.

Few, and comparatively feeble, have, up to the present, been the attempts made by mycologists to unravel the mysteries of these phenomena, as they are presented to us in the vast range of species which are included under the name of fungi. At any rate, however, so important is the subject of mimicry to the philosophical naturalist that almost any attempt to indicate the more important instances of it, as presented by these low forms of vegetable life, can hardly fail to be interesting, however clumsy may be the effort.

In working upon such a subject, as the one before us, it is exceedingly difficult to avoid being led away by the imagination beyond the limits of reason, to fancy forms which do not exist, and to see similarities where there are none.

Mr. W. G. Smith, in the *Gardeners' Chronicle*, and Dr. M. C. Cooke, in *Grevillea*, have both written papers upon this subject, but

the remarks of these writers bear chiefly upon the mimicry of one species of fungus by an other (interfungal mimicry). This only touches the fringe of the subject, and rather trenches upon the question of what is entitled to rank as a species, and what as a variety. Now this is a highly important question, especially to the fungologist, for he labours amongst a group of organisms so extensive that no one man can ever hope to master them as individuals. They are forms of organic life to which the most rabid opponents of evolution have never yet suggested the possibility of applying the test of hybridization for the differentiation of species. Perhaps there is no group of organisms more calculated to shake one's belief in the permanency of species than the one under consideration. But to return to the subject of mimicry.

In the whole range of species included in the *Agaricini*, in only a few instances do we find species protecting themselves by mimicking the plants and objects upon or amongst which they grow. Of the hundreds of agarics which grow amongst grass, in pastures, on lawns, or by road sides, two and two only have a green colour, viz., *Agaricus æruginosus*. Curt., and *Agaricus odorus*, Bull. ; and it is noteworthy that these are almost the only two bright green agarics known, the total number of agarics, with any shade of green about them at all, being very small. Now in the first named species (*A. æruginosus*) the green colour is not permanent, for it disappears *pari passu* with the maturation of the plant. Young specimens have a vivid enough colour, it is true, but then it is relieved by dead white floccose scales, which are, however, evanescent, and have all disappeared by the time the fungus has assumed its whitish yellow hue of maturity. One can hardly say, then, that this species has been very successful in mimicking its grassy surroundings, if even it would by so doing gain any advantage in the struggle for existence. With the other agaric (*A. odorus*) it is quite different, for it more closely simulates its surroundings. Its colour is not æruginous, but a much quieter shade of green, and it has the odour of "new mown hay," *i.e.*, of *Athoxanthum odoratum*. It is worth noting that of these two green agarics, one is edible and the other poisonous. The other instances of agarics, simulating their surroundings, are found principally amongst the *Derminii*, especially amongst the *Hebelomæ*, where the humbler shades, brown, grey, or black, are common. The great majority of agarics, however, on the contrary, contrast strikingly with their surroundings, white, red, yellow, pink, violet, orange, and indeed almost every imaginable hue, excepting green. One cannot but be struck with this fact, and conclude that the fungi must derive an advantage from it in some way analogous to flowering plants. Unfortunately this is only a surmise, as we know almost nothing of the physiology of the reproduction of the *Hymenomycetes ;* and hitherto attempts made by experimentalists at growing these fungi from their spores have been failures. Mr. W. G. Smith, however, has pointed out the strong probability, to

say the least, of the existence of a bisexuality in the hymenia of agarics, in which he regards the spores as the female element, and cystidia as the male. Now if subsequent observation should confirm this important discovery, which no one has as yet disproved, or even seriously called in question, we at once obtain a clue to the advantages likely to accrue to fungi from the visits of insects and the consequent interchange of reproductive elements. If insects can carry pollen from the anthers of phanerogams, they can assuredly carry the spores or spermatia of cryptogams.

But in the event of the sexuality of the *Hymenomycetes* being disproved, there remains another fact in connection with the germinative energy of fungus spores, and the vitality of certain species which must be born in mind. On the first appearance of a fungus in a new locality, it often grows with great vigour, and occurs in great abundance, but in the course of a few years it gradually declines, and may disappear altogether. To take a recent example, *Puccinia malvacearum*, Corda, was described and figured by Corda,* in 1854; and also by Montagne,† in 1856, from Chili. In June and July, 1873, it appeared for the first time in this country, and in the course of a short time devasted our hollyhocks, and also spread to our common species of *Malva* to such an extent that in the autumn scarcely a plant of *M. sylvestris* could be found without its foliage being destroyed by the fungus. At the present time it is by no means so common a fungus, and our gardeners have ceased to dread it as "the hollyhock disease." *Puccinia Apii*, Corda, is another instance. This fungus appeared first in this country in the autumn of 1866-7, on the cultivated celery, causing much mischief to the plant. We never see it now upon the celery in gardens, although it is occasionally met with upon the wild celery (*Apium graveolens*).

