

CHAPTER III

PASTEUR'S MEMOIRS OF 1857

LOUIS PASTEUR, the son of a tanner, was born at Dôle in the year 1822. Intense strength of will, acute worldly wisdom and unflagging ambition were the prominent traits of his character. He first came into notice in connection with crystallography by discovering that the crystalline forms of the tartrates are hemihedral. His son-in-law has recorded his jubilation over his early achievement, and has told us how he left his experiment to rush out of the laboratory, fall upon the neck of a curator whom he met accidentally, and then and there drag the astonished man into the Luxembourg garden to explain his discovery.¹

Work so well advertised did not fail to become a topic of conversation, and eventually reached the ears of M. Biot. On hearing of this Pasteur wrote at once to ask for an interview with this well-known scientist, with whom he had no previous acquaintance but upon whom he now showered every attention likely to be appreciated by the rather misanthropical old worker, whose influential patronage became undoubtedly the first contributory factor in the triumphal career of the ambitious young chemist. All the same, M. Biot's persuasions never succeeded in gaining Pasteur a place in the Academy of Science. This he obtained only after the former's death, when nominated by the Mineralogical Section, and then, oddly enough, exception began to be taken at once to his early conclusions on crystallography.²

This, however, was not until the end of 1862. Meanwhile, in 1854, Pasteur was appointed Professor and Dean of the new Faculty of Science at Lille. In 1856 a request for advice from a local manufacturer of beetroot alcohol made him turn his attention to the problem of fermentation, which was then exercising the minds of the learned. His observations were interrupted by a journey to Paris to canvass for votes for his election to the Academy of Science. Obtaining only sixteen and completely failing in his attempt to enter the select circle of Academicians, Pasteur returned to Lille to his study of fermentations.

¹ *The Life of Pasteur*, by René Vallery-Radot, p. 39 (Pop. Ed.).

² *The Life of Pasteur*, by René Vallery-Radot, pp. 101, 102.

In spite of the work done by Cagniard de Latour, Schwann and others, the idea was prevalent that animal and vegetable matters are able to alter spontaneously, while the authority of the famous German chemist, Liebig, carried weight when he asserted that yeast induces fermentation by virtue of progressive alteration in water in contact with air.¹ Another German, named Lüdersdorff, so we learn from Béchamp,² had undertaken experiments to prove that yeast ferments sugar because it is living and organised. An account had been published in the Fourth Volume of the *Traité de Chimie Organique*, which appeared in 1856.

Now let us examine Pasteur's contribution towards this subject the following year, since at that date popular teaching assigns to him a thorough explanation of fermentation.

During 1857 Pasteur left Lille to work at the *École Normale* in Paris; but we are not here concerned with his movements, but simply with what he had to reveal on the mysterious subject of fermentation.

His son-in-law tells us³ that it was in August 1857 that, after experimenting in particular with sour milk, Pasteur first made a Communication on "Lactic Fermentation" to the Scientific Society of Lille. Be this as it may, we find his extract from a Memoir on the subject in the *Comptes Rendus* of the French Academy of Science, 30th November, 1857.⁴ The entire Memoir was printed in April 1858 in the *Annales de Chimie et de Physique*,⁵ and from this latter we gain full details.

The experiment consisted in Pasteur taking the substance developed in ordinary fermentation, nourished by sugar, chalk, casein or fibrin, and gluten (an organic matter occurring in cereals) and placing it in yeast broth (a complex solution of albuminoid and mineral matters), in which he had dissolved some sugar and added some chalk.

There was nothing new in the procedure, so Béchamp points out,⁶ it was only the same experiment that Liebig had undertaken some sixteen or seventeen years previously. Unlike Liebig, he did not ignore microscopic examination, and so made obser-

¹ *Traité de Chimie Organique*, traduit par Ch. Gerhardt, Introduction, p. 27. 1840.

² *Les Grands Problèmes Médicaux*, par A. Béchamp, p. 62.

³ *The Life of Pasteur*, p. 83.

⁴ *Comptes Rendus* 45, p. 913. *Mémoire sur la fermentation appelée lactique*.

⁵ *A. de Ch. et de Ph.*, 3e série, 52, p. 404.

⁶ *Les Grands Problèmes Médicaux*, p. 56 et suivant.

vations that had been missed by the German chemist. Thus Pasteur is able to tell us that a lactic ferment is obtained which, under the microscope, has the appearance of little globules, which he named "lactic-yeast," no doubt from their resemblance to yeast, although in this case the little globules are much smaller. In short, he saw the minute organism known to-day to be the cause of lactic-acid fermentation.

