'father' but as time goes on, it begins to distinguish one man from another.

It is with these three signs that Aristotle concludes his Proemium to the Physics. It is difficult to find a reason for the order in which they are given. The first and the third seem more manifest than does the second. The third seems the most manifest of all. One may wonder why Aristotle added the three. Perhaps the reason was that the doctrine was so important, he was using as many signs as possible. Further, he states in the text that the natural process is from confusion to distinction. By immediately giving three different examples from common experience, he immediately shows that it is natural. It is natural for us to know by the sense the whole before the part. It is natural that we have at least a confused idea of the meaning of a word before we can give a strict definition of it. And it is natural that children first know all men confusedly and later on distinguish their fathers from other men.

CHAPTER SIX

THE CERTITUDE OF GENERAL KNOWLEDGE.

In our Introduction we stated that it was the purpose of this work to make some considerations on the mode of the philosophy of nature which would throw some light on the nature of that science. The particular aspect of the mode which we have chosen to manifest is that the philosophy of nature has as its starting point a general and confused knowledge and that it proceeds toward the particular. The meaning of this statement we have tried to show by commenting on the Proemium of Aristotle's Physics. In the next two chapters we shall try to further manifest the significance of this mode of procedure proposed by Aristotle. We shall do this in two steps.

First of all, we shall show that the general knowledge with which we begin our study of nature is certain. Secondly we shall indicate the value and importance of this general knowledge. This second point shall be taken up in Chapter Seven.

There are two ways by which it is possible to show the certainty of general knowledge. The first which is more complete is to analyze each of the general notions as proposed by Aristotle in the Physics and resolve them into first principles. This is really the task of a complete course in the philosophy of nature. The second way which is less complete, briefer and sufficient for the purposes of this paper is a negative way. It consists in showing how the truth of the general knowledge proposed by Aristotle may be distinguished from the errors

introduced in his steps toward concretion. It consists in pointing out the actual order followed by Aristotle and in pointing out the precise point in that order where we go from certainty to probability and as actually turned out in the case of Aristotle from truth to error.(1) Some of the things which he said about nature are outmoded. But there remains much which is true and this truth is most important. It is this truth which we shall try to manifest in the present chapter.

The description of the order of procedure as presented in the Proemium to the Physics is rather general and does not make very precise for us the methods by which one is to proceed from the general to the particular. To understand these methods we must follow Aristotle as he proceeds in his order of determination. In this chapter we propose to do three things. First of all, we shall give a general idea of the order which he followed. Secondly we shall make some comments on the presuppositions of this order and finally we shall try to indicate the modifications necessary in this order and its presuppositions. All of this will be done to manifest the certainty of the general knowledge which precedes concretion.

In general, this may be said. A scientific knowledge of nature according to the canons of science explained in Chapter One requires a

(1) - The errors which Aristotle made in his steps in concretion in no way detract from his stature as a philosopher. In fact, there were very good reasons why, for example, he held that the ultimate elements were earth, air, fire and water.

knowledge of the elements of nature, the "prima inter ea quae insunt rebus". Demonstrations in nature depend on knowledge of these elements. Knowledge, however, of these elements is not easily come by.

Our knowledge of nature depends on our external senses. These senses, however, are so joined with their object in the act of sensation that it is very difficult for us to distinguish that which is distinctive of the object causing the sensation from that which is distinctive to the organ of sensation. How much is the taste or the quality that causes the taste, in the apple and how much is it in the tongue of this man or this other man with a fever ? Now, when Aristotle begins with his very general principles, he may prescind from this question because the conclusions are so general that change of organ or qualitative difference of organ make no difference. This is true of much of the teaching of the Physics. But as soon as Aristotle takes his first step toward concretion, he relies on the sense organs to lead him to a knowledge of the elements. For him, the proper sensibles lead us to the elements. Actually, if it were possible for us to attain the elements of the material world, it would only be by means of these

(1) - "Sed quia omnis cognitio est per aliqua prima, ex quibus definitiones et demonstrationes procedunt; manifestum est autem quod elementa quarumlibet rerum sunt prima inter ea quae insunt rebus (licet aliqua extrinseca principia possent esse priora, puta agens et finis); oportet quod ad cognoscendum generationem corporum, prius cognoscatur quae sunt elementa, et ulterius quot sunt elementa, et qualia corpora." St. Thomas, In III De Coelo et Mundo, lect. 8, n. 599. This text applies particularly to the second species of motion, namely, qualitative. But as we have seen both in Chapters One and Four, the elements may be principles of demonstration in all of the philosophy of nature.

proper sensibles unless we were as Eddington puts it 'a god contemplating the external world.'(1) History, however, has revealed to us that the proper sensibles do not reveal the elements to us. Thus there are many things taught by Aristotle in his steps in concretion which are outmoded. We shall return to this point later.

A. - The Order of Concretion in Aristotle's Natural Science.

As we have mentioned above, Aristotle in the Proemium to the Physics explains the order of procedure in natural science in very general terms. To actually discover his order of determination (ordo in determinando) we must follow him as he determines successive subjects of demonstration in the other natural treatises. This order of determination is also called 'the order of concretion' and this with good reason. This order goes from general to particular, from universal to singular, from the abstract to the concrete. Each step in the process from the universal in predication (universale in praedicando) is a step toward the more concrete. The order, consequently, is called the order of concretion.

> Unde et scientiam naturalem incipit tradere ab his quae sunt communissima omnibus naturalibus, quae sunt motus et principium motus; et demum per modum concretionis, sive applicationis principiorum communium, ad quaedam determinata mobilia, quorum quaedam sunt corpora viventia. (2)

For a brief but rather detailed outline of this order we turn to the Proemium to the Meteorologica where Aristotle outlines for us the

(1) - Sir Arthur Eddington, The Mathematical Theory of Relativity, Cambridge (1930), p. 1.
(2) - St. Thomas, In De Sensu et Sensato, lect. 1 (edit. Leonine), n. 2.

study of nature.

> We have already discussed the first causes of nature, and all natural motion, also the stars ordered in the motion of the heavens, and the physical elements - enumerating and specifying them and showing how they change into one another - and becoming and perishing in general.
>
> There remains for consideration a part of this inquiry which all our predecessors called meteorology. It is concerned with events that are natural, though their order is less perfect than that of the first elements of bodies. They take place in the region nearest to the motion of the stars. Such are the milky way, and comets and movements of meteors. It studies also all the affections we call common to air and water, and the kind and parts of the earth and the affections of its parts. These throw light on the causes of winds and earthquakes and all the consequences the motions of these kinds and parts involve. Of these things some puzzles us, while others admit of explanation in some degree. Further the inquiry is concerned with the falling of thunderbolts and fire-winds, and further, the recurrent affections produced in these same bodies by concretion.
>
> When the inquiry into these matters is concluded let us consider what account we can give, in accordance with the method we have followed of animals and plants both generally and in detail. When that has been done we may say that the whole of our original undertaking will have been carried out. (1)

This Proemium contains three parts. In the first paragraph, Aristotle tells us what he has done thus far in the study of nature. In the second, he tells us what subjects are to be studied in this tract of meteorology. In the final paragraph he tells us what is to be studied in the rest of the science of nature. Here we are particularly interested in the first paragraph. The subjects to be treated in the

(1) - Meteorologica, I, c. 1, 338 a 20 - 339 a 9.

Meteorologica do not particularly interest us now. Nor do the later treatises on living being which although part of the order of concretion have nevertheless their own peculiar mode of concretion the study of which is beyond the limits of this work.(1)

Aristotle begins the first paragraph by telling us what he has studied in the Physics.

> We have already discussed the first causes of nature, all natural motion.

In this brief sentence, Aristotle indicates proemialiter the general division of the Physics into two parts. It is in both of these parts that we find the common and general notions the certitude and importance of which we are attempting to manifest in this thesis.

The first part which is contained in Books One and Two is described by the phrase 'the first causes of nature.' In the First Book, Aristotle establishes the principles of the subject of natural science. These principles are matter, form and privation. The argument is founded on very general experience and on an analysis of change. There is no attempt to specify what is the form of a particular natural being, but rather the doctrine is left in a very general and common states. There is no inquiry into the natural bodies to verify substantial change on

(1) - For the distinctive characteristics of the order of concretion in the study of living being see Charles De Koninck "Introduction à l'étude de l'âme" in Stanislas Cantin's Précis de psychologie thomiste, (Laval University) (1948) pp. xlvi - xlvii. This work is most important for an understanding of the order of concretion of natural science.

the level of inorganic being. The discussion is carried on first in terms of accidental change and when substantial change is approached the most obvious example is given, namely that of the generation of man. At the end of the long and careful study of the First Book, we know the principles of change but only in a general way. The knowledge obtained here is 'confused' and 'universal' in the sense of the Proemium. It will be made distinct not by demonstration but by a detailed determination of subjects in later books.

In the Second Book, Aristotle discusses the principles of the science of nature. This involves as we have seen in Chapter One, the determination of the subject of this science and the causes by which it demonstrates. This knowledge, too, is rather general. For example, the principle of finality in nature will be established but there will be no attempt at determining the finality of a particular organ of a particular animal. This will come in much later steps in concretion.

The second part of the Physics is summed up in the words 'all natural motion.' It is in this second part that the science of nature really begins. The first two books were more or less introductory. The subject of the science of nature is nature. Nature, however, is defined as the principle of motion and change. If we are to understand nature, we must understand motion. Consequently the science of nature must begin with a consideration of motion. Thus we read in the first lines of Book Three.

