A CHEMICAL STUDY

OF OILS AND FATS

OF ANIMAL ORIGIN

BOOK I

CHAPTER 1

DEFINITIONS

1. My first encounter with the analysis of vegetable matter made me realize that the way in which the theory of organic immediate principles[1] is presented is unsatisfactory. Because although people recognize that gum arabic differs from gum tragacanth and that sugars that can be isolated as crystals are hardly likely to be confused with liquid sugars, they consider gums and sugars as two different species[2]. This method of distinction is then extended to liquid oils[3], volatile oils, resins, etc. This amounts to acknowledging that a species as defined by its organic immediate principles is not a collection of entities having identical properties. In my opinion, sugars and gums should on the contrary be regarded as genera comprising different species, whereas oils, resins, etc. should be considered as compounds comprising different immediate principles. The composition of these compounds is not subject to the law of definite proportions[4] whereas the molecular formula of each of these principles is. I arrived at this opinion after I had discovered stearin and olein. I have described this discovery in a small article on the composition of plants[*] and in several separate articles. No doubt this method of publication is to blame for the little attention given to my views, and also the reason why they have not been quoted in writings that express opinions and report experiments that are more or less analogous to mine.

2. I define a *species* as present in mixtures as *a collection of entities that are identical with respect to the nature, proportion and arrangement of the elements of which they are composed* because the difference in properties that we observe in the mixtures we have been able to analyze can be

[*] *Éléments de botanique* by Mirbel, Vol. 1.

attributed to three causes. Different elements, or the same elements present in different proportions, give rise to compounds that are clearly different one from the other. It is well known that there are substances that on analysis are shown to contain the same elements in the same proportion, but that nevertheless display quite different properties[5]. Therefore, to understand the cause of the difference these substances exhibit, we must look for a difference in the arrangement either of their elementary atoms or of their combined atoms or particles[6]. However, before we can accept this third cause as an explanation of the difference between two such substances, it is necessary to verify that the substances are indeed identical with respect to the type and proportion of their elements. Numerous experiments are required to arrive at this result, as illustrated by the extensive research carried out to find a difference in composition between Iceland spar and aragonite[7] and a general tendency to presume a difference in composition when there is a difference in properties. Nevertheless, if people *keep within the limits of the experimental evidence*, they will not see any other possible explanation of the example I mentioned than assuming different arrangements of atoms or particles. But I want to repeat that this conclusion is based on the scientific knowledge we have today, just as the elemental nature that we attribute to substances that cannot be broken down any further.

3. I use the word *variety* for substances of *the same species* that differ in secondary aspects or some properties of little importance from the substance that is considered to be typical.

4. Finally, the word *genus* should only be applied to a collection of *species* that have one or more important properties in common such as the property of sugars of undergoing alcoholic fermentation when in contact with yeast.

5. By IMMEDIATE PRINCIPLES OF COMPOUNDS, or ORGANIC IMMEDIATE PRINCIPLES, I mean *compounds that have been synthesized by life[8] and from which you cannot separate various kinds of material without changing their nature.* Some scientists think that the expression *immediate principle* is flawed because using the word *principle* to refer to a complex substance is not logical. I do not share this opinion for the following reason. When you look in general at the composition of a salt as established by Lavoisier, it is a combination of an acid and a base rather than a combination of the elements of that acid and those of that base. If you imagine those elements combined in different proportions to those in an acid or a base, then you no longer get the idea of a salt. Consequently, it is only logical to say that acid and base are *the two immediate principles of salts.* It is the same with sugar, gum, starch, wood etc. with respect to plants; also with fibrin, albumin and cellular tissue with respect to animals. These substances should be regarded as immediate principles

that are characteristic of the plant or the animal to which they belong, even though oxygen, nitrogen, carbon and hydrogen are the more elementary principles.