Now let us go on to his remarkable explanation of the phenomenon. He tells us that it is not necessary to introduce the lactic ferment in order to prepare it, as "*it takes birth spontaneously as easily as beer-yeast every time that the conditions are favourable.*"¹ This assertion surely demonstrates Pasteur's belief in the spontaneous generation both of beer-yeast and of that which he called "lactic-yeast." It remains to be seen what "the favourable conditions" are, according to his teaching. He tells us before long. "These globules of lactic-yeast take birth spontaneously in the body of the albuminoid liquid furnished by the soluble part of the [beer] yeast."² There is certainly nothing in this to overthrow the general belief in spontaneous generation. But, in fairness, we must not overlook a note that he added to the full edition of his Memoir, as we find it in the *Annales de Chimie et de Physique*.³ Before this account appeared in April 1858 Professor Béchamp, as we shall find, had provided the French Academy of Science with an illuminating explanation of the origin of ferments. In face of Béchamp's irrefutable views, Pasteur may have thought it only wise to add a proviso to a Memoir that from start to finish has no solution whatever to offer as to the appearance of moulds except as a spontaneous origin. Therefore, by the sentence "it [lactic-yeast] takes birth spontaneously as easily as beer-yeast" we see a star and, looking below, find a footnote in which he says he uses the word "spontaneously" as "the expression of a fact," but reserves the question of spontaneous generation.⁴ Certainly any denial of it is completely excluded from this Memoir with its assertion of the spontaneous appearance of beer-yeast and "lactic-yeast." Where

¹ "*elle prend naissance spontanément avec autant de facilité que la levûre de bière toutes les fois que les conditions sont favorables.*" *A. de Ch. et Ph.* 3e série, 52, p. 413.

² "*Les globules prennent naissance spontanément au sein du liquide albuminoid fourni par la partie soluble de la levûre.*" *A. de Ch. et de Ph.* 3e série, 52, p. 415.

³ *A. de Ch. et de Ph.* 3e série, 52, p. 413.

⁴ "*Je me sers de ce mot comme expression du fait, en réservant complètement la question de la génération spontanée.*"

Pasteur differed from other Sponteparists was in omitting to attempt any explanation of such a marvel.

His followers, ignoring the confusion of his views, have seized upon the concluding statement in this same Memoir as a triumphant vindication of the correctness of his teaching, since he said: "Fermentation shows itself to be correlative of life, of the organisation of globules, not of the death and putrefaction of these globules, still more that it does not appear as a phenomenon of contact."¹ But this was only what others had said and had gone some way to prove years before him. So devoid was he of proof that he had to make the following admission in regard to his hypothesis that "the new yeast is organised, that it is a living being," namely: "If anyone tells me that in these conclusions I am going beyond facts, I reply that this is true, in the sense that I frankly associate myself with an order of ideas² that, to speak correctly, cannot be irrefutably demonstrated."

We have therefore in Pasteur's own words his confession of non-comprehension of a problem that the rigid experiments of another worker, Professor Béchamp, had already, as we shall shortly see, solved by an irrefutable demonstration. The reason why Pasteur should get the credit for demonstrating that which he owned he could not demonstrate is as much of a puzzle to the lover of historical accuracy as was the phenomenon of fermentation to Pasteur.

However, let us not deny ourselves a thorough examination of his work, and now consider his *Memoir upon Alcoholic Fermentation*, of which his son-in-law, M. Vallery-Radot, tells us³ that Pasteur said: "The results of these labours [on lactic and alcoholic fermentation] should be put on the same lines, for they explain and complete each other."

We find the author's extract from this latter Memoir among the reports of the French Academy of Science of 21st December, 1857.⁴

Pasteur's procedure in this experiment was as follows: He took two equal quantities of fresh yeast, washed in water. One was left to ferment with pure sugared water; and after having extracted from the other all its soluble part by boiling it with plenty of water and filtering it to get rid of the globules he added

¹ *ibid.*, p. 418.

² *A. de Ch. et de Ph.* 3e série, 52, p. 417.

³ *The Life of Pasteur*, p. 85.

⁴ *Comptes Rendus*, 45, p. 1032.

to the limpid liquor as much sugar as he used in the first fermentation and then a trace of fresh yeast.

He expressed his conclusions as follows: "I am just establishing that in beer-yeast it is not the globules that play the principal part, but the conversion into globules of their soluble part; because I prove that one can suppress the globules that are formed and the total effect on the sugar remains sensibly the same. Thus, certainly, it matters little if one suppresses them by means of filtration with the separation of their soluble part, or if one kills them by a temperature of 100° and leaves them mixed with this soluble part."¹

In view of the fact that he was supposed to be reasoning on the hypothesis that yeast is organised and living, there was so much that was extraordinary in this that he pauses to reply to inevitable criticism.