> Nature has been defined as a 'principle of motion and change,' and it is the subject of our inquiry. We must

> therefore see that we understand the meaning of 'motion;' for if it were unknown, the meaning of 'nature' too would be unknown. (1)

The study of motion, takes up the rest of the Physics. Books Three to Six discuss motion in itself. Books Seven and Eight discuss the relationship between motion and that which moves and that which is moved. Once again the considerations are very general and notify for us 'confused masses' which will be made distinct in later tracts. Thus Books Three and Four discuss and define motion, the infinite, place, time and the void. It is in Book Five that we find the division of motion into its species. This is most important for the steps in concretion for it is here that we will learn the formal division of natural science. This division will be the guide for the ordering of the remaining tracts in natural science. It is very general but very important.

The first paragraph of the Meteorologica continues :

> ... also the stars ordered in the motion of the heavens, and the physical elements - enumerating and specifying them...

These few words indicate what has been treated in the second tract of natural science, namely in the De Coelo et Mundo. Having considered motion in general, a universal according to predication (universale in praedicando), Aristotle proceeds to the particular, to the species of

(1) - Physics, III, c. 1, 200 b 12 - 14.

motion. Now what is the first kind of motion which the scientist encounters as he takes his first step toward concretion ? He does not immediately descend to particular species of mobile being but rests in a certain generality. He does not immediately descend to the motion which is proper to living beings, nor to that motion which we call 'coming to being and passing away.' He rather first encounters what we call 'local motion.' Two reasons may be assigned for treating local motion before any other.

The first may be found in Book VIII of the Physics where we are told that local motion is the primary and most perfect motion.(1) All other motion presupposes it. Consequently it is the most common motion and should be considered before we descend in the order of determination to the other species of motion.

The second reason may be deduced from what Aristotle says in the opening lines of the De Coelo et Mundo.

> The science which has to do with nature clearly concerns itself for the most part with bodies and magnitudes and their properties and movements, but also with the principles of this sort of substance, as many as they may be. For of things constituted by nature some are bodies and magnitudes, some possess body and magnitude, and some are principles of things which possess these. (2)

(1) - "Now of the three kinds of motion that there are - motion in respect of magnitude, motion in respect of affection, and motion in respect of place - it is this last, which we call locomotion, that must be primary. ... If, therefore, there must always be motion, there must also always be locomotion as the primary motion..." Physics, VIII, c. 7, 260 a 27 - 260 b 9.

(2) - De Coelo et Mundo, I, c. 1, 268 a 2 - 7.

The science of nature has to do with bodies because the things of nature are either bodies and magnitudes themselves, or possess bodies and magnitudes or are principles of things which possess bodies and magnitudes. The notion of nature is intimately linked with the notion of the corporeal world. This is true of all nature whether it be the nature of living beings or beings that 'come in to being and pass away.' The notion of body is common to all nature. The motion, however, of a body in so far as it is a body is local motion. Thus local motion is common to all of nature. The first step in concretion will be the study of local motion, of the motion of the corporeal world. Local motion, however, is motion according to situs. Thus the subject of this first tract in concretion, the De Coelo et Mundo, is the universe which is nothing else but the corporeal world with its parts arranged according to situs.

> Et ideo rationabiliter videtur sententia Alexandri, quod subjectum hujus libri sit ipsum universum, quod dicitur coelum vel mundus; et quod de simplicibus corporibus determinatur in hoc libro, secundum quod sunt partes universi. Constituitur autem universum corporeum ex suis partibus secundum ordinem situs : et ideo de illis solum partibus universi determinatur in hoc libro, quae primo et per se habent situm in universo, scilicet de corporibus simplicibus. (1)

The subject, then, of the De Coelo et Mundo is the universe. Following the order of concretion, in this book, we should apply the general principles of the Physics to the universe precisely as it is the subject of local motion. Further, since science is the work of reason, and since

(1) - St. Thomas, In I De Coelo et Mundo, Proemium, n. 5.

it is proper to reason to impose order, within the interior of the study of the universe, there is also an order to be followed.(1)

First of all, one may consider the entire corporeal universe in so far as it is to be considered before the parts which make it up. Thus in the First Book of the De Coelo et Mundo, Aristotle considers certain things pertaining to the entire universe, namely, its perfection and whether or not it is infinite. This first part is sort of a consideration of whole before parts. The whole considered here, however, is not the potential whole of which we spoke in the previous chapter. The whole here is an actual whole and the parts to which it is opposed are not the parts of the species (partes speciei) but rather the parts which are according to matter (partes materiae). St. Thomas points out the distinction between these two kinds of parts in his Proemium to the De Coelo et Mundo.(2) The parts of the species (partes speciei) belong to the very definition of the whole. Consequently the whole cannot be known before they are known. For example, the parts of the species of man (not of the universe) are bones and flesh etc. There is no complete knowledge of the whole which is man without knowledge of these. They are parts of the very definition of man. The parts according to matter (partes materiae) are the parts according to the individual. They would be in the case of man, these bones, this flesh. We may consider the whole which is man without considering these parts according to matter. In the First Book of the De Coelo et Mundo,

(1) - St. Thomas, In I De Coelo et Mundo, Proemium, n. 5. This whole Proemium contains a careful study of the order in the De Coelo et Mundo. See also, De Koninck, op. cit., pp. lxix-lxxiii.

(2) - Ibid., n. 2.

Aristotle considers the whole universe in so far as it is opposed to the partes materiae.

Secondly one may consider the simple bodies which make up the universe before one considers the composites which are in it. Among these simple bodies one may consider first those which are prior. Thus in the Second Book, Aristotle considers the celestial bodies. In Books Three and Four, he considers other simple bodies.

> Et quia, ut supra dictum est, in hoc libro principaliter intendit Aristoteles determinare de universo corporeo et principalibus partibus ejus, quae sunt corpora simplicia, inter quae potissimum est corpus caeleste, ideo dividitur liber iste in partes tres; in prima determinat de universo corporeo; in secunda determinat de corpore caelesti, et hoc in libro secundo. ... in tertia parte determinat de aliis simplicibus corporibus, scilicet de gravi et levi, in tertio libro. (1)

It will be noted that in this first step of concretion, Aristotle considers the elements of the corporeal world. Here, however, the consideration is not of the elements as they are principles of generation but rather of the elements according as they have position in the universe. Thus they are not considered in so far as they are hot, cold, wet or dry but in so far as they are light or heavy.

> Unde et de quatuor elementis non determinatur in hoc libro secundum quod sunt calida vel frigida, vel aliquid hujusmodi; sed solum secundum gravitatem et levitatem, ex quibus determinatur eis situs in universo. (2)

---

(1) - St. Thomas, In I De Coelo et Mundo, lectio 2, n. 8.
(2) - Ibid., Proemium, n. 5.

Thus the determination of the elements in the Third and Fourth Books is dialectical and general.(1) It is in the De Generatione et Corruptione that they are treated as hot, cold etc. and as principles of generation.

It will further be noted that in the De Coelo, plants, animals etc. are not treated as such but only in so far as they have position in the universe. Thus the universe as conceived in the De Coelo et Mundo is the universe of local motion.

> Aliis autem partibus universi, puta lapidibus, plantis et animalibus, non determinatur situs secundum se, sed secundum simplicia corpora : et ideo de his non erat in hoc libro agendum. Et hoc consonat ei quod consuevit apud Latinos dici, quod in hoc libro agitur de corpore mobili ad situm, sive secundum locum : qui quidem motus communis est omnibus partibus universi. (2)

The second step in concretion may be found summarized in the final words of the first paragraph of the Meteorologica.

> ... and showing how they change into one another and becoming and perishing in general.

These few words sum up proemialiter the subject matter of the De Generatione et Corruptione.

Having considered local motion which is common to all nature, Aristotle proceeds to those kinds of motion which are not common to all

---

(1) - For a study of the difference of approach to the elements in the De Coelo and the De Generatione see Paul Germain, Génération et Corruption des Mixtes (Thesis presented at Laval University) (1951) pg. 48. This work also contains a good discussion of the order of these two tracts and the significance of the elements in the natural science of Aristotle.
(2) - St. Thomas, In I De Coelo et Mundo, Proemium, n. 5.

nature. Among these, the primacy is held by change which we call generation and corruption. For Aristotle, generation and corruption are less common than local motion in so far as the celestial bodies which move locally are not corruptible. Thus, the second step in concretion is a study of generation and corruption.

The relation between the De Coelo et Mundo and the De Generatione et Corruptione is indicated briefly in the last sentence of the former and the first of the latter.

The De Coelo et Mundo ends :

> We have now finished our examination of the heavy and the light and of the phenomena connected with them. (1)

In other words, Aristotle has completed the study of local motion. The De Generatione et Corruptione takes up from there :

> Our next task is to study coming-to-be and passing-away. We are to distinguish the causes, and to state the definitions, of these processes considered in general - as changes predicable uniformly of all the things that come-to-be and pass-away by nature. Further, we are to study growth and 'alteration.' We must inquire what each of them is; and whether 'alteration' is to be identified with coming-to-be, or whether to these different names there correspond two separate processes with distinct natures. (2)

In this brief paragraph, Aristotle indicates what he is going to study in the De Generatione et Corruptione. First of all, he will study

(1) - De Coelo et Mundo, IV, c. 6, 313 b 24.
(2) - De Generatione et Corruptione, I, c. 1, 314 a 1 - 5.

coming-to-be and passing-away and its common causes. Secondly, he will study growth and alteration. Thirdly, he will indicate the differences between generation and alteration.

In the De Coelo et Mundo, the kind of motion studied was local motion. What kind of motion is the subject of the De Generatione et Corruptione ? Here a difficulty arises. Generation and corruption although they are species of mutation are not species of motion in the strict sense as was pointed out in Book V of the Physics. In what sense then can we say that the subject of the De Generatione et Corruptione is generation and corruption and is at the same time a species of motion ? The subject of the De Generatione et Corruptione is that which is mobile according to quality. The qualitative change or alteration which is principally studied is that which leads to substantial change. The tract is called De Generatione et Corruptione in so far as this title designates the term of the principle subject, alteration. (1)

In the First Book, Aristotle treats of generation and corruption in general. In chapters one to five, he distinguishes generation from alteration and from growth. In chapters six to ten, he discusses the pre-requisites for generation. That which is generated is formed out of certain constituents which combine. Combination, however, implies reciprocal action and passion and contact. All of these topics are treated in chapters six to ten.

