Journals (*continued*).

Revue Médico-Pharmaceutique. 1891. Nos. 6-10. 4to. [*Constantinople.*] The Editors.

Stazioni Sperimentali Agrarie Italiane (Le) Vol. XXI. Fasc. 4. 8vo. *Asti* 1891. R. Stazione Enologica, Asti.

Victorian Year-Book. 1889–90. 8vo. *Melbourne* 1890. The Government of Victoria.

December 17, 1891.

Mr. JOHN EVANS, D.C.L., LL.D., Treasurer, in the Chair.

A List of the Presents received was laid on the table, and thanks ordered for them.

The Chairman read the following letter from Professor Dewar:—

Royal Institution,
17*th December*, 1891.

DEAR SIR WILLIAM THOMSON,

I had intended coming to the Society, in order to make a further communication with regard to the magnetic and other properties of liquid oxygen, but I am confined to the Laboratory, owing to difficulties with regard to the progress of such investigation. In the meantime it may interest the Fellows to know that I have examined the properties of liquid *ozone* in the magnetic field, and find it also highly attracted.

I hope to make a detailed communication very soon to the Society.

Yours faithfully,
JAMES DEWAR.

The following Papers were read:—

I. "The 'Ginger-beer Plant,' and the Organisms composing it: a Contribution to the Study of Fermentation-yeasts and Bacteria." By H. MARSHALL WARD, M.A., F.R.S., F.L.S., Professor of Botany at the Forestry School, Royal Indian Engineering College, Cooper's Hill. Received November 19, 1891.

The author has been engaged for some time in the investigation of a remarkable compound organism found in home-made ginger-beer fermentations.

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It occurs as jelly-like, semi-transparent, yellowish-white masses, aggregated into brain-like clumps, or forming deposits at the bottom of the fermentations, and presents resemblances to the so-called *Kephir* grains of the Caucasus, with which, however, it is by no means identical.

He finds that it consists essentially of a symbiotic association of a specific *Saccharomycete* and a *Schizomycete*, morphologically comparable to a Lichen, but, as met with naturally, invariably has other species of yeasts, bacteria, and mould-fungi casually associated with these.

He has successfully undertaken the separation of the various forms, and groups them as follows:—

1. The essential organisms are a yeast, which turns out to be a new species allied to *Saccharomyces ellipsoideus* (Reess and Hansen), and which he proposes to call *S. pyriformis;* and a bacterium, also new and of a new type, and named by him *Bacterium vermiforme.*

2. Two other forms were met with in all the specimens (from various parts of the country and from America) examined—*Mycoderma cerevisiæ* (Desm.) and *Bacterium aceti* (Kützing and Zopf).

3. As foreign intruders, more or less commonly occurring in the various specimens examined, were the following:—

α. A pink or rosy yeast-like form—*Cryptococcus glutinis* (Fresenius.)?

β. A small white aërobian top-yeast, with peculiar characters, and not identified with any known form.

γ. The ordinary beer-yeast—*Saccharomyces cerevisiæ* (Meyen and Hansen).

δ. Three, or probably four, unknown yeasts of rare occurrence.

ϵ. A bacillus which forms spores, and liquefies gelatine with a greenish tinge.

ζ. A large spore-forming bacillus, which also liquefies gelatine.

η and θ. Two—perhaps three—other Schizomycetes not identified.

ι. A large yeast-like form which grows into a mycelium, and turns out to be *Oïdium lactis* (Fresenius).

κ. A common blue mould—*Penicillium glaucum* (Link).

λ. A brown "Torula"-like form, which turns out to be *Dematium pullulans* (De Bary).

μ. One, or perhaps several, species of "Torula" of unknown origin and fates.

Of these forms, the author has succeeded in cultivating and examining very thoroughly all but those under θ and μ in the foregoing list.

Saccharomyces pyriformis (n.sp.) is a remarkably anaërobian bottom-yeast, forming spores, and developing large quantities of carbon dioxide, but forming little alcohol. It has also an aërobian form—veil form of Hansen—in which the rounded cells grow out into club-shaped or pyriform cells, whence the proposed specific name. It inverts

cane sugar, and ferments the products; but it is unable to ferment milk sugar. It forms rounded, morula-like, white colonies in gelatine, and the author has separated pure cultures from these. He has also studied the development and germination of the spores, which are formed in 24—48 hours at suitable temperatures on porous earthenware blocks. They also develop on gelatine.

The technological characters have been kindly determined and confirmed for the author by Mr. Horace Brown, F.R.S., and Dr. Morris, of Burton-on-Trent.

The specific Schizomycete (*Bacterium vermiforme*, n.sp.) has been very fully studied by the author. It occurs in the fermentations as rodlets or filaments, curved or straight, encased in a remarkably thick, firm, gelatinous sheath, and is pronouncedly anaërobic, so much so, that the best results are got by cultivating it in carbon dioxide under pressure.

The sheathed filaments are so like worms, that the name proposed for the species is appropriately derived from this character.

It will not grow on gelatine, and separation cultures had to be made in saccharine liquids by the dilution methods.

It grows best in solutions of beet-root, or of cane sugar, with relatively large quantities of nitrogenous organic matter—*e.g.*, bouillon, asparagin—and tartaric acid. Good results were obtained with mixtures of Pasteur's solution and bouillon.