It is well-known to practical brewers that by using yeast over and over again its efficacy becomes impaired to such an extent that it becomes useless. Under these circumstances, according to an established custom of the trade, an exchange of yeast with some other brewery is effected. Why a yeast which is languid in one place should in another, where it is apparently grown under exactly the same conditions, become active, it is difficult off-hand to say, but the fact remains that a change of locality does invigorate the growth of fungi.

Although instances of agarics, simulating their surroundings, in appearance are comparatively few, yet many of the larger *Peziza* do this. In turning over the plates of Cooke's *Mycographia* I was struck by this. Now the *Peziza*, compared with agarics, enjoy a great immunity from insect depredation, and the manner in which the *Elvellacei* disseminate their spores seems to be connected with this. The sporidia of the larger *Peziza* are expelled by

* "Corda Icones," vi., p. 4, t. i., f. 12.
† "Montagne Sylloge.," p. 314.

the rupture or sudden opening of the upper end of the asci, which seems to be induced when their tension has attained a certain point—the bursting strain. As each ascus ruptures, it relieves the tension of the whole hymenium to an extent equal to its own diameter, the next ascus does not give way until the requisite tension has been regained. Of course the integrity of the cup forms an important element in the production of this tension, hence the advantage to *Peziza* of availing themselves of protective mimicry to guard against external injury. This seems further borne out by the fact that the only markedly odouriferous *Peziza* amongst our British species (*P. venosa*, Pers.) has the concavity of its hymenium broken by prominent ridges.

The honey secreted by the flowers of phanerogamous plants is, of course, the source of attraction to insects, but this inducement does not exist in fungi. The advantages which are derived by flowering plants from fertilization by pollen from another individual of the same species are probably equalled by an interchange of reproductive elements amongst fungi, and we here find an explanation of many facts that are otherwise inexplicable. Although there is no honey to be obtained from fungi, still there are advantages to be gained by the visiting insects. The larger *Hymenomycetes* are well calculated to afford abundant food to insect larvæ, and the rapidity with which the fleshy species disappear before the voracious appetites of their numberless tenants shows that insects fully avail themselves of this source of nutriment for their offspring. But larvæ do not feed on all fungi with equal avidity. The majority of agarics are so attacked; some species, such as *Agaricus rubescens*, can hardly ever be found without their burrows somewhere about it, either in the pileus, in the stem, or especially in the bulb. Most of the *Russulæ* are greedily devoured—even such acrid species as *R. emetica* and *fragilis*. The *Lactarii*, on the other hand, enjoy a comparative immunity from insect depredation compared with other fungi. Insects find their way even into subterranean fungi. I have frequently raked up *Hymenogasters* and found them full of active larvæ. Messrs. Berkeley and Broome,* speaking of *Tuber bituminatum*, B. and Br., say—"Some of the specimens were attacked by worms (larvæ ?), the flesh of which became quite black when dry." *Tuber cibarum* is often preyed upon by a species of *Liodes*,† to which fungus *Anisotoma cinnamonea* is also said to be attached.

Many beetles live in the larger *Polyporei* and in *Scleroderma*—*Cis Boleti* for example. Dr. T. A. Chapman has described ‡ the life history of a small beetle—*Abdera bifasciata*, Marsh—which

* "Berkeley and Broome Annals." Nat. Hist. Series, ii.; vol. vii, No. 581.

† "Berkeley English Flora," vol. v, part 2, p. 228.

‡ Chapman, T. A. "Transactions of the Woolhope Club," 1869; p. 161; "Entomological Monthly Magazine," vol. vi, p. 259.

seems to be exclusively attached to *Corticium quercinum, Fr.* This gentleman, to whom I am indebted for much valuable information, says in a letter to me—"The *Coleoptera* and *Diptera* attached to fungi would probably amount to two hundred species of each. Then you would find a contingent nearly as large of the ichneumons and other parasites on these, and the predaceous beetles (chiefly *Staplylimes*) that devour them."