(1) - Germain, op. cit., pq. 59 ff. discusses the subject of the De Generatione. See also John of St. Thomas, Cursus Philosophicus, III, Proemium, p. 536 a 40.

The opening lines of the Second Book resume that which was treated in Book One and indicate the subject of Book Two.

> We have explained under what conditions 'combination,' 'contact,' and 'action-passion' are attributable to the things which undergo natural change. Further, we have discussed 'unqualified' coming-to-be and passing-away, and explained under what conditions they are predicable, of what subject, and owing to what cause. Similarly, we have also discussed 'alteration,' and explained what 'altering' is and how it differs from coming-to-be and passing-away. But we have still to investigate the so-called 'elements' of bodies. (1)

In Book Two, Aristotle examines the elements. In chapters one to eight, he discusses their principles, their number, their mutual transformations. It is here that we find a proper consideration of the elements according as they are hot, cold, wet or dry. Finally in chapters nine and ten, he discusses the causes of generation and corruption.

In the second paragraph of the introduction to the Meteorologica, Aristotle indicates what he will study in the Meteorologica itself. This book is a further step in concretion in so far as it applies to specific areas of the universe, the general teaching about the elements which had been proposed in the De Generatione et Corruptione. Thus Aristotle treats the movements of stars, comets, meteors etc. He also treats of bodies on this earth but the name of the treatise is taken from that of bodies in the heaven because they were considered superior to the earthly bodies.

---

(1) - De Generatione et Corruptione, II, c. 1, 328 b 25 - 30.

Having considered the first two species of motion, local and qualitative, Aristotle proceeds to a study of quantitative motion. This third step is summed up in the third paragraph of the Proemium to the Meteorologica.

> When the inquiry into these matters is concluded let us consider what account we can give, in accordance with the method we have followed, of animals and plants both generally and in detail. When that has been done we may say that the whole of our original undertaking will have been carried out.

Beginning with the De Anima, Aristotle treats of beings which have movement according to quantity, that is living beings. Here, we will not enter on the discussion of the order proper within this last section of natural science. Suffice it to say, that in general, it, too, follows the order of concretion beginning with a study of the soul in general and then descending even to the different species of living beings.

B. - Some Presuppositions of Aristotle.

In this section, it will not be our purpose to make a minute criticism of the teaching of Aristotle in the progressive steps of concretion. Such a task would require a specialist in each part of natural science. Our purpose is much more limited. It is to disengage from Aristotle's natural science certain presuppositions which render obsolete those parts of his teaching which depend on them. We shall do this in an effort to show what part of his teaching has been outmoded and what part remains certain, valid and as we hope to show in the next chapter, important.

If we were to consider one by one the conclusions reached in the Physics, we would find for the most part that they depend on a very general experience. To establish the notions of matter, form, motion, the infinite, place, the void, time, it suffices to have a very general knowledge. Knowledge of these does not depend on the possibility of our being able to distinguish between that which is proper to our sense faculty and that which is proper to the object sensed. The definition of motion does not depend on the reliability of our sense faculties. Suffice it, that we know that there is some change. There is a specifically different experience for motion according to place, that according to quality and that according to quantity. There is experience of a leaf changing color from green to brown. To analyze the notion of motion, we do not have to know how much greenness is in the eye, how much in the leaf. It suffices to know that there is a change. The same is true of many of the considerations of the Physics. In the study of the infinite, some arguments are drawn from the nature of the four elements but there are others,more general, which prescind from this completely.

As soon, however, as Aristotle takes the first step toward concretion, he must start speaking about the elements. As we have seen above, the subject of the De Coelo et Mundo is the universe of local motion. In the First Book, Aristotle discusses the parts which make up the perfection of this universe. Immediately he sets about showing that there is another body besides the four elements. The whole discussion, however, presupposes the existence of the four elements.

It is presupposed that we are capable of arriving at knowledge of the elements. Again in the Third and Fourth Books, the elements are considered in so far as they are heavy and light.

As we have seen, too, it is in the De Generatione et Corruptione that we have a formal consideration of the elements. The teaching on the elements influences the Meteorologica and all the other natural works. Even some of the considerations of the third step in concretion, namely, the consideration of quantitative motion, involve the elements.

Much, then, of what Aristotle says in the more concrete tracts depends on a knowledge of the elements. Knowledge of the elements, however, requires a much more detailed study than does knowledge of the general notions taught in the Physics. In making that detailed study Aristotle made certain suppositions which cannot be verified and which consequently led him into error. Large sections of what he taught in the more concrete tracts must be rejected. But for our purpose, here, it is necessary that we point out how the general knowledge of the Physics is verifiable antecedent to the steps in concretion and consequently verifiable antecedently to the false suppositions.

We are attempting here to distinguish clearly the certain general knowledge of the Physics from the untenable presuppositions of the later tracts. What are these suppositions ? To answer this question we must briefly examine the method by which Aristotle determines the elements.

For the sake of brevity and clarity, we shall number the steps by which Aristotle determines the elements.

(1) - Aristotle is seeking the elements, namely the first material principles of bodies.:

> Sed quia omnis cognitio est per aliqua prima ex quibus definitiones et demonstrationes procedunt, et manifestum sit quod elementa quarumlibet rerum sint prima inter ea quae insunt rebus (licet aliqua extrinseca possent esse priora puta agens et finis) oporteret quod ad cognoscendum generationem corporum, prius cognoscatur quae sunt elementa corporum generabilium et corruptibilium et qua ratione, et ulterius quot sunt elementa, et qualia corpora: (1)

(2) - However, we do not know substantial forms through our sense knowledge :

> Nulla forma substantialis est sensu perceptibilis sed solum intellectu; cujus objectum est quod quid est, ut dicitur in tertio De Anima. (2)

(3) - Accidental differences which are perceptible to the senses may reveal to us substantial differences :

> Dicendum est ergo quod sicut habetur in VIII Metaphysicorum differentiae substantiales, quia sunt ignotae per differentias accidentales manifestantur. (3)

(4) - The elements which we seek are the principles of alteration and generation. Alteration and generation, however, require action and passion. Action and passion in turn require contact.

---

(1) - St. Thomas, In III De Coelo et Mundo, lect. 8, n. 599.
(2) - St. Thomas, In I De Generatione et Corruptione, lect. 8, n. 62.
(3) - Ibid.

> For all those who generate the 'elements' as well as those who generate the bodies that are compounded of elements make use of 'dissociation' and 'association,' and of 'action' and 'passion.' (1)
>
> But if we must investigate 'action-passion' and 'combination,' we must also investigate 'contact.' For action and passion (in the proper sense of the terms) can only occur between things which are such as to touch one another; nor can things enter into combination at all unless they have come into a certain kind of contact. (2)

(5) - Our sense of touch reveals to us the very tangible qualities by which the elements react one on the other. All of the tangible qualities which we sense may be reduced to four which are irreducible to others. These four are hot, cold, dry and wet. These qualities which are the primary ones of our sensation are also the primary qualities of the elements. These are the qualities which reveal the elements to us.

> Since, then, we are looking for 'originative sources' of perceptible body; and since 'perceptible' is equivalent to 'tangible,' and 'tangible' is that of which the perception is touch; it is clear that not all the contrarieties constitute 'forms' and 'originative sources' of body, but only those which correspond to touch. For it is in accordance with a contrariety - a contrariety, moreover of tangible qualities - that the primary bodies are differentiated. (3)
>
> Accordingly, we must segregate the tangible differences and contrarieties, and distinguish which amongst them are primary. (4)

---

(1) - De Generatione et Corruptione, I, c. 6, 322 b 6 - 8.
(2) - Ibid., 322 b 22 - 28.
(3) - Ibid., II, c. 2, 329 b 6 - 12.
(4) - Ibid., 329 b 18 - 19.

A study of the tangible qualities reveals that there are four which are elementary, the hot, cold, wet and dry. These qualities may be coupled in four ways revealing to us the primary elements, earth, air, fire and water.

> The elementary qualities are four, and any four terms can be combined in six couples. Contraries, however, refuse to be coupled : for it is impossible for the same thing to be hot and cold, or moist and dry. Hence it is evident that the 'couplings' of the elementary qualities will be four : hot with dry and moist with hot, and again cold with dry and cold with moist. And these four couples have attached themselves to the apparently simple bodies (Fire, Air, Water and Earth) in a manner consonant with theory. (1)

It is in this fifth step that we meet one of the fundamental hypotheses of the Aristotelian study of nature, namely that the primary and elemental material causes of things are definable in terms of the proper sensibles.

> Il importe avant tout d'en saisir l'hypothèse fondamentale : les causes matérielles premières et 'élémentaires' des choses se définissent par des sensibles propres, et qui plus est, par les qualités sensibles les plus 'élémentaires'. (2)

According to this hypothesis, Aristotle identifies that which is most fundamental in itself with that which is most elementary for us. It is the sense of touch which is most fundamental to us and it is this which reveals the elements of material things.

---

(1) - De Generatione et Corruptione, II, c. 3, 330 a 30 - 330 b 2.
(2) - De Koninck, op. cit., pg. lix.

