CHAPTER VII

Rival Theories and Workers

Undoubtedly one of the chief factors of Pasteur's success was the quickness with which he pushed into the forefront of any scientific question, thus focusing public attention upon himself. Béchamp's illuminating explanations of ancient problems were conveniently to hand just at a moment when M. Pouchet brought the controversy on spontaneous generation again into the limelight of general interest. Pasteur, seizing the opportunity, entered the lists, and, as Béchamp comments, M. Pouchet's observations being as wanting in precision as Pasteur's, it was not hard for the latter to emerge as victor, genuinely impressing the world of scientists.

Thus he who had taught the spontaneous origin of yeast and of micro-organisms of all sorts now discoursed with almost childish enthusiasm upon the germs of the air, and began to make life synonymous with atmospheric organisms. Not only, according to his new views, was fermentation caused by pre-existing germs of air-borne origin, but each germ induced its own definite specific form of fermentation. Here he fell foul of Béchamp, for according to the latter's physiological explanation each micro-organism may vary its fermentative effect in conformity with the medium in which it finds itself; may even change in shape, as modern workers are finding out. Pasteur, however, proceeded to label each with a definite and unalterable function. In 1861, claiming to discover a special butyric vibrio, which he thought could live only *without air,* he divided living beings into two classifications, the ærobic and the anærobic, or those that require air and those that flourish without it. Fermentation he defined as life without oxygen. The verdict of time, to which he himself has relegated all scientists for final judgment, is scarcely in his favour. To quote, for instance, from one of his eulogists in the article on "Fermentation" by Julian Levett Baker, F.I.C., in the *Encyclopædia Britannica,*[1] we read: "According to Pasteur . . . 'fermentation is life without air, or life without oxygen.' This theory of fermentation was materially modified in

[1] Eleventh Edition.

1892 and 1894 by A. J. Brown, who described experiments which were in disagreement with Pasteur's dictum."

Pasteur himself, in controversies both with M. Trécul and with the Turin Commission, which investigated his prophylaxis for anthrax, was forced to admit that anærobics could gradually be induced to live with air without becoming ferments and that ærobics could become ferments. Thus he himself destroyed his own classification. Yet this untenable description was Pasteur's chief support for his later equally untenable claim that he had been the first to regard fermentation as a phenomenon of nutrition and of assimilation. In a statement of his made in 1872 and repeated in his *Études sur la Bière,* we find quite contrary teaching:[1]

"That which separates the chemical phenomenon of fermentation from a crowd of other acts *and especially from the acts of ordinary life* is the fact of the decomposition of a weight of fermentative matter much superior to the weight of the ferment."

What more inevitable act of "ordinary life" could there be than that of nutrition and digestion from which the famous chemist thus separated the phenomenon of fermentation? Pasteur was here only appropriating the same singular idea of physiology that had already been voiced in 1865 by a follower of his, M. Duclaux:[2]

"When in our alcoholic fermentation we see a certain weight of sugar transformed into alcohol by a weight of yeast one hundred, nay, a thousand times smaller, it is very difficult to believe that this sugar made at any time a part of the materials of the yeast, and that it (the alcohol) is something like a product of excretion."

It seems strange that scientists should have required the following simple physiological explanation from Professor Béchamp:[3]

"Suppose an adult man to have lived a century, to weigh on an average 60 kilogrammes: he will have consumed in that time, besides other foods, the equivalent of 20,000 kilogrammes of flesh and produced about 800 kilogrammes of urea. Shall it be said that it is impossible to admit that this mass of flesh and of urea could at any moment of his life form part of his being? Just as a man consumes all that food only by repeating the same act a

[1] *Comptes Rendus de l'Académie des Sciences* 75, p. 785 (1872).
[2] *Annales Scientiques de l'École Normale,* 2, 6. 249 (1865).
[3] *Comptes Rendus de l'Académie des Sciences* 75, p. 1523.

great many times, the yeast cell consumes the great mass of sugar only by constantly assimilating and disassimilating it bit by bit. Now, that which only one man will consume in a century a sufficient number of men would absorb and form in a day. It is the same with the yeast; the sugar that a small number of cells would only consume in a year a greater number would destroy in a day; in both cases the more numerous the individuals the more rapid the consumption."