The hymenium in the *Phalloidei* is moist and gelatinous, and Mr. Berkeley says "it affords a welcome food to multitudes of flies." * It is difficult to see how the spores of these fungi become disseminated of their own accord. The spores of our three principal British species measure 5 mikromillimeters in length by about 2 mk. in width; they are, in fact, very small spores, smaller than the *Bacillus anthracis* which Koch says "may be as long as 20 mk., and as thick as 1 to 1·25 mk." † Every one who has seen any of the *Phalloidei* growing must have noticed the cloud of flies that are always attracted to them, and there can be little doubt that the flies here act the part—to a great extent, at any rate—of spore diffusers.

Many species of *Ustilaginei* are confined to the interior of the ovary, or to the seeds of plants such as *Tilletia caries*, Tul.; *Ustilago receptaculorum*, Fr.; *U. utriculosa*, Tul.; *U. urceolorum*, Tul.; *U. olivacea*, Tul.; *U. montagnei*, Tul.; *Sorosporium saponariæ*, Reed; *Thecaphora hyalina*, Fing., &c. Most of these have extremely small spores, which could be carried as easily as pollen grains by insects from an infected to a healthy plant. Anyone who has watched bees must have observed how they visit flower after flower, and that they will light upon flowers which appear to us to have passed long since their honey-bearing stage. One is almost tempted to ask how else could the anthers of *Silene* and *Lychius* become affected with *Ustilago antherarum*, Fr., unless the spores be implanted upon them by insects, when every other part of the plant appears to be perfectly healthy.

We have seen, then, that insects visit fungi *(a)* to deposit their eggs, where the young larvæ shall find suitable and abundant food; *(b)* for the purpose of obtaining food themselves.

Let us now see what attractions fungi offer insects as inducements to visitation. These appear to be of two kinds—(1), external appearances; (2), odours, agreeable and otherwise. The outward appearance of the larger fungi is, as we have already seen, usually in contrast with their surroundings, as anyone who has gathered mushrooms in a meadow will readily admit; but, more than this, there are many instances in which fungi mimic other objects with great felicity, especially objects from the animal kingdom, either parts of animals or animal excrements.

* "Berkeley Introduction to Cryptogamic Botany," p. 347.

† "Koch on Traumatic Infectious Diseases." Translated by W. Watson Cheyne; New Sydenham Society, 1880, p. 58.

Vegetable Semblances.—There are some few vegetable mimicries that it will be convenient to take first, as they are not numerous. If Mr. Fitche's figure of *Balanophora involucrata*, Hook.,* can be relied upon to the extent his figures usually can, a more striking resemblance to *Agaricus muscarius*, Linn., can hardly be imagined. The colour of the pileus, with the white warts upon it, the white stem and volva of the fungus, here find their counterparts so accurately delineated that the uninitiated can hardly be persuaded he is not looking at the representation of a specimen of *A. muscarius* which has just burst its volva, until the letterpress be referred to.

Of *Hygrophorus calyptræformis*, B. & Br., Mr. Berkeley † says —"The young pileus has a great resemblance to the internal bractea of an artichoke just before expansion."

The young plant of *Hydnum coralloides*, Scop., bears considerable resemblance to a cauliflower, as was long ago pointed out by Persoon. ‡

Tremella moriformis, Berk., receives its name from its likeness to a mulberry, which is heightened by its communicating a violet stain "to whatever the plant touches."

Exidia glandulosa, Fr., especially in damp weather, mimics most accurately of all the *Tremellæ*—the common Nostoc. Anyone who has seen *Licea fragiformis*, Fr. (*Tubulina cylindrica*, Bull.) just before maturity must have been struck by its resemblance to a ripe strawberry.

Animal Semblances.—It is unnecessary to do more than indicate the semblance which the name of *Cynophallus* implies; but it is worthy of notice that, although flies feed greedily upon its hymenium, it rarely if ever falls a prey to their larvæ. The peculiar structure of the stem is not totally unlike the *Corpus cavernosum* of the anatomist. It is remarkable amongst the *Phalloidei* for being nearly scentless.