6. The above definitions were necessary to make a distinction between the immediate principles considered as species and the groups of several of these principles which have been included in the list of species or which have been considered as genera. The greater the number of substances grouped under a common denomination, the more arbitrary this grouping becomes. Although there is certainly nothing arbitrary about the chemistry demonstrating the existence of virtually all oils and fats whose composition has been clearly determined, that is not at all the case when trying to establish the genera formed by combining species according to the dominance attributed to certain properties over others, because it will be virtually impossible to demonstrate this dominance. When I called this book *A study of oils and fats*[9], I did not consider them as a genus nor as an order of distinct genera. I have used the names that the substances I have been working on already had. But although I continued to use these names, I undertook to point out their vagueness because I attribute many of the obstacles encountered in natural science by those who start their study with the intention of expanding the field, to the common failure to establish distinctions between the different degrees of precision inherent in the definitions.

7. The designation OILS AND FATS has been given to *substances that burn with a large flame while depositing soot, that are soluble in alcohol and not or hardly soluble in water.* The first distinctions that have been made between the various oils and fats are based mainly on the different temperatures at which they melt. Accordingly, the term oil refers to fatty matter that is liquid at 10 to 15°C[10] and even below. The term *butter* applies to fatty matter that is soft at 18°C and melts at a few degrees higher. In general, animal *fats* have a slightly higher melting point than butters. *Tallows* melt at about 40°C and finally *waxes* melt at 44 to 64°C. The term *fatty matter* was later extended to cover other groups of materials such as *resins* and *essential oils*, etc. Resins are characterized by being solid and having a higher melting point than waxes; they can be brittle and have a more or less strong smell. *Balms* only differ from resins by being softer and nearly always by having a more pronounced smell. The characteristic properties of *essential oils* are a penetrating smell, their volatility and the ease with which they stain paper just like true oils. However, there is a difference in that the stain produced by the former disappears when the paper is exposed to air whereas it is permanent if produced by true oils. The above shows just how vague the expression *fatty matter* really is and also demonstrates that we are at present unable to define it scientifically.

[1] I decided to adhere to the literal translation of "principe immédiat" because several authors including Albert B. Costa (*Michel Eugène Chevreul, Pioneer of Organic Chemistry*, The State Historical Society of Wisconsin, Madison, 1962) also uses this term. It should be interpreted as a sort of 'constituent moiety'. See also endnote 6, page xxxvii.

[2] Here the author starts using words that stem from the system of classification that was successfully introduced by *Linnaeus* to categorize animals and plants according to: Kingdom, phylum, class, order, family, genus and species. So the olive tree *Olea Europæa* belongs to the kingdom of plants, the phylum of the *Magnoliophyta*, the class of the *Magnoliopsida*, the order of the *Lamiales*, the family of the *Oleaceæ*, the genus *Olea,*. and finally the species of the *Olea europæa*. To remember this series of categories and sub-categories, my daughter-in-law who went to university in Vancouver, Canada, provided me with the following mnemonic: "King Philip came over for good soup" which not surprisingly students immediately changed to "… for good sex."

[3] The text refers to "huiles fixes" and the translation into 'liquid oils' may be incorrect.

[4] The author refers to Dalton's law.

[5] It should be noted that at the time of writing, notions about molecular weight (or relative molecular mass as it is called nowadays), were quite vague. It was only in 1811 that Amedeo Avogadro (1776-1856) suggested that gases of elements could consist of molecules comprising more than a single atom. Little attention was given to this hypothesis and it wasn't until 1860 (Karlsruhe Congress) that it became fully implemented at the instigation of Stanisloa Cannizzaro (1826-1910).

[6] The word 'particles' should probably be interpreted as a synonym for atom.

[7] Both minerals consist of calcium carbonate but they differ in crystal structure. Iceland spar, which shows birefringence and is used in polarisation microscopy, has a rhombohedral crystal, whereas aragonite crystallises in an orthorhombic structure.

[8] This statement is of a vitalistic nature, "the belief that organic bodies obeyed special forces which differed from the ordinary chemical forces operating in the mineral realm and served to modify chemical affinity" (Costa, *loc. cit.*, page 24-25).

[9] In French, there is a collective description: *corps gras,* which can be translated as *fatty matter* or *lipids.* However, I prefer to use the common term *oils and fats* whenever possible despite the fact that strictly speaking, these do not include waxes, cholesterol etc. If the latter are present, the term *fatty matter* will be used.

[10] Somewhat later, in sub-section (27), Chevreul mentions that he uses degrees centigrade (°C) throughout; this is also supported by some of the melting points reported, the values of which are too low to have been reported in degrees Réaumur.