"But how, it will be asked, can the fermentation of sugar take place when yeast is used that is heated to 100°, if it is due to the organisation of the soluble part of the globules and these have been paralysed by a temperature of 100°? Fermentation then takes place as it does in a natural sugared liquid, juice of the grape, of sugar-cane, etc., that is to say, *spontaneously*. . ."

Here is seen the prevalent idea of spontaneous alteration, though Pasteur goes on to state that "in all cases, even those *most liable in appearance* to drive us from belief in the influence of organisation in the phenomena of fermentation, the chemical act that characterises them is always correlative to a formation of globules."

His final conclusions are held up for admiration: "The splitting of sugar into alcohol and carbonic acid is an act correlative of a vital phenomenon, of an organisation of globules, an organisation in which sugar plays a direct part by furnishing a portion of the elements of the substance of these globules." But, far from understanding this process, we find that Pasteur owns three years later, in 1860: "Now in what does this chemical act of decomposition, of the alteration of sugar consist? What is its cause? I confess that I am entirely ignorant of it."

¹ *Comptes Rendus*, 45, p. 1034. "Je viens d'établir que dans la levûre de bière, ce ne sont point les globules qui jouent le principal rôle mais la mise en globules de leur partie soluble; car je prouve que l'on peut supprimer les globules formés, et l'effet total sur le sucre est sensiblement le même. Or, assurément, il importe peu qu'on les supprime de fait par une filtration avec séparation de leur partie soluble ou qu'on les tue par une température de 100 degrés en les laissant mêlés à cette partie soluble."

In any case, the critical mind inquires at once: How can fermentation be explained as a vital act by the operation of a dead organism; or by the conversion into globules of its soluble part, whatever that may mean; or by spontaneous alteration? No wonder that Béchamp comments:¹ "Pasteur's experiments were so haphazard that he, who acknowledged with Cagniard de Latour the fact of the organisation and life of yeast, *boiled* this living being to study its soluble part!" Indeed, Béchamp's account of Liebig's and Pasteur's closely allied work is well worth perusal from p. 56 to p. 65 of *Les Grands Problèmes Médicaux*.

The chief point to be noted is that as Pasteur made use for these experiments of substances with life in them, such as yeast broth, etc., they could not, in any case, furnish evidence as to the foremost question at stake, namely, whether life could ever arise in a purely chemical medium. That problem was never so much as touched upon by Pasteur in 1857. If we had only his explanation of fermentation, made during that year, we should indeed have a strange idea of the phenomenon. We should believe in the spontaneous generation of alcoholic, lactic and other ferments. We should be puzzled to understand how fermentation could be a vital act and yet be effected by dead organisms. Of the air-borne origin of ferments we should not have an inkling, that is, as far as Pasteur was concerned, for either he was ignorant of, or else he ignored the truth already propounded by others, particularly by Schwann, the German. Pasteur passed over with slight allusion the contacts with air that were involved in his experiments, because his aim was to disprove Liebig's theory that the alteration of yeast broth was due to an oxidation by air, and he seems to have had no idea of the important part that air might play, although for a very different reason from the one imagined by Liebig.

Clearly in 1857 Pasteur was a Sponteparist, without, however, shedding light upon the controversy. The housewife, puzzled by the souring of milk, could only have learned from him that living globules had put in a spontaneous appearance, which explanation had held good many years earlier to account for the maggots found in bad meat, until it had occurred to the Italian, Francesco Redi, to keep flies from contact.

Here the reader may interpolate that Pasteur's vision, although still obscured, was gradually piercing the fogs of the mystery. But, as it happened, those fogs were by this time dispersed: a

¹ *Les Grands Problèmes Médicaux*, p. 60.

"beacon experiment" was shedding light on the difficulty. In 1855 and in 1857 there had been presented to the French Academy of Science Memoirs that were to prove the lode-star of future science, and it seems high time that now, nearly a century afterwards, credit should be given where credit is due in regard to them. And here let us turn to the outcome of work undertaken in a quiet laboratory by one who, perhaps unfortunately for the world, was no adept in the art of advertisement and was too much immersed in his discoveries to be at that time concerned about his proprietary rights to them. Let us again open the old French documents and see for ourselves what Professor Antoine Béchamp had to say on the subject of the vexed question of fermentation.