Clathrus cancellatus, Mich. When Mr. Broome found this fungus in an advanced state in Italy, he was struck by the resemblance it bore to the entrails of some animal. He says in a letter to me—"It was when in a state of decay the meshes appeared to elongate, and to form an intricate fœtid mass. I forget the circumstance of the flies hovering over it but no doubt they did so from its horrible odour."

Nœmatelia encephala, Fr., Mr. Berkeley ‖ says, "looks like the brain of some animal," and anyone who is acquainted with it will agree with him.§

* "Berkeley Outlines of British Fungology," pl. ii, fig. 8.

† "Berk. Annals Nat. Hist," No. 3; May, 1838, p. 199, No. 63.

‡ "Persoon Synopsis," p. 564.

‖ "Berkeley Outlines," p. 290.

§ A striking resemblance to brain matter amongst the cryptogamia is found in *Dasyglœa amorpha*, Berk. This curious Nostoc-like Alga, is not uncommonly found in this country, and has been brought to me with the

The well-known *Fistulina hepatica*, Fr., affording, as it does, one of the best instances of animal mimicry amongst fungi, is peculiarly interesting, from the fact that, at different periods of its growth, it mimics two separate animal structures with great fidelity. In its young state, soon after it has made its appearance, it is light red in colour, and has the shape, size and colour of the human tongue; and, moreover, it has its upper surface studded with numerous darker, prominent papillæ, exactly as the before-mentioned organ has. Here the external likeness ceases; but if a section be made, the alternately darker and lighter lines which radiate and diverge from its base recall to the anatomist's mind the fasciculi of the genio-hyo-glossus muscle of the above organ. As the fungus approaches maturity, it increases in size and loses its light red colour, becoming darker, and at length reddish brown. Its upper surface gradually gets less firm in consistency, while from its under side are exuded drops of a red fluid. It now looks exactly like the liver of some animal from which blood is dripping.

Peziza leporina, Batsch, bears some resemblance to the ear of a rabbit or hare, especially is this the case with a variety which grows in fir woods. I have gathered this condition more than once near King's Lynn.

The resemblance of *Morchella Smithiana*, Cooke, and other morells in a less marked degree, to a mass of honey comb, both in form and colour is considerable, and it is not lost until the size of the cells be taken into account. These fungi are especially subject to insect depredation.

Thamnomyces hippotrichioides, Ehrb. resembles a tangled mass of black horse hair.

Excrementitious Semblances. Many instances of these are afforded by the *Myxomycetes* in their young state. For example, *Æthalium septicum*, Fr. (*Fuligo varians* Somm.), looks very like a small portion of recent human odoure, as do the earliest stages of some of the *Trichiæ*. Immature specimens of *Reticularia maxima*, Fr. (*Brefeldia maxima*, Fr.), and *spumaria alba*, Bull, have a decidedly fæculent appearance. The most striking resemblance to dung amongst the *Myxomycetes* is, however, afforded by *Lindbladia effusa*, Fr., to patches of cow dung. So remarkable is this similarity that upon one occasion when I was directed by an eminent Scottish mycologist to search for this fungus upon the sawdust at Rothiemurchus, and told its similarity, yet when I arrived at the spot I actually passed over several specimens of *Lindbladia*, carefully avoiding them, thinking they were cow droppings.*

query, "What Tremella is this? Or is it the brain of some animal?" The likeness is enhanced by the presence of bands of thickened tissue, which one might take for pia mater, intersecting, as they do, the opalescent semi-gelatinous structure of the plant.

* It is a curious coincidence that upon both *Lindbladia effusa* and upon cow dung two *Stilba* occur (*S. globosum* and *S. fimetarium*), which bear much resemblance to each other in form and colour, but not in size.

Scleroderma vulgare, Fr. is very like, at first sight, lumps of horse dung.