> La théorie conclut à la coincidence entre ce qui est le plus élémentaire en soi dans les choses matérielles et ce qui est le plus élémentaire pour nous dans la connaissance. (1)

The first four steps which we have outlined seem acceptable. The fifth, however, which influences so much of the Aristotelian natural science is to be seriously questioned. Can we be sure that those qualities which seem most fundamental to our senses, are actually the primary and fundamental qualities of natural bodies. The hot, the cold, the wet and the dry are the primary and fundamental qualities known to us. All other sensible qualities may be reduced to them and they themselves may be reduced no further. In the line of sensible quality, we can go no further in explaining them. There is no other way of explaining to you precisely what I mean by heat than to place your hand on a hot stove or to take with you a walk in the sun. I may give you an explanation in terms of velocity of molecules but that is only an extrinsic explanation. To know what heat is, you have had to be hot. But the question arises. Is heat also the primary quality of the natural body ? Is it so proper to the natural body that it reveals the nature of natural body as would a proper accident ? This is the question which must be answered if we are to accept the Aristotelian elements and this is a question which seems almost impossible to answer. Is there any way of verifying that what is most elementary in my sense knowledge is most elementary in itself. How can I verify this ? The

---

(1) - De Koninck, op. cit., pg. lix.

only possible instrument of verification is the sense organ itself which being intrinsecally material (1) lends itself very reluctantly to a scientific study. In this respect because of its immersion in matter, the sense faculty is more difficult to study than the intellectual faculty which depends on matter only extrinsecally.

> Si, d'une part, l'organisation de la matière est plus hétérogène selon qu'elle est fonction d'une opération moins concrétisée à la matière, en sorte que la science pleinement naturelle de cette opération et de sa puissance demanderait une connaissance proportionnelle du corps, d'autre part, l'étude quasi-abstraite des puissances inférieures n'offre plus les possibilités ni la fécondité de l'étude des puissances dont les opérations relèvent davantage de l'âme comme telle... En effet, les opérations, par elles-mêmes plus dégagées de la matière, sont à cet égard plus accessibles à l'abstraction. Par contre, les sens externes et les fonctions végétatives (outre que nous n'éprouvons pas ces dernières) sont plus réfractaires à cette abstraction et demandait aussitôt que l'on désigne les organes et qu'on s'applique à leurs examens. (2)

If we wish to be sure that our sensations reveal to us the elementary qualities of their objects, we must study both the sense organ and the object. But the only way by which we may study both of these is by

---

(1) - "Observation of the sense organs and their employment reveals a distinction between the impassibility of the sensitive and that of the intellective faculty. After a strong stimulation of a sense we are less able to exercise it than before, as e.g. in the case of a loud sound we cannot hear easily immediately after, or in the case of a bright colour or a powerful smell, but in the case of mind, thought about an object that is highly intelligible renders it more and not less able afterwards to think objects that are less intelligible : the reason is that while the faculty of sensations is dependent upon the body, mind is separable from it." De Anima, III, c. 4, 429 a 29 - 429 b 4.
"Haec autem est differentia, qua differt cognitio intellectiva a sensitiva, quod sentire est aliquid corporeum. Non enim operatio sensus est sine organo corporali." St. Thomas, In III De Anima, lect. 4, n. 622.

(2) - De Koninck, op. cit., pg. lv.

way of the given of external sensation. The sense faculty and the object of sense are very obscure as is attested by the arduous work of the experimental psychologist who must try to explain them. The psychologist uses all sorts of methods and detours to explain our sensations, to distinguish them, to correlate them. This is because the sense faculty is material. Were it spiritual and capable of reflection on itself the task would be easier. A sign of this opaqueness of the sense faculty is found in the very evolution of the concept of the universe. Compare, for example, the ancient image of the universe founded on the proper sensibles and discussed in terms of hot, cold, wet and dry and the modern image where sensations will be described in terms of equations taken from integral calculus. Philosophers have become more and more aware of this opaqueness and consequently in place of the proper sensibles they have substituted mathematical constructions to explain the sense organ and its object.

> L'évolution des sciences expérimentales nous permet de nous former une idée plus concrète de l'épaisseur du sens. Comparez seulement à l'ancienne image de l'univers qui s'est maintenue pendant près de vingt siècles, les ébauches de représentations toujours provisoires tracées par les théories contemporaines, représentations qui ne sont même plus imaginables au sens courant du mot. (1)

Granted the data of the problem which confronts us namely that we wish to show that the elementary qualities of our sensations are the elementary qualities of the natural bodies, the only absolute proof

---

(1) - De Koninck, op. cit., pg. lvi.

would be had if we were as Eddington put it 'gods contemplating the external world.' We could verify the primary qualities of bodies, if we were outside the universe looking in, examining both our sensations and their objects but not by the means of sense organs. The primary qualities may be hot and cold, wet and dry but we cannot prove it.

A priori, then, considering the very nature of sensation, we cannot be sure that the primary qualities of our sensations are the primary qualities of natural bodies. A posteriori history has let the theory of the four elements fall by the wayside. Natural science has abandoned the way of proper sensibles and qualities and has turned to a study of the common sensibles which we shall explain shortly and quantity. This quantitative study, although it will make very precise our knowledge of nature and although it has opened up vast horizons in natural science, is not a qualitative study and consequently will not lead us to the elements which alone can be principles of demonstration.

We have arrived here at a very important point in the natural science of Aristotle. The study of nature, as we have seen, begins with very common notions and definitions drawn from general experience. As it proceeds in concretion, it turns toward the theory of the elements. This theory of the elements will have its effects throughout the steps in concretion. But the point to be remarked here is that this theory of the elements is not the starting point of the philosophy of nature. Strictly speaking it does not appear till after the Physics, consequently most of the notions of the Physics in no way fall with it. Verification of these notions is a long process, as the length of the

Physics attests but this verification can take place independantly of the theory of the elements. The tracts in concretion will obviously depend much more on this outmoded theory. Nevertheless, here, too we must distinguish that which depends on the theory of the elements and that which does not. The principles of natural bodies, matter and form, the definition of motion, time, place, the species of motion as determined in the Physics may all be verified. Nor should we be too quick to condemn everything which is said in the De Coelo et Mundo. For example, the discussion on possibility and corruptibility in chapters 10 to 12 is still most valuable.

From what has been said, it would seem that we may divide the natural science of Aristotle into two parts. There is a first part which is very general and which depends on a very common experience. This part does not tell us very much but what it does tell us is certain. There is a second part which is more concrete, richer in content but which based as it is on an unverifiable doctrine of the elements is untenable. We insist on this division in order to defend the certitude of the first part and to show that it does not depend on a detailed experience. This is as we have mentioned a negative way of defending this certitude but it seems to suffice here. The next step would be to analyze these general notions one by one and see if they may be defended on the basis of general experience.

In defending them, however, one must not lose sight of the fact that they are very general and that they do not tell us very much about nature. Any attempt to defend them on the grounds that they are more

ultimate principles than the principles discovered in experimental science only tends to confuse their true meaning and render their defence more difficult. These notions, as we have pointed out in the previous chapter have a universality not of causation but of predication. They are not actual wholes but potential wholes. They are only a starting point.

C. - The Possibilities of Concretion.

In this chapter we have tried to indicate the general lines of the order of concretion as actually followed by Aristotle and certain pre-suppositions of Aristotle which render many of these steps in concretion obsolete. This we have done as a way of distinguishing the certain general notions of Aristotle's natural science from some of the untrue particular notions. As a final section in this chapter, we shall add something on the possibilities of concretion that lie open to the natural scientist of today. This we shall do both as a further manifestation of the idea of concretion and as a preparation for the next chapter wherein we shall speak of the importance of the general knowledge with which we begin our study of nature.

Granted that the general and confused knowledge of the first part of natural science is certain and granted that the way of concretion by means of proper sensibles is more or less limited, how may we proceed in concretion ? Strictly speaking, we can give no a priori answer to this question. The process of concretion is a slow and laborious process the direction and methods of which are known to us only after

the natural scientist has discovered and used them. There are, however, certain general principles which we may establish a priori and which may help us understand the significance of a particular method used by a scientist.

In this discussion of the process of concretion in natural science, it is of prime importance that we do not forget the subject of this science as indicated in Chapter One of this work. The subject is ens mobile. There are three species of motion, local, qualitative and quantitative. A process of concretion should include all three.

It must also be remembered that although the way of the proper sensibles is limited, nevertheless the ultimate resolution of this science is in the senses. While it is proper to mathematics to resolve in the imagination and to metaphysics to resolve in the intellect, it is proper to natural science to resolve in the senses. As St. Thomas says the term of natural science is the senses and we form our judgments in natural science according to what the senses tell us. Neglect of the senses in natural science results in error.

> Sed terminus cognitionis non semper est uniformiter. Quandoque enim est in sensu, quandoque in imaginatione, quandoque autem in solo intellectu... Et ideo in scientia naturali terminari debet cognitio ad sensum, ut scilicet iudicemus de rebus naturalibus, secundum quod sensus eas demonstrat, ut patet in III Caeli et Mundi, et qui sensum negligit in naturalibus, incidit in errorem. (1)

(1) - St. Thomas, Expositio in Boethium de Trinitate, q. VI, art. 2. This is in no way to deny that it is common to all human knowledge and consequently to all the sciences to have the senses as a permanent principle. Resolution, however, in senses is proper to natural science. See ibid., ad 5.

Thus, although the way of proper sensibles involves pitfalls not thought of by the ancients, nevertheless it remains true that in our steps toward concretion we must stay as close to sense knowledge as possible. How is this possible ?

In the De Anima, Aristotle discusses the relation between the senses and the sensible objects and makes the very helpful distinction between what we call the proper sensibles and the common sensibles.