By the need of such an explanation evidence is given that Pasteur had failed to understand fermentation to be due to physiological processes of absorption and excretion. It would take too long to follow the varying examples that substantiate this criticism, and, naturally, difficult scientific intricacies were beyond the comprehension of the general public, a great part of whom, having no idea of the processes required for the food they put into their own bodies, were still far less likely even dimly to fathom the nutritive functions of organisms invisible except through the microscope! It was nothing to them that, among the learned reports of the Academy of Science, treatises were to be found, by a professor working at Montpellier, that clearly explained the why and the wherefore of the intricate chemical changes that go by the name of fermentation. But, on the contrary, more or less everyone had heard, so widely had the subject been ventilated, of the controversy as to whether life, in its lesser forms, sprang invariably from antecedent life, or whether chemical combinations could produce life independently of parents. The public, too, could follow the account of M. Pasteur's holiday tour in pursuit of the question. Very little cudgelling of brains could make anyone understand the history of the flasks that he unsealed, some by a dusty roadside, some on an Alpine summit. Since visible dust could cloud a fluid, it was easy to realise that invisible aerial germs could also affect the contents of the scientist's phials. Minute living things afloat in the atmosphere were not hard to imagine, and Pasteur commenced so enthusiastically to discourse of these that it was not remarkable that an impression was created that he had been the first to demonstrate them; especially since the obstinacy with which a number of scientists declined to endorse his views made him appear a special champion to confound the Sponteparists whose opinions he had cast off so recently.

All this time, in spite of M. Biot's influential patronage, Pasteur had remained outside the select circle of Academicians. But at

the end of 1862, as we have said before, he was at last nominated by the Mineralogical Section. No sooner was his candidature commenced than exception began to be taken to his early conclusions on crystallography. None the less, by thirty-six out of sixty votes, he secured his coveted place in the Academy of Science; and, advised to drop crystallography, he proceeded to experiment further in connection with his new views on air-borne organisms.

To secure matter free from atmospheric dust, he made observations upon muscle, milk, blood, etc., taken from the interior of bodies. From the start he cannot but have been handicapped by his lack of medical training. His view-point was that of the chemist. According to his conception, as Béchamp points out,[1] the marvellous animal body was likened to wine in the cask or beer in the barrel. He looked upon muscle, milk, blood and so forth as mere mixtures of chemical proximate principles. He did, it is true, draw some distinction between the interior of an organism and that of a barrel of beer, or a cask of wine, for we find that he said that the first is[2] "endowed with powers of transformation that boiling destroys" (*"vertus de transformation que l'ébullition détruit"*). Béchamp here shows how Pasteur's mind reverted to the old-fashioned belief in spontaneous alteration. Recognising nothing inherently alive in the composition of animal and vegetable bodies, it was his aim to show that meat, milk, blood, etc., would remain unchanged if completely secured from invasion by aerial organisms. And when, later on, he copied an experiment that Béchamp had undertaken on meat, and found in his own observation that, in spite of precautions against germs of the air, the muscular masses of the meat yet became tainted, he was driven to fall back for an explanation upon vague, occult "powers of transformation."

In the same way, for the wonderful evolution of an egg into a bird he had no solution except these same mysterious transformatory powers. How can it be said that he had destroyed belief in spontaneous generation when he could only ascribe to a spontaneous change the amazing development of, for instance, the cells of an egg to a circulatory apparatus, bony and nervous systems, glands, organs, and finally a bird covered with feathers? For a spontaneous change there must be if the substance of an egg is only a chemical mixture of the same order as wine or beer.

[1] *Les Microzymas*, p. 754.
[2] *Les Microzymas*, p. 399.

What are Pasteur's "powers of transformation" if not the same as Bonnet's "excellent modification," which produces the organisation of matter, or if not the same as the *"nisus formativus,"* or productive forces, vegetable and plastic, with which Needham, and, later Pouchet, the believers in spontaneous generation, were satisfied to explain the phenomenon? Pasteur appears merely to have provided fresh words in place of other words.

But here again such intricacies were beyond the comprehension of the general public. The Man in the Street delved no deeper than the surface test that alterable substances could be preserved by excluding air, and that as the atmosphere was said to be filled with living germs there was no need to cudgel his brains as to the possible emergence of life from mere chemical sources. The religious felt duly grateful for views that appeared to controvert the materialistic tendencies of the nineteenth century, and were blandly innocent of the superficial character of the contradiction. Meanwhile, the talk of the controversy and the exploits of M. Pasteur reached the ears of the Emperor, who, like most rulers, felt it incumbent upon him to patronise contemporary science. Soon after his election to the Academy of Science, M. Pasteur, in the month of March 1863, had the honour of being presented to Napoleon III at the Tuileries.