Fungoid Odours. Before speaking of the odours of various substances that are mimicked by fungi, it is advisable to make a few remarks upon the subject generally. In the first place there are many persons who are to a greater or lesser degree odour blind. Neither is there any means of accurately measuring, either the extent or quality of odours. To some persons an odour may be intensely offensive, while others can hardly appreciate it, or may indeed, question its existence altogether. Again, odours which are unpleasant to some persons are to others agreeable. The power of smell is possessed, as is well known, much more perfectly by some of the lower animals, for by it the *Carnivora*, track their prey in a manner totally beyond the ability to do so possessed by any human being. Hence, although we may be unable to detect an odour in any particular fungus, it by no means follows that that fungus is odourless. In the same way some sounds are inaudible to certain ears, for example, some persons cannot hear the cry of the bat which is heard readily enough by most persons. Having no standard by which fungous odours can be accurately compared, mycologists have adopted the following, among many other, arbitrary terms for indicating the observable presence or otherwise of odours in fungi : odour strong, odour unpleasant, odour offensive, and the like. When a number of persons are asked to liken the odour of any fungus to some known smell, the most diverse similitudes are often given. The majority of persons unaccustomed to smelling fungi for diagnostic purposes will say it smells "like a fungus" or else "like a mushroom." A specimen of *Agaricus gliocephalus*, Fr. was once sent to an eminent British fungologist who compared its odour to that "of rotting broad beans." Another *Agaricus ameides*, B. and Br. is said by Messrs. Berkeley and Broome "to resemble a mixture of orange flower water and starch,"* while Mr. Berkeley says, *Agaricus alcalinus*, Fr., has "a pungent odour like fermented or putrid walnuts."† From these complex comparisons it is clear that the difficulty of correctly and concisely describing the odour of many fungi is very great.

Of the 452 species of *Agaricus* included in Cooke's "Handbook of British Fungi," 83 species or 18 per cent. have their odours mentioned for diagnostic reasons, but it does not follow that the remainder are without smell, for such marked odoriferous species as *A. campestris*, Linn. ; *A. meleagris*, Sow ; *A. rimosus*, Bull., &c., are passed over without any allusion being made to this character. In the genus *Lactarius*, the percentage is 12, while in *Trametes* it rises to 75, but this is an exceptional genus. Of the 20 species of the *Hypogei* 40 per cent. are mentioned as odoriferous, while in the *Tuberacei* it rises to 55 per cent. To illustrate the manner in

* Berkeley and Broome, "Ann. Nat. His." 1865, No. 999.
† "Berk. English Flora," vol. v, pt. 2, p. 58.

which the odours of fungi are indicated the subjoined extracts from the Handbook will be useful.

Hypogæi (20 species). Odours noticed in eight species as under :—

1045* The smell is just like the pungent odour of some *Ichneumon* or small bee.
1046 The smell was slight.
1048 Abominable smell, which resembles that of assafætida.
1050 Smell at first like of that of some *Hypericum*, then exactly that of a decaying puff-ball.
1052 The smell is very much like that of 1048 when old, but when young it has an acid smell like that of sour ham.
1054 Smell very slight.
1060 Smell like that of *Lactarius theiogalus.*
1061 Smell like that of *Lact. theiogalus.*

Tuberacei (27 species). Odour noticed in fifteen species :—

2237 Odour strongly alliaceous.
2238 Odour bituminous and very strong of horse radish.
2239 Odour faintly aromatic.
2241 Smell at length rather disagreeable.
2242 The odour is said by Vittadini to be strong and nauseous.
2243 Odour, when recent, nauseous.
2244 Odour of the radish.
2245 With little odour.
2246 Had a very strong odour.
2248 Smell in some specimens like that of an agaric, in others strong and nauseous.
2249 Has a strong smell like that of rotting seaweed.
2251 The smell is very strong and disagreeable, resembling that of 1048.
2255 Smell strong.
2258 Odour faint not peculiar.
2259 The smell is very powerful.

No mention is made of the smell of *Tuber æstivum*, which is very peculiar and penetrating, especially after it has been kept in a close atmosphere for a few hours.

The above list contains several examples of fungi, mimicking the odours of various substances, such as sour ham, radishes, assafætida, insects and the like. The question naturally presents itself, of what use can these odours be to the fungi? These subterranean species are protected by the mode of growth from many accidents to which other fungi are liable, yet they are at a considerable disadvantage on the score of spore dissemination. It is quite true that many of them are not absolutely subterranean throughout the whole course of their existence, but for every single individual found above ground at least a score are

* The numbers are those of the species in Cooke's "Handbook of British Fungi," p. 355 to 363 and p. 738 to 750.

found buried some inches below it. A fungus which lives and dies below ground has but a very poor chance of scattering its spores compared to other fungi. It is true that insect larvæ are constantly found it these fungi, but the chance of a volant insect emerging from a hypogean fungus and carrying with it spores that still retain their power of germination can be but slight. But we do find these subterranean species eagerly sought for by animals notably by pigs, and also by the smaller rodents.