> In dealing with each of the senses we shall have first to speak of the objects which are perceptible by each. The term 'object of sense' covers three kinds of objects, two kinds of which are, in our language, directly perceptible, while the remaining one is only incidentally perceptible. Of the first two kinds one (a) consists of what is perceptible by a single sense, the other (b) of what is perceptible by any and all of the senses. I call by name of special object of this or that sense that which cannot be perceived by any other sense than that one and in respect of which no error is possible; in this sense colour is the special object of sight, sound of hearing, flavour of taste. Touch indeed, discriminates more than one set of different qualities. Each sense has one kind of object which it discerns, and never errs in reporting that what is before it is colour or sound (though it may err as to what it is that is coloured or where that is, or what it is that is sounding or where that is). Such objects are what we propose to call the special objects of this or that sense.
>
> 'Common sensibles' are movement, rest, number, figure, magnitude; these are not peculiar to any one sense, but are common to all. There are at any rate certain kinds of movement which are perceptible both by touch and by sight.
>
> We speak of an incidental object of sense where e.g. the white object which we see is the son of Diares; here because 'being the son of Diares' is incidental to the directly visible white patch we speak of the son of Diares as being (incidentally) perceived or seen by us.
>
> Because this is only incidentally an object of sense, it in no way as such affects the senses. (1)

When we speak of 'objects of sense' we refer to three things. First of all, there are the objects which are directly perceptible by but a single sense. We call these objects, the proper sensibles. Thus a proper sensible is heat, I have the sensation of heat. I am hot. This is irreducible. I can explain to you no further what I mean when I say that 'I am hot' except to make you stand in the sun with me. It is this type of sensible in which the sense faculty recognizes qualities and it is this type of sensible which we discussed in the previous section. Although this type of sensible is unverifiable and limited in what it can tell us about the sensible world, nevertheless, it is a necessary starting point for our knowledge of the sensible world. Our natural science is an attempt to explain the things which make noise, burn, are visible. Natural science is not a research into the meaning of abstract concepts like justice or of mathematical entities.

Among the objects of our senses, there are also those which may be the objects of several senses. Heat is an object but of one sense, the sense of touch. Color is sensible only to the eye. Movement, however, rest, number, figure and magnitude may be perceived by a number of senses. I can see an object move, I can feel it move. I can see three bowling pins. I can touch three bowling pins. It is

---

(1) - De Anima, II, c. 5, 418 a 6 - 23.

immediately evident that this type of sensible is more capable of revealing the nature of the physical world to us than are the proper sensibles. At least, here, we may compare senses. I see three bowling pins. There is further verification by the fact that I can touch three bowling pins. These common sensibles then seem to be truer interpreters of reality than the proper sensibles.

These common sensibles, however, have another characteristic which is even more important. All of them may be reduced to quantity or to modes of quantity. This is obviously true of number and magnitude. Figure is reducible to quantity in so far as it is concerned with magnitude while motion and rest involve the notions of one and many.

> Sensibilia vero communia omnia reducuntur ad quantitatem. Et de magnitudine quidem et numero patet quod sunt species quantitatis. Figura autem est qualitas circa quantitatem, cum consistat ratio figurae in terminatione magnitudinis. Motus autem et quies sentiuntur, secundum quod subjectum uno modo vel pluribus modis se habet secundum magnitudinem subjecti vel localis distantiae, quantum ad motum augmenti et motum localem; vel etiam secundum sensibiles qualitates, ut in motu alterationis; et sic sentire motum et quietem est quodammodo sentire unum et multum. Quantitas autem est proximum subjectum qualitatis alterativae, ut superficies coloris. (1)

Thus, although the common sensibles are perceived by means of the proper sensibles, nevertheless they are in a way anterior to these qualities in so far as they are reducible to quantity which is the subject of

(1) - Summa Theologica, I, q. 78, a. 3, ad 2.

quality. From this point of view, they are quantitative determinations which are anterior to sensible qualities. Knowledge of them gives us a chance to bypass some of the obstacles which block our way to knowledge by means of the proper sensibles.(1) Further, since they are quantitative determinations, they may be known by measure which is our means of knowing quantity.(2) They allow themselves therefore to more precise study than do the proper sensibles.

When Socrates stands in the sun, he may feel unbearably hot. Plato, who at the moment may be suffering from chills might wish the sun were much hotter. At such a moment, an objective study of heat or even the amount of heat would be practically impossible. If, however, Plato and Socrates agreed that they would take as an objective norm of heat, the length of a column of mercury when subjected to the same sun, a certain amount of objectivity is arrived at. Of course, they must also be sure of the pressure to which the mercury is subject, so that they can compare their findings with those of Aristotle who is far away and who will join them in their study of this phenomenon called heat. It is this way of common sensibles and measure which modern science has

(1) - "Déjà à cet égard il faut envisager un double rapport dans le sensible commun. Nous le connaissons d'abord sous la dépendance de quelque sensible propre. Il faut ou voir, ou toucher, la grandeur, le nombre, la figure, le mouvement. Mais ce que nous percevons sous la dépendance d'un sensible propre est en même temps le sujet des qualités sensibles. C'est précisément ce rapport d'antériorité qui doit attirer notre attention. A ce point de vue, les sensibles communs sont des déterminations quantitatives antérieures aux qualités sensibles... L'attention à ce rapport d'antériorité permet un premier recul devant les objets." De Koninck, op. cit., pp. lxiv - lxv.

(2) - "For measure is that by which quantity is known." Metaphysics, X, c. 1, 1052 b 20.

taken in its steps toward concretion. It is steps in concretion such as these which will take place today of much of what is taught in the De Coelo et Mundo, the De Generatione et Corruptione and the Meteorologica.

It should be noted that steps in concretion which have as their starting point measurement of common sensibles, will never lead us to demonstrations of the reasoned fact as explained by Aristotle in the Posterior Analytics. They will lead to a sort of demonstration of the fact and to a sort of dialectic. Demonstration as we have seen in Chapter One depends on knowledge of causes and definitions. The definitions, however, which are given by way of common sensibles, that is the definitions of modern mathematical physics are not essential definitions in the Aristotelian sense of the word.(1) They are neither in the first nor the second degree of abstraction as explained in Book Two of the Physics. The definition of heat arrived at by the warm Socrates, the chilled Plato and the distant Aristotle was different than their definition of man, cat or horse or even of motion. The notion we have of man is abstracted directly from reality. The degree of temperature, however, of which Socrates and Plato speak is not obtained by an immediate abstraction from reality. First of all, they have to agree that they will use a tube of mercury as their base. Further, they must agree on the pressure to which this tube is subjected. Determining pressure

(1) - For a study of the definitions, laws, theory and methodology of mathematical physics see, Emile Simard, La Nature et la Portée de la Méthode scientifique, Québec, Les Presses Universitaires Laval (1956).

is another complicated procedure where the scientific operations of Plato and Socrates enter. Finally, their definition of a degree of temperature is in terms of measurement. Measure, however, of a continuum is always only approximate. There is not the rigorous definition which is required for true demonstration.

Consequently the definitions which we arrive at by means of the measurement of common sensibles are not the strict definitions necessary for demonstration of the reasoned fact. They may, however, be used in a sort of a demonstration of the fact or in a sort of dialectic. We use the expression 'sort of' purposely. In strict demonstration of the fact we argue from an effect to cause. Thus Socrates arguing from the proper sensible of smoke argues to something which he will also explain in terms of proper sensibles, namely, fire. Arguing from this vaguely visible cloud which darkens the sky over one place and which affects the nostrils in a certain way, he argues to the existence of something which appears red, which burns ones skin and which destroys a piece of wood. Even though Socrates cannot explain the reason for either cause or effect, he knows that where there is smoke there is fire. The two 'facts' exist. Once, however, he begins to discuss his mathematical physics with Plato, once he discusses the relationships of measure based on a bar which he and Plato have set aside in Paris, his argumentation is a bit different. He may argue from effect to cause from fact to fact but they seem to mean something different than the facts of smoke and fire. The fact which is the effect from which he argues depends largely on his convention with Plato, on the accuracy of his rule, on

the operations which he performs. A meter is not something he meets in reality as is smoke. The meter depends on the factors explained above. Arguing then from this kind of 'fact' he should arrive at the same kind of 'fact.' The cause will also be provisional, approximate and operational. These kinds of facts seem to lend themselves to a 'sort of' demonstration. The argument approaches strict argumentation but is not exactly the same thing.

The dialect, too, is a 'sort of' dialectic. Dialectic as opposed to demonstration may be defined as argument from the common and probable rather than from the proper and certain. We use dialectic argument when we are incapable of defining a subject and when consequently we argue from something extrinsic to the definition. We cannot attain the essence of the subject, consequently we try, as it were, to surround it arguing from τόποι (1) which in Latin we call loci. Locus is extrinsic to the subject, yet it helps us locate the subject. Dialectic is extrinsic to the subject, yet it helps us to locate the subject. It does not give us strict science, yet it is a preparation for science. (2)

---

(1) - "Oportet igitur ut in hoc negotio topice procedatur, ostendendo in quibus rerum habitudinibus, ut in quibusdam locis claudatur ignoti notitia, quod scire desideramus ; propter quod etiam haec scientia liber Topicorum vocatur... Et ideo dicitur dialecticus, quia procedit ex probabilibus... Ex communibus autem dico, quae vel in pluribus vel in omnibus inveniuntur, non profundata in ipsis, sicut profundantur propria et essentialia, sed quae apparent in superficie statim." St. Albert, In I Topicorum, Tract. I, caput 1.

(2) - "Est autem utile ad tria, ad exercitationes, et ad obviationes, et tertio ad secundum Philosophum disciplinas, id est, quae sunt secundum philosophiam." Ibid., caput 5.