As usual, his numerous correspondents seem to have been notified at once of the interview, for his son-in-law tells us[1] "Pasteur wrote the next day" (to whom he does not say), "I assured the Emperor that all my ambition was to arrive at the knowledge of the causes of putrid and contagious diseases."

Here we have an interesting illustration of the contrast between the methods of Pasteur and Béchamp. As we have seen, right up to 1860 Pasteur's Memoirs contained sponteparist opinions. It was now only 1863. He had but recently changed his standpoint. Yet it is clear that already, before any proofs could have been brought into bearing on the subject, Pasteur in his mind was connecting the ferments of the air with a former idea, voiced by earlier workers, Linné, Raspail and others, that specific organisms might be the cause of specific diseases. The best and the worst of us invariably preach against our own individual weaknesses; and therefore Pasteur rightly quoted a great writer as having declared that "the greatest derangement of the mind is to believe things because one wishes them to be so."[2] He could well

[1] *The Life of Pasteur,* by René Vallery-Radot, p. 104.
[2] *Comptes Rendus de l'Académie des Sciences* 80, p. 91 (1875).

apprehend this danger, since it was one to which we find he was subject.

Béchamp's attitude to his work was diametrically opposite. He gave his imagination no play until he had interrogated Nature. Not until he had received a direct reply to a direct demand did he allow his mind to be carried away by resultant possibilities, and even then experiments punctuated the course to his conclusions. In short, he did not direct Nature and decide what he wished to discover. He allowed Nature to direct him and made his discoveries follow her revelations.

For fortunate Pasteur Imperial patronage was no dead letter. Four months after his presentation to Napoleon, in July of the same year, he received direct encouragement from the latter to turn his attention to the vinous diseases that were then interfering with the trade in French wines. Once more Pasteur started on a scientific tour during the holidays, this time to vineyards, and with the Emperor's blessing to lighten his pathway.

Meanwhile his opponents, Messrs. Pouchet, Joly and Musset, followed his former example and climbed mountains, testing air collected in small glass flasks. They returned triumphant, for although they had scaled one thousand metres higher than M. Pasteur there was alteration in their phials.

We have no need here to discuss the wagging of tongues on the subject and M. Flourens' pronouncement in favour of Pasteur at the Academy of Science. It suffices to mention that the deep problem of spontaneous generation became so popular that when Pasteur entered the lecture room of the Sorbonne on the evening of 7th April, 1864, to discourse on the subject, every seat available was filled, not simply by learned professors, but also by literary celebrities, Alexandre Dumas and George Sand among them, and also Princesse Mathilde and all the well-known votaries of fashion, the "smart set" of Paris. And happily for these worldlings, M. Pasteur had nothing very abstruse to set before them. He simply asseverated the impossibility of dispensing with parents, a subject likely to provoke banter rather than very deep reasoning. He wound up by explaining an experiment in which dust from the air had been excluded from a putrescible liquid and in consequence no animalculæ had become apparent.

To quote his own words:[1] "It is dumb because I have kept it from the only thing man cannot produce, from the germs that

[1] *The Life of Pasteur,* by René Vallery-Radot, p. 109.

float in the air, from Life, for Life is a germ and a germ is Life. Never will the doctrine of spontaneous generation recover from the mortal blow of this simple experiment."

There was never a word how this partial truth had been originally arrived at years before, as far back as 1857, by his contemporary, Professor Béchamp. There was no acknowledgment made of the great Memoir that had enlightened Pasteur's progress and revealed to him early errors. He took to himself all the credit, and that which is taken sufficiently forcibly the public seldom tries to hold back. We can picture the fashionable audience dispersing, proud of having understood the subject under discussion, as they no doubt imagined, and delighted with the lecturer for having proved them so much more scientific and clever than they had ever supposed themselves. Pasteur became the protégé of Society; the Church gave him her blessing; the Emperor invited him at the end of 1865 to spend a week at the Palace of Compiègne. His name and fame were established. Can we wonder that scientists who had never received such honours should have felt reluctant to oppose this favourite of fortune, who was naturally singled out to undertake scientific missions.

But to pause for an instant and consider his noted lecture at the Sorbonne—what after all was there in it? He had merely ascribed to the germs of the air a mysterious quality—life—that he denied to the component parts of more complicated animal and vegetable beings. For the origin, the source of his atmospheric germs, he provided no explanation, neither has any since been found by his innumerable followers, for whom the description "life is a germ and a germ is life" was soon to evolve into "disease is a germ and a germ is a disease," an infinitely more lugubrious axiom.