Mr. Broome has found *Hypogæi** gathered up by one of the field mice. He did "not see the animal, but it was evident from the runs (underground), which converged to the store that the animal had collected them." It was not unreasonable to suppose that the spores of these fungi should retain their power of gemination after having passed through the intestinal canal of these animals, when we consider how abundantly mushrooms are produced upon horse dung. In fact some fungologists go so far as to say that the spores of *Agaricus campestris* will not produce active mycelium unless they have been subjected to this treatment.

Fungal Odour-mimicry.—Not only do the vast majority of fungi possess peculiar and in many instances characteristic odours of their own, but we find them mimicking the odours of other vegetables, of animals, and also of other substances.

Confining ourselves to British species we have the following examples. These, although perhaps now collected for the first time are not mere fanciful similitudes jotted down on the spur of the moment, but are almost all of them given in our standard text-books of fungology, and have been recognised as long as the species themselves have.

Vegetable Odour-mimicries.—The odour of melilot (*Melilotus officinalis*, Linn.) is possessed powerfully and persistently by *Lactarius camphoratus*, Fr.; *Hydnum graveolens*, Dell; and *Hydnum tomentosum*, Linn.

The odour of aniseed (*Pimpinella anisum*) is possessed by *Agaricus fragrans*, Sow.; *Trametes suaveolens*, Fr.; *T. odora*, Fr.; *Polyporus salicinus*, Fr.; and *Hydnum suaveolens*, Scop.

The odour of field-mint (*Mentha arvensis*, L.) is possessed by *Lentinus Vulpinus*, Fr.

The odour of tarragon (*Artemesia dracunculus*, L.) is possessed by *Agaricus euosmus*, Berk.

The odour of peppermint (*Mentha piperita*, Huds.) is possessed, as well as the taste, by *Hygrophorus aromaticus*, Berk.

The odour of garlic (*Allium sativum*) is possessed by *Marasmius porreus*, Fr., and *M. scorodonius*, Fr.

The odour of radishes (*Raphanis sativus*) is possessed, as well as the taste, by *Agaricus purus*, Pers. *Tuber puberulum*, B. & Br., has the same odour.

* *Octaviania asterosperma*, Vitt., the quotation is from a letter Mr. Broome sent me on the subject.

The odour of horse radish (*Cochlearia armoracea*, L.) is possessed by *Tuber bituminatum*, B. & Br.

The odour of cucumber (*Cucumis sativus*) is possessed by *Agaricus (Naucoria) Cucumis*, Pers.

The odour of ripe apricots (*Prunus armeniaca*) is possessed by *Cantharellus cibarius*, Fr.

The odour of rotting pears (*Pyrus communis*) is possessed by *Agaricus pyriodorus*, Pers.

Pilacre Petersii, B. & Curt., and *Hysterangium nephriticum*, Berk., in its young state, smell like "some *Hypericum*."

Agaricus frumentaceus, Bull., and 15 other species of the genus *Agaricus*, enumerated in the "Handbook," smell like new meal or flour, or have a farinaceous odour.

Animal Odour-mimicries.—*Agaricus incanus*, Fr., has the odour of mice (*Mus musculus*).

Agaricus (Nolanea) pisciodorus, Cés.) has the odour of putrid fish (rancid herring).*

Hygrophorus russo-coriaceus, B. & Br., has the odour of Russian leather.

Rhizopogon rubescens, Tul., "has when young an acid smell like that of sour ham."

Hygrophorus cossus, Fr., has the smell of the larvæ of the goat moth (*Cossus ligniperda*).

Lactarius quietus, Fr., and *L. cyathula*, Fr., have the odour of the common house bug (*Cimex lenticularis*).

Odours of Chemical Compounds.—*Agaricus sulfureus*, Bull., and *A. lascivius*, Fr., have the odour of gas-tar water.

Agaricus radicosus, Bull., has the odour of hydrocyanic acid (HCN).

Peziza venosa, Pers., has the odour of nitric acid (HNO_3).

Agaricus alcalinus, Fr., *A. nidorosus*, Fr., and *Hygrophorus nitratus*, Fr., have odours closely resembling a dilute state of nitric oxide (NO).