Knowledge by means of measurement of common sensibles has some of the characteristics of dialectic. The conventions and constructions of the mathematical physicists bear resemblance to the loci. There is, however, one difference. Dialectics since it is a way to science, should bear on the universal, but many of the definitions of Socrates and his fellow mathematical physicist, Plato, are not based on universals. In speaking of temperature, they speak of the length of a column of mercury. This length is measured on the basis of a bar in Paris which we call the meter. The meter, however, is not something abstracted from reality as is the notion of 'man.' The notion of meter must be ultimately reduced to a single bar which is carefully preserved in Paris under certain conditions of temperature and heat. Strictly speaking that bar cannot be measured in meters for all measure depends on a norm but the only norm for a meter is the bar itself. This bar is a singular bar and consequently it may be questioned whether or not it is a sufficient foundation for dialectical argumentation which must be based on universality. We shall go no further into this point here for it is not our purpose to give a critique of mathematical physics but merely to indicate some of the possibilities of concretion in the philosophy of nature.

There is, however, another detour taken by mathematical-physics in its study of nature which should be briefly outlined here. It is a detour which is closely allied to the fact that mathematical-physics proceeds by way of measurement. This detour is the detour by way of symbols. The subject of symbols is rather vast and demands a much more

thorough study than we intend here.[1] Here we will but indicate the possibilities of concretion by way of symbol. The natural science of Aristotle proceeds for the most part by way of names. Mathematical-physics proceeds by way of symbols. It is most important to distinguish the two. Aristotle has left us a basic discussion of what he means by 'name' in the Peri Hermeneias.[2] He distinguishes it carefully from what he calls the 'infinite name.' He has not left us with a study of the symbols of mathematical-physics. This study we would have to do ourselves. Nevertheless, a good starting point would be the basic text of Aristotle on the 'name' and 'infinite name.' In general, this may be said. A name signifies a determined nature, while an infinite name signifies pure indetermination. The name 'man' stands for an unum per se. 'Non-man' is pure indetermination. A symbol stands more or less between the two. The etymology of the word might throw some light on its meaning. It comes from σύμ and βάλλειν which are the Greek words for 'with' and 'to throw.' The etymology indicates a throwing together without order. Thus the Symbolum Apostolorum is a throwing together of articles of faith. Now the symbols of mathematical physics (and here we are making a tremendous leap from one imposition to another) mean that under one sign we are throwing together many disparate elements. There is not an unum per se here as in the case of man but the mind is imposing unity on a number of disparate elements.

Thus for example we have the symbol T. This symbol does not

(1) - For a brief but careful study of names and symbols see C. De Koninck, "Noms et Symboles" (Cours d'été de philosophie) Québec, Doyon. (1955).

(2) - Peri Hermeneias, c. 2, 16 a 19 - 16 b 5.

stand for a notion immediately abstracted from nature, as man, horse or potato. It stands for a number of disparate elements. There is a tube of mercury whose length I measure by means of a meter bar in Paris, whose weight is determined similarly. This tube is subjected to a certain pressure (which is another notion which I have not immediately abstracted from reality but which also has been constructed). I put this tube in the sun. On the scale, I read 32. Thus I say that T is 32. This T stands for all of these elements thrown together and unified by the mind. It is symbols of this nature which are used by mathematical-physics and which have revealed very much about the nature of the physical world.

Although the measurement of the common sensibles and the use of symbols have opened up new pathways for our knowledge of nature, it must not be thought that they exhaust the possibilities of concretion. There is still a natural science of common experience and of words. There are large areas of natural science which transcend the common sensibles and symbols. There remains large sections of the De Coelo, the De Generatione and the De Anima which are most important for our knowledge of nature. Here we have but indicated some other ways of concretion which must be taken into account if one wishes to employ all the means possible for furthering knowledge of nature.

D. - An Objection.

It might be objected against these possibilities of concretion the general outlines of which we have indicated that they are not really steps in concretion. The idea of concretion implies that we go from the abstract and general to the concrete and particular. Modern science, however, knows nothing about the abstract and general principles of the Physics. Consequently its use of common sensibles, symbol etc. is completely independant of the knowledge of the Physics and can in no way be considered as a step in concretion from the general notions. This objection may be backed up by the very definition of concretion given us by St. Thomas :

> Unde et scientiam naturalem incipit tradere ab his quae sunt communissima omnibus naturalibus, quae sunt motus et principium motus; et demum processit per modum concretionis, sive applicationis principiorum communium, ad quaedam determinata mobilia... (1)

If modern mathematical physics proceeds by way of symbol, how can it be called an application of the Physics which proceeds with words?

For the moment this objection can be partially answered by pointing out that historically modern mathematical-physics has grown up in a world which has its traditions rooted in the philosophy of nature of Aristotle. This might be a rather negative argument but it is a fact that modern mathematical-physics did not grow up among Oriental philosophies. It grew up in the western tradition. But a more complete answer to this objection will be given in the next chapter where we will show the importance of this general knowledge.

(1) - St. Thomas, In De Sensu et Sensato, lect. 1, n. 2.

CHAPTER SEVEN.

THE IMPORTANCE OF GENERAL KNOWLEDGE.

Recently at a meeting of philosophers and scientists in which both presented their views on the relations between classical natural philosophy and modern science, a scientist presented as more or less typical of the modern scientists attitude toward natural philosophy the following brief report.

> The type of physical principles used in pre-Galilean science would not constitute a significant contribution to modern science for several reasons :
>
> a. They are already used by scientists who do, in fact, inquire about the "four causes," without calling them such. For example, in discussion of waves on the surface of water, they consider the material cause (water), the wave pattern (form), the disturbing vibration (efficient cause), and the resulting transfer of energy across space (final cause).
>
> b. They are trivial, i.e. they are obvious conditions of thinking but contribute little or nothing to solving concrete scientific problems.
>
> c. They are applicable to the macroscopic world, but modern developments suggest that they do not apply to the microscopic world. This was illustrated by the paradoxes of the wave and the particle aspects of electrons passing through slits. (1)

For the purposes of this thesis it will not be necessary to discuss either the first or the third of these comments. However, it will be useful to discuss the second according to which the physical

(1) - Kane, Corcoran, Ashley and Nogar, Science in Synthesis, Dominican College of St. Thomas Aquinas, River Forest, Illinois (1953) pp. 52-53. The session to which we refer was held in 1952. Science in Synthesis is the report issued by the staff.

principles used in pre-Galilean science are 'trivial' in so far as they do not help to solve concrete physical problems. It may be granted that these principles do not help to solve problems which are posed in terms of common sensibles, numbers and symbols and if this be the definition of 'trivial' then they are trivial. The Aristotelian notions of matter, form and motion are in no way necessary for the working out of a particular problem. If, however, the scientist wishes to locate his science in the whole realm of human knowledge, including his own science and metaphysics, these notions are far from trivial but are rather most important. It will be the purpose of this chapter to show the true importance of the general principles of Aristotelian natural science. The status quaestionis may be put briefly as follows. Granted that the confused and general knowledge of nature is certain, what is its value and importance ?

The general and confused knowledge spoken of here is the knowledge which is acquired in the Physics. However, it should be noted that any knowledge which does not manifest the ultima species and its properties is in a way general and confused. The last stage in concretion is reached when the ultimate species is known. Thus any knowledge above that of the ultimate species may be considered as general knowledge. In comparison to the Physics, the De Coelo et Mundo and the De Generatione et Corruptione are considered to be steps in concretion but they in turn are more general than later treatises. The De Coelo, for example, is further removed from concretion than is the Meteorologica. In this chapter, general and confused knowledge means for the most part the knowledge of the Physics.

In the climate of opinion of the twentieth century there is another precision which must be made on the meaning of general and confused knowledge. For the modern man, any knowledge which is not expressible in measure and number is general and confused. Even the later steps in concretion of Aristotle's natural science would be considered general, confused and inexact. It may be noted here that this notion of the 'exactness' of modern science as compared to the 'inexactness' of natural philosophy may be overstressed. In the first place measure of a continuum is always only proximate and is never completely exact. This from the very nature of measure.(1) Secondly the general definitions of natural philosophy are very exact even though they contain their subjective parts only in confusion.

Here it will not be necessary to go into a detailed account of the content of this general knowledge. Suffice it to point out the more important notions. It includes the intrinsic principles of mobile being, matter, form and privation; the definition of nature and the establishment of the causes found in nature; the definition of motion and its conditions both intrinsics and extrinsics, such as the infinite, place and time; the division of motion into its species of local, qualitative and quantitative; and finally it includes the relation of the moved to the mover and to the prime mover. Of what importance are these notions ? We shall answer this question both negatively and positively. First of all, we shall deny to them an importance which at

(1) - Concerning the proximate character of measure see Simard, op. cit., pg. 72 and De Koninck, op. cit., pg. lxix.

times is attributed to them and which does not seem justified. Secondly we shall indicate their true importance.

A. - False Notions of the Importance of General Knowledge.

In ascribing importance to the general notions of the Physics, it only confuses matters to ascribe to them an importance which they do not have. Their importance is not rooted in the fact that they are a metaphysical study nor in the fact, that they are an ultimate study of that which is studied only proximately in experimental science. The Physics is not a tract in metaphysics nor does it pierce more deeply the nature of ens mobile than do the experimental sciences. We shall discuss both of these points.

First of all, the general notions of the Physics are not metaphysical. There is abundant evidence for this both in the text of Aristotle and from an analysis of the notions themselves. As was noted in the first chapter of this thesis, when Aristotle determines in Book Two of the Physics[1] the subject of natural philosophy, he does not bother to distinguish it from metaphysics. There is no need. As the human intellect approaches the study of nature it knows the world of mathematics and the world of motion. They must be distinguished. It does not, however, know the world of metaphysics. The subject of metaphysics is not arrived at by a more general abstraction as though by proceeding higher and higher in the line of total abstraction, the

(1) - Physics, II, c. 2.

mind would finally arrive at the notion of being. The being of metaphysics includes both sensible and separated substance. Separated substance, however, is not obtained by abstraction but is known only by means of a demonstration. It does not suffice to go from man to animal to substance to being in order to arrive at the subject of metaphysics. Thus before the human mind comes in contact with the world of metaphysics, it must make a demonstration the elements of which are found in physics. Consequently in the Second Book of the Physics, since Aristotle has not yet demonstrated the subject of metaphysics, he feels no need to distinguish the subject of physics from the subject of metaphysics. The subject of physics is not as the subject of mathematics 'in thought separable from motion'[1] but rather is immersed in matter and in motion.