The author found that the bacterium into which the filaments subsequently break up can escape from its sheath and become free, in which state it divides rapidly like ordinary bacteria. Eventually, all the forms—filaments, long rods, short rodlets—break up into cocci. No spores have been observed. These changes are dependent especially on the nutritive medium, but are also affected by the gaseous environment and the temperature. The jelly-like clumps of the so-called "ginger-beer plant" are essentially composed of these sheathed and coiled Schizomycetes, entangling the cells of *Saccharomyces pyriformis*. But the action of the Schizomycete alone on the saccharine medium differs from that exerted when it is associated with the yeast, and from that exerted by the latter alone.

This was proved by cultivating each separately, and also by cultivations in which, while each organism was submerged in the same fermentable medium, they were separated by permeable porcelain (Chamberland filters), through which neither could pass.

The author has also reconstructed the "ginger-beer plant" by mixing pure cultures of the above two organisms; the Schizomycete entangled the yeast-cells in its gelatinous coils, and the synthesised compound organism behaved as the specimens not analysed into their constituents.

Some very curious phenomena in connexion with the formation of

the gelatinous sheaths and the escape of the bacteria from them were observed in hanging-drop cultures, and are figured and described by the author. The conditions for the development of the gelatinous sheaths—and therefore of the coherent brain-like masses of the Schizomycete—are a saccharine acid medium and absence of oxygen. The process occurs best in carbon dioxide: it is suppressed in bouillon, and in neutral solutions in hydrogen, though the organism grows in the free, non-sheathed, motile form under these conditions.

The behaviour of pure cultures of the bacteria in as complete a vacuum as could be produced by a good mercury pump, worked daily, and even several times a day for several weeks, is also noteworthy. The author records his thanks to his friend and colleague Professor McLeod for much assistance in regard to this apparatus. The development of the sheaths is apparently indefinitely postponed *in vacuo*, but the organism increased, and each time the pump was set going an appreciable quantity of carbon dioxide was obtained. In vacuum tubes the same gas was evolved, and eventually attained a pressure sufficient to burst some of the tubes. The quantity of carbon dioxide evolved daily by the action of the bacterium alone, however, is small compared with that disengaged when the organism is working in concert with the symbiotic yeast; in the latter case the pressure of the gas became so dangerous that the author had to abandon the use of sealed tubes.

The products of the fermentation due to the Schizomycete have not yet been fully determined in detail; lactic acid, or some allied compound, seems to be the chief result, but there are probably other bodies as well.

The author owes acknowledgment to Dr. Matthews, of Cooper's Hill, for advice and assistance in examining the products of these fermentations.

The pink yeast-like form proved to be very interesting. It has nothing to do with the "ginger-beer plant" proper, though it was invariably met with as a foreign intruder in the specimens. The author identifies it with a form described by Hansen, in 1879;* unfortunately the original is in Danish, but the figures are so good that little doubt is entertained as to the identity. It is also probably the same as Fresenius' *Cryptococcus glutinis* in one of its forms. It is not a Saccharomycete, and does not ferment like a yeast; it is aërobian.

The chief discovery of interest was that in hanging drops the author traced the evolution of this "rose-yeast" into a large complex mycelium, bearing conidia, and so like some of the Basidiomycetes that it may almost certainly be regarded as a degraded or

* 'Organismer i Öl og Ölurt,' Copenhagen, 1879.

"torula" stage of one of these higher fungi. Full descriptions and figures are given by the author.

The form *Mycoderma cerevisiæ* was thoroughly examined. The author's results confirm what is known as to its aërobian characters. Statements as to its identity with *Oïdium lactis* were not only not confirmed, but the author grew these two forms side by side, and maintains their distinctness. Nor could he obtain spores in this fungus, thus failing to confirm earlier statements to the contrary. He regards it as probable that oil-drops have been mistaken for spores; he also finds that in later stages of fermentation by this organism a strong oily-smelling body is produced.

With regard to *Bacterium aceti*, the author has nothing new to add. A point of some interest was the repeated production of acetic ether, which scented the laboratory when this Schizomycete was growing in company with the small white aërobian top-yeast referred to under (β). As this phenomenon was found to have nothing to do with the question being investigated, the author did not pursue it further. It seemed probable, however, that the yeast produced alcohol, which the Schizomycete, in presence of oxygen, partially oxidised, and that the fragrant ether was produced by interaction of the products.

With regard to the other forms found, the author was chiefly concerned with testing their relations to the important and essential organisms. It need only be remarked here that hanging-drop cultures of *Dematium pullulans* were very successful, and that some of the moulds, and at least one *bacillus* (of which the spore-formation, &c., were traced also), were traced to the ginger used in the manufacture of the well-known beverage.

The author hopes very shortly to have the honour to lay before the Society a full account of his research, of which the above is only a brief notice. The fuller account will contain detailed descriptions, as well as figures of the apparatus, mode of culture, &c.

II. "Studies in the Morphology of Spore-producing Members. Preliminary Statement on the Lycopodinæ and Ophioglossaceæ." By F. O. Bower, F.R.S. Received November 27, 1891.

It is currently held that the sporophyte, or neutral generation in archegoniate plants, is the result of elaboration of the zygote: that while in certain Algæ the zygote simply divides to form a number of spores (carpospores), in the lower Bryophyta there has been a differentiation of an external, sterile, and protective wall, distinct from the