Marasmius fœtidus, Fr., has exactly the odour of Cacodyle † ($C\ H_3|_2\ As.$).

What advantage it should be to a fungus to stimulate the smell of such poisonous substances as prussic and nitric acids it is very difficult to imagine, unless it be for protective purposes. But the fact that they do so is well known to all mycologists. The other odours—namely, of vegetable and animal

* This it has in common with *A. nigripes*, Trog., a species not yet recorded in Britain. *A. pisciodorus* is by no means an uncommon species, but it is often confounded with *A. cucumis*, from which it differs both in the colour of its spores and in its smell.

† Cacodyle or Arsendimethyl is an extremely poisonous substance, which is prepared by heating arsenious oxide with potassium acetate. It has a most disagreeable garlic-like smell. I have never yet come across any other fungologist who was acquainted with this compound, but the odour of it, to my mind, exactly resembles that of *Marasmius fœtidus*.

substances—are most probably attractive to insects, for Sir John Lubbock, with whom I communicated on the subject, was kind enough to inform me that "there can be no doubt that insects possess the power of smell;" and I believe the same opinion is held by other entomologists.

Luminosity.—Dr. T. A. Chapman tells me "there are some 160 species of the *Dipterous* family, *Mycetophilidæ*, many of which live in rotten wood, or rather on the mycelium in it, as many beetles do." Now, there is a well-known property of some mycelia which they possess in common with certain insects—viz., luminosity, the the advantage of which to the fungus is very difficult to perceive. That this is advantageous to myceliophagus insects is obvious, but it would seem rather detrimental than otherwise to the mycelium. It is possible, however, that the depredations of myceliophagus insects are more than compensated for by the advantages accruing to the fungus possessing luminous mycelium from the visits of non-myceliophagus insects bringing with them a fresh stock of germinating or re-vivifying spores. Whether subsequent observation will bear out this suggestion or not, the fact remains that certain fungi and certain mycelia especially possess the property of luminosity in common with certain insects.

That flies are able to transport the spores of fungi, if it has not yet been actually demonstrated, is rendered exceedingly probable from their ability to convey other low forms of vegetable life. The terrible disease, anthrax, has long been known to occasionally originate from the bite of a fly, and it has always been supposed the fly must previously have visited some diseased or putrefying animal matter. Virchow and Bourgeois consider that the infection may be communicated by their soiled wings and feet, although mostly it is held that a puncture by the fly's probosces is necessary. The last named gentleman (Bourgeois) has seen the disease produced by the puncture of a gadfly, which came out of a fleece of wool.*

The recent researches of M. Pasteur have demonstrated that anthrax is due to the presence in the blood of *Bacillus anthracis* (an organism, be it remembered, that sometimes attains a length four times greater than that of the spores of *Phallus impudicus*). A fly settling upon the body of an animal recently dead from this disease, or sucking the blood from one yet alive suffering from it, would constitute a most effectual means of transmitting it to the next animal or man which it punctured with its probosces.†

Interfungal Mimicries.—There are several well-marked instances of this, the mere enumeration of which will recall them to mycologists; such as *Agaricus atratus*, Fr., and *Cantharellus car-*

* Aitken, "Science and Practise of Medicine," 1863, Vol. i, p. 689.

† M. Pasteur has still more recently shown that earth-worms are capable of transmitting *Bacillus anthracis* from the buried bodies of infected animals to the surface of the ground, and that sheep feeding upon the place contracted and died from anthrax.

bonarius, A. & S.; *Agaricus naucinus*, Fr. and *Agaricus cretaceus*, Fr. The branched *Clavariæ* and *Lachnocladium*, the club-shaped *Clavariæ*, and *Geoglossum* or *Torrubia*, *Podaxon*, and *Coprinus*.* *Scleroderma geaster*, Fr., mimics the Geasters, while conversely an unexpanded specimen of *Geaster coliformis*, P., looks so exactly like a washed specimen of *Scleroderma vulgare*, Fr., that I once had such an one in my possession for more that a week without discovering what it was.