In the Sixth Book of the Metaphysics where he distinguishes the sciences one from the other, he explicitly states that if there is no immovable substance, physics is the first science. The existence of immovable substance, however, must be demonstrated. Consequently before one has made this demonstration, there is only the science of physics. As yet there is no metaphysics.

> We answer that if there is no substance other than those which are formed by nature, natural science will be the first science; but if there is an immovable substance, the science of this must be prior and must be first philosophy, and universal in this way because it is first.

(1) - Physics, II, c. 2, 193 b 33.

> And it will belong to this to consider being qua being - both what it is and the attributes which belong to it qua being. (1)

It should be noted here that by 'first science,' Aristotle means not that which is first known but that which studies first causes. (2)

St. Thomas, too, is clear on the difference between the two. In his Proemium to the Physics, he places the subject of natural philosophy and consequently the general notions of the Physics in a different degree of abstraction than that of metaphysics. Sciences are distinguished according to diversity of definition. The definitions of metaphysics prescind from matter but the definitions of natural science and consequently the definitions of the Physics include matter. (3)

It might be objected that despite what Aristotle and St. Thomas say, the general notions of the Physics have a metaphysical character. First of all, they are extremely general; much more general than the definitions of the more concrete tracts of Aristotle. Secondly they seem to involve notions studied in metaphysics. For example, the definition of motion is given in terms of act and potency. It is defined as "the fulfillment of what exists potentially, in so far as it exists potentially." (4) This definition, however, is the fundamental definition of the Physics. Consequently the Physics appears to be a metaphysical study.

---

(1) - Metaphysics, VI, c. 1, 1026 a 27 - 33.
(2) - St. Thomas, In I Metaphysicorum, Proemium.
(3) - St. Thomas, In I Physicorum, lect. 1, n. 3. See also St. Thomas, In VI Metaphysicorum, lect. 1; Expositio in Boethium de Trinitate, q. V, a. 1.
(4) - Physics, III, c. 1, 201 a 10 - 11.

On neither count is this objection valid. First of all, sciences are not distinguished merely according to degrees of generality. If by a process of total abstraction, the intellect proceeds toward greater and greater universality, the universality is that of the universal in predication (universale in praedicando). This abstraction gives a potential whole. Substance is more universal than animal and it is at the same time more potential. This is not the subject of metaphysics. Metaphysics seeks universal causes not universal predicates. (1) Consequently the greater generality of the notions of the Physics as compared with notions in the more concrete treatises of natural science, in no way implies that they belong to metaphysics.

Secondly the words 'act' and 'potency' in terms of which motion is defined are not the act and potency of the Metaphysics. Act and potency as discovered in mobile being are more known to us than act and potency as we discuss them in metaphysics. It is by the first that we come to the latter. Thus in the Ninth Book of the Metaphysics when Aristotle discusses act and potency, he clearly states that although act and potency are more properly applied to mobile being, nevertheless we must go beyond them to get the act and potency discussed in metaphysics.

> And first let us explain potency in the strictest sense, which is not the most useful for our present purpose. For potency and actuality extend beyond the cases that involve a reference to motion. But when we have spoken

---

(1) - St. Thomas, In I Metaphysicorum, lect. 2, n. 46.

of this first kind, we shall in our discussions of actuality explain the other kinds of potency as well. (1)

In his commentary on this passage, St. Thomas points out that it is only after we have studied act and potency as applied to mobile being that we will be able to understand it as applied to the intelligible substances. This is according to the proper order of knowledge which proceeds from sensible things which are more manifest to us. This is so true that even in metaphysics where we are not primarily concerned with mobile being, it is necessary to first speak of potency with regard to mobile being in order that we understand it as applied to the separated substances.

> Sed cum dixerimus de potentia, quae est in rebus mobilibus, et de actu, ei correspondente, ostendere poterimus et de potentia et actu secundum quod sunt in rebus intelligibilibus, quae pertinent ad substantias separatas, de quibus postea agetur. Et hic est ordo conveniens, cum sensibilia quae sunt in motu sint nobis magis manifesta. Et ideo per ea devenimus in cognitionem substantiarum rerum immobilium.
>
> Ex quo etiam apparet sensus alterius litterae quae sic habet, "Et quidem potentia quae dicitur proprie, non solum utilis est ad quod volumus nunc" : quia licet potentia quae est in rebus mobilibus maxime proprie dicitur, non tamen hoc solum dicitur potentia, ut dictum est. Et utilis est ad praesentem intentionem, non quasi de ea principaliter intendatur, sed quia per eam in alias potentias devenimus. (2)

For Aristotle and for St. Thomas who was his faithful disciple in this matter, there are three distinct sciences, natural science,

(1) - Metaphysics, IX, c. 1, 1045 b 36 - 1046 a 4.
(2) - St. Thomas, In IX Metaphysicorum, lect. 1, nn. 1771-1772.

mathematics and first philosophy. The Physics belonged to the first group. Consequently the notions given there are specifically different from the notions of the Metaphysics. One does not simplify matters by appropriating the first degree of abstraction to modern experimental science and then because this seems different than the Physics of Aristotle relegate this latter to Metaphysics. This only distorts the true meaning of the Physics, confuses it with the Metaphysics and in a way compromises them both. For unless the way is prepared for metaphysics by natural science, there is no metaphysics. The first science which we learn is natural science, the subject of which is obtained by abstraction. The subject of metaphysics depends on a demonstration. If we are not capable of demonstrating the existence of separated substances, there is no metaphysics but only physics. Physics then would become the supreme science.

Secondly, the importance of the general notions of the Physics does not lie in the fact that they are the result of a study of the ultimate causes of natural being while experimental sciences are the result of a study of proximate causes. Setting up terminology as this, it seems that we immediately award the palm to natural philosophy in so far it goes more profoundly into things than does mathematical-physics. The difference between the philosophy of nature and experimental science is not based on the fact that one is ultimate, the other proximate but rather on the fact that one is general the other particular, that one is demonstrative while the other is dialectic, that one uses words while the other frequently uses symbols. The words 'ultimate'

and 'proximate' do not seem to express these ideas at all. It is true that demonstrative knowledge is more perfect than dialectic, that words are more perfect than symbols but in the case of natural philosophy the demonstrations are restrained to a very general level and do not really tell us very much. The ideas discussed are universal but this is the universality of predication which is more potential than actual. We know very little about nature at the end of the Physics. And we are not content with the poverty of our knowledge.

In his commentary on the Meteorologica, St. Thomas is very clear on this. In science as in nature, that which is in potency is not yet perfect. Knowledge, however, of the general and universal is still knowledge in potency. For example, to know that man is animal and nothing more is merely knowledge in potency. Knowledge is in act when the complete definition is known. Thus for the perfection of science, it does not suffice to have general and common knowledge but one must proceed to the proper and distinct knowledge of species.

> Sicut in rebus naturalibus nihil est perfectum dum est in potentia, sed solum tunc simpliciter perfectum est, quando est in ultimo actu; quando vero medio modo se habens fuerit inter puram potentiam et purum actum, tunc est quidem secundum quid perfectum, non tamen simpliciter; sic et circa scientiam accidit.
>
> Scientia autem quae habetur de re tantum in universali, non est scientia completa secundum ultimum actum, sed est medio modo se habens inter puram potentiam et ultimum actum. Nam aliquis sciens aliquid in universali, scit quidem aliquid eorum actu quae sunt in propria ratione ejus : alia vero sciens in universali non scit actu, sed solum in potentia. Puta, qui cognoscit hominem solum secundum quod est animal, solum scit sic partem definitionis hominis in actu, scilicet genus ejus : differentias autem constitutivas speciei nondum scit actu, sed potentia tantum.
>
> Unde manifestum est quod complementum scientiae requirit quod non sistitur in communibus, sed procedatur usque ad species : individua enim non cadunt sub considerationne artis; non enim eorum est intellectus, sed sensus. (1)

If we say that the general knowledge of the Physics is ultimate we really have no need to proceed further. The word 'ultimate' seems more apt for expressing the universal cause (universale in causando) than the universal in predication (universale in praedicando). The universal cause, however, is known only at the end of the Physics and is studied more carefully at the end of the Metaphysics. The common meaning of the word 'ultimate' would refer it to the ultimate in resolution not the ultimate in predication. It should apply to that which is in act rather than to that which is in potency.

When Aristotle denominates as 'proximate' the causes discussed in the more concrete parts of natural science, this is a 'proximate' not opposed to 'ultimate' but opposed to causes which are 'first,' that is first known to us and 'remote' that is, more general. This should be clear from the following passage of the Metaphysics and St. Thomas' commentary on the same.

> When one inquires into the cause of something, one should, since 'causes' are spoken of in several senses, state all the possible causes. E.G. what is the material cause of

(1) - St. Thomas, In I Meteorologicorum, lect. 1, n. 1.

> man ? Shall we say 'the menstrual fluid'? What is the moving cause ? Shall we say the 'seed'? The formal cause ? His essence. The final cause ? His end. But perhaps the latter two are the same. - It is the proximate causes we state. What is the material cause ? We must name not fire or earth, but the matter peculiar to the thing. (1)

St. Thomas' commentary on this passage is quite clear. Here Aristotle is opposing proximate causes to first causes, that is, causes which are first known and consequently are universal and imperfect.