Was Pasteur correct even in his denial of alteration apart from air-borne organisms? In his own experiment upon meat he had to admit that the latter became tainted. To assume that this was caused by some faultiness in operation is not to explain the appearance of micro-organisms in cases where no air-borne germs could possibly account for their origin. Thus it is that Pasteur's boast in his lecture at having struck a "mortal blow" at the doctrine of spontaneous generation has not met with real fulfilment. Not only was his contemporary Pouchet never satisfied, but the later work of M. Gustave le Bon and of Dr. Charlton Bastian affected to demonstrate, according to their view, the production of organised beings from inorganic matter.

Professor Bastian asserts:[1] "Living matter may have been continuously coming into being all over the surface of the earth ever since the time of man's first appearance upon it; and yet the fact that no member of the human race has ever seen (or is ever likely to see) such a birth throws no doubt upon the probability of its occurence."

Professor Bastian based this belief upon such observations as his experiment with the "*cyclops quadricornis,* one of the *Entomostraca* so commonly to be found in ponds."[2]

"If we take one of these little creatures," he writes, "put it in a drop of distilled water, on a glass slip with a fragment of a No. 2 cover-glass on each side of it, and place over all a cover-glass, it will be found that the animal is soon killed by the weight of the latter, though the fragments of glass prevent rupture of the body. We may then place the microscope slip in a Petri dish containing a thin stratum of water (so as to prevent evaporation from beneath the cover-glass), and fixing upon one of the tail *setae* (these being larger than those of the abdominal feet), we may examine it from time to time. What may be observed is this. After an interval of two or three days (the duration depending upon the temperature of the air at the time) we may see, under a high power of our microscope, scarcely visible motionless specks gradually appear in increasing numbers in the midst of the structureless protoplasm, and, still later, we may see some of these specks growing into bacteria. . . . At last the whole interior of the spine becomes filled with distinct bacteria. . . . Later still, all the bacteria, previously motionless, begin to show active swarming movement. In such a case it is clear we have to do with no process of infection from without, but with a *de novo* origin of bacteria from the protoplasmic contents of the spines or *setae*. The fact that they appear in these situations as mere separate motionless specks, and gradually take on the forms of bacteria (also motionless at first) is, as I have previously indicated, just what we might expect if they had actually taken origin in the places where they appear. On the other hand, such a mode of appearance is totally opposed to what might be expected if the micro-organisms had obtained an entry from without, through the tough chitinous envelope of the spines."

[1] *The Evolution of Life,* by H. Charlton Bastian, M.A., M.D., F.R.S., F.L.S., p. 31.

[2] *The Nature and Origin of Living Matter,* by H. Charlton Bastian, M.A., M.D., F.R.S., F.L.S., R.P.A. ed., p. 110 (Watts & Co.).

Professor Bastian gives numerous examples of the finding of bacteria in internal animal organs and in fruit and vegetables, where he demonstrates the impossibility of an invasion. Can the followers of Pasteur provide any solution of the mystery? If they cannot, it must be conceded that no "mortal blow" at the doctrine of spontaneous generation was struck by Pasteur, as he proudly boasted. The dealer of the blow, or, at any rate, the provider of an explanation, apart from heterogenesis, was not the French chemist, dilating to a fashionable audience which included "all Paris," but a hard-working French professor and physician, who was also a chemist and a naturalist, and who was taking little part in all the talk because he was so hard at work wresting fresh secrets from Nature.

Even admitting that he demonstrated before Pasteur, and far more thoroughly, the rôle of air-borne organisms, it may yet be asked how Béchamp's observations enlightened any better the deeper depths of the heterogenetic mystery.

The answer to this is that, in his Memoir of 1857, the Professor did not include certain of his observations. His reason for the omission was that the results he obtained seemed too contradictory to be accurate. Believing that he had made some mistake, he set aside these particular experiments for the time being. In the end, as the following pages hope to set forth, his apparent failure was to prove the solution of the problem and was to give, so he at least believed, the basic explanation of the development of organised life from the minutest commencements. It was, in fact, according to him, to be the nearest elucidation ever given of animal and vegetable upbuilding, of the processes of health, disease and final disruption. In short, it was to wrest from Nature the stupendous truth which, in the great master's own words, rings out like a clarion: *"Rien n'est la proie de la mort; tout est la proie de la vie!"* [1]

[1] "Nothing is the prey of death; everything is the prey of life!"