I have no special remarks to make on the present occasion upon these curious resemblances, leaving what I may have to say for a future communication; but a very remarkable series of mimicries exists which must be mentioned—namely, that which exists between many edible and poisonous fungi. The number of accidents which have happened from eating poisonous, in mistake for edible fungi, many of which have been followed by a fatal result, shows that this mimicry is not a mere figment of the imagination. These lamented accidents have cast an opprobrium upon the whole fungus kingdom as articles of food, which is quite unmerited. The subjoined table shows at a glance, these mimicries, although there may be some species included with the poisonous species whose toxic qualities enthusiastic fungophagists may take exception to on the ground that they have never yet caused death:—

Edible Species.	Poisonous Species.
Agaricus cæsarius, *Scop.*	Agaricus muscarius, *Linn.*
Agaricus ovoideus, *Bull.*	Agaricus phalloides, *Fr.*
Agaricus rubescens, *Fr.*	Agaricus pantherinus, *D.C.*
Agaricus procerus, *Scop.*	Agaricus rachodes, *Vitt.*
Agaricus ostreatus, *Jacq.*	Agaricus euosmus, *Berk.*
Agaricus campestris, *Linn.*	Agaricus melaspermus, *Bull.* Agaricus fastibilis, *Fr.* Agaricus Taylori, *Berk.*
Lactarius deliciosus, *Fr.*	Lactarius torminosus, *Fr.*
Russula lepida, *Fr.*	Russula rubra, *Fr.*
Russula alutacea, *Fr.*	Russula emetica, *Fr.*
Cantharellus cibarius, *Fr.*	Cantharellus aurantius, *Fr.*
Marasmius oreades, *Fr.*	Marasmius urens, *Fr.*
Fistulina hepatica, *Fr.*	Polyporus quercinus, *Fr.*

It is not assumed that any of these species copy each other so accurately as to present any difficulty to the scientific botanist in discriminating them, but in most instances so close is the resemblance that the fungi must be gathered, and the colour of the spores and other characters noticed, before a definite opinion can be given. Of course objection will be taken to *A. rachodes* being included with the poisonous species, as there are persons still living who have eaten it. It is generally admitted, however, to be greatly inferior to *A. procerus*. Mr. Berkeley holds that "it is not

* See M. C. Cooke on Mimicry in Fungi, "Grevillea," Vol. ix, p. 151; and W. G. Smith on Mimicry in Fungi, "Gardener's Chronicle," 10th Feb., 1877, and 16th Nov., 1872.

so good for food as the last (*A. procerus*), if really wholesome."* Fries, too, in his latest book, says, "Vix edulis."† Of the imitators of the common mushroom three only are given; none of them are very accurate copyists, but as most of the accidents which happen to the general public in this country arise from mistaking other fungi for *A. campestris*, it is clear it has mimickers. *Agaricus fastibilis* is given on the authority of Mr. W. G. Smith.‡ *A. melaspermus* is one of the closest mimics, even to the dark ring and separable cuticle. *Lactarius torminosus* and *L. deliciosus* frequently grow in company with each other, and I have often pointed out to my friends the impossibility, with some specimens, of saying which was which without gathering them. *Fistulina hepatica* and *Polyporus quercinus* would not have been included in this list had not the mistake occurred in Mrs. Hussey's family of gathering and cooking the latter for the former. The error was only detected by the intense bitter taste of the *Polyporus* and the brilliant yellow colour it assumed after salt had been sprinkled upon it.§

Summary.—Instances of mimicry are not rare amongst fungi. They are more frequently attractive than protective mimicries. They may be of vegetable, of animal, or of excrementitious substances, either as regards external appearance or as regards odour. The main object of these mimicries is the attraction of insects, the advantages of which to the plants are—(1) Either fertilization of hymenomycetous spores by co-specific spermatia from other individuals, or by the transportation of spores from the hymenium of one fungus to that of another, or perhaps increased germinative energy to the spores is obtained by the admixture of other co-specific spores without the element of sexuality; (2) the diffusion of fungus spores by insects as well as by the larger animals.

King's Lynn, 7th July, 1881.

THE CRYPTOGAMIC SOCIETY OF SCOTLAND.

The Seventh Annual Conference will be begun at Salen, Island of Mull, on Tuesday, August 30, 1881. Fellows who purpose being present may learn further on application to the Secretary after August.—F. Buchanan White.

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* Berkeley, "Outlines," p. 92.
† Fries, "Hymenomycetes Europæi," p. 29.
‡ Smith, "Gardeners' Chronicle," 16th Nov., 1872.
§ Hussey, "Illustrations of British Mycology," Series I., pl. 52.