> Ostendit quod non solum oportet assignare omnes causas, sed etiam oportet dicere causas proximas, ut incipiendo a causis primis perveniamus ad causas proximas. Per causas enim primas habetur cognitio de re aliqua solum in universali et imperfecta. Per causas autem proximas habetur cognitio rei et perfecta. Sicut si quis quaerat causam materialem hominis, non debet assignari pro causa, ignis aut terra quae sunt materia communis omnium generabilium et corruptibilium, sed debet assignari propria materia, ut et caro, et os, et hujusmodi. (2)

If the discussion of general notions such as found in the Physics is called an investigation into ultimate causes, it is quite possible that modern scientists will be misled as to the meaning of natural philosophy. If this knowledge is really ultimate, there is no need for progress in the sphere in which it is found. If there is no need for progress, the assumption should be that this knowledge has reached its perfection. A scientist, however, when told this, will instinctively although probably not distinctly realize that it is really general and confused and for that reason imperfect. When it is presented as

(1) - Metaphysics, VIII, c. 4, 1044 a 32 - 1044 b 2.
(2) - St. Thomas, In VIII Metaphysicorum, lect. 4, n. 1738.

perfect, he will regard it as 'trivial' in comparison to his own knowledge which has been much more fruitful, appears much more exact and is always the foundation for new and better knowledge and theories.

B. - The True Importance of General Knowledge.

The general knowledge of the Physics is not metaphysical nor is it the result of a study of ultimate causes. What, then, is its value ? Why is it important ? It is important both for the science of nature and for metaphysics. We shall try to manifest both of these points.

1. - General Knowledge and Natural Science.

a. - The Unifying Principle.

In the discussion of the Proemium to the Physics it was seen that Aristotle and after him St. Thomas considered the order of procedure in the philosophy of nature as an order from the universal toward the particular, from the confused to the distinct, from the common to the proper. In each of his Proemia to the natural works of Aristotle, St. Thomas comes back to this same point indicating how each tract is more concrete than that which preceded.

In the Proemium to the De Coelo, he indicates how we proceed from the common of the Physics to the proper subject of each of the succeeding tracts. Here it is the subject of the De Coelo.

> Nam primo determinatur communia naturae in libro Physicorum, in quo agitur de mobili inquantum est mobile.

> Unde restat in aliis libris scientiae naturalis hujusmodi communia applicare ad propria subjecta. Subjectum autem motus est magnitudo et corpus : quia nihil movetur nisi quantum. (1)

In his Proemium to the De Generatione et Corruptione, he takes up the same idea. After treating motion in general, we proceed to the most common of the species of motion, namely local motion. After local motion we treat the less common species of motion and among these the principle is generation and corruption.

> Primus autem motuum est motus localis, qui est perfectior ceteris, et communis omnibus corporibus naturalibus, ut probatur in VIII Physicorum. Et ideo post considerationem motuum et mobilium in communi, quae fuit tradita in libro Physicorum, primo oportuit quod tractaretur de corporibus secundum quod moventur motu locali, in libro De Coelo; quae est secunda pars scientiae naturalis. Restat igitur consideratio de motibus aliis consequentibus, qui non sunt communes omnibus corporibus, sed inveniuntur in solis inferioribus. Inter quos principatum obtinet generatio et corruptio. (2)

In each step towards concretion, St. Thomas is careful to point out the order which is followed and this for good reason. Science is the work of human reason and that which distinguishes human reason from the sense faculty is its ability to order.(3) Consequently in all science there should be order. This theme of order comes up time and again.

---

(1) - St. Thomas, In I De Coelo et Mundo, Proemium, n. 3.
(2) - St. Thomas, In I De Generatione et Corruptione, Proemium, n. 1.
(3) - "Et hoc est rationabile : nam processus scientiarum est opus rationis, cujus proprium est ordinare; unde in omni opere rationis ordo aliquis invenitur, secundum quem proceditur ab uno in aliud." St. Thomas, In I De Coelo et Mundo, Proemium, n. 1.

In the Proemium to the Posterior Analytics where he is showing the necessity of logic by manifesting the difference between art and nature, the discussion is in term of order. "Nihil enim aliud ars esse videtur, quam certa ordinatio rationis."(1) Again in the Proemium to the Ethics he divides all human science according to diverse relations between mind and order.(2) The importance of order probably is manifested most clearly in the Proemium of the Metaphysics where Wisdom is defined as that which orders. "Sapientis est ordinare."(3)

As was mentioned in the Introduction(4) all order involves priority and posterity. There is that which is principle and starting point and there is that which comes after it. If the principle is neglected the order is lost and the work becomes that much less a work of reason. In all ordered things, however, that which comes first perdures throughout. That which is most fundamental has its influence on that which follows. For example, man not only uses that which belongs to him in so far as he is rational but also that which belongs to him in so far as he is merely an animal. In the generation of man, man is first animal then rational. But when the rational soul is created, the animality remains.(5) The same may be seen in the hierarchy of the senses.

---

(1) - St. Thomas, In I Posteriorum Analyticorum, Proemium, n. 1.
(2) - St. Thomas, In I Ethicorum, lect. 1, n. 1.
(3) - St. Thomas, In I Metaphysicorum, Proemium.
(4) - Supra, pg. 8.
(5) - "Ad cujus evidentiam sciendum est, quod in rebus ordinatis oportet primum modum includi in secundo, et in secundo inveniri non solum id quod sibi competit secundum rationem propriam, sed quod competit secundum rationem primi; sicut homini convenit non solum ratione uti, quod ei competit secundum propriam differentiam, quae est rationale, sed uti sen-

The most fundamental sense is that of touch. The sense of sight is superior in so far as it makes for more distinct knowledge. Nevertheless the organ of sight is also subject to the sense of touch which is fundamental and which remains throughout.(1)

The same is true in the realm of knowledge. That which is principle and foundation should remain throughout. In the use of words, it is the first imposition of the word which is the principle and foundation. If this first imposition of the word is forgotten much of the significance of the word is lost. For example, a complete understanding of the word 'genus' as used in logic, requires knowledge of the first imposition of the word which referred to clan. The word 'judgment' in philosophy takes on new and richer significance when its first imposition in terms of the law courts is remembered. In his Spiritual Exercises, St. Ignatius aptly calls the consideration on the end of man and of creatures, the Principle and Foundation. The ideas contained therein are a starting point and are to color all that follows.

In the philosophy of nature as in all science there is ordered process from a principle or starting point. As in all ordered things this principle is retained throughout. This principle is the confused and general knowledge of the Physics which remains as the background for

---

su vel alimento, quod ei competit secundum genus suum, quod est animal vel vivum." St. Thomas, Quaestiones Disputatae, De Veritate, q. 22, a. 5.

(1) - Ibid.

all of the steps of concretion and unifies them all. Were human knowledge like that of the angels, its principle of unity would be the universal in representation (universale in representando) which contains many objects at the same time and contains them distinctly. However, it is not angelic but depends on abstraction. The object of the human intellect is the quiddity of sensible beings which exist in time and space. The only way the human intelligence can unify them is by abstracting from their diversity. This abstraction gives a potential whole, the universal in predication (universale in praedicando). It is this potential whole which gives unity to science and which is its starting point.(1) From there the process is toward distinction. It is in terms of the confused knowledge of the universal in predication that the distinct knowledge of later steps in concretion is unified.

The local motion studied by the physicist, the qualitative motion studied by the chemist (if indeed the modern chemist really attains qualities) and the quantitative motion studied by what we call today the rational psychologist are all distinct kinds of motion and demand their proper study and method. Each step toward concretion in each of these fields seems to draw them further and further apart. How may they be unified ? They find their unity in the general knowledge of the Physics, in the definition of motion in general. They are all motion and whatever is said about motion in general may be said about them. True this knowledge is not very rich in content but it is neces-

---

(1) - Concerning the role of the universal in predication in the unity of science, see De Koninck, op. cit., pp. xxxviii-xxxix.

sary and at the same time shows the true nature of human knowledge. Our knowledge proceeds from the universal in predication (universale in praedicando) toward the universal cause (universal in causando). This process is accomplished (as much as it can be accomplished in this world) in two steps. There is a first step 'downward' toward concretion from the confused potential whole to a more distinct actual knowledge of the particular species. This step is the proper task of the philosopher of nature. There follows a second step 'upward' toward the universal cause which step is accomplished only at the end of the Metaphysics.

This confused and general knowledge is necessary not only for the unity of the science of nature but also for distinct knowledge of the various species of motion. For example, it does not suffice for a distinct knowledge of local motion to be able to measure things in time and space. Local motion will be understood completely only when the physicist knows what it has in common with the other species of motion and how it differs from them. This cannot be learned merely by studying local motion. It must be learned on another more general level. This more general level is the proper field of investigation of the Physics. It is the Physics which investigates the common definition of motion and which divides motion into its species.(1) Thus although it may be true that general knowledge is 'trivial' in so far as it does not aid in the solution of a particular problem in the

(1) - Physics, V.

realm of local motion, yet it is not 'trivial' for one who wishes a distinct knowledge of local motion.

The general notions of the Physics are necessary in so far as they unify knowledge of nature and help for a more distinct knowledge of the various kinds of mobile being. They have another function which is not less important. This is the function primarily envisaged by Aristotle and St. Thomas thinking as they did that the elements of nature were accessible to us by way of the proper sensibles. If the elements are accessible to the natural scientist, the study of nature in large part becomes an application of the general principles of mobile being to particular species of it.

> Unde et scientiam naturalem incipit tradere ab his quae sunt communissima omnibus naturalibus quae sunt motus et principium motus : et demum processit per modum concretionis, sive applicationis principiorum communium, ad quaedam determinata mobilia... (1)

Thus after it has been established in the First Book of the Physics that natural beings are composed of prime matter and substantial form, it is the task of the scientist in his steps toward concretion to determine the substantial form of particular species of natural being. Thus the scientist applies the general teaching to the particular. However, due to the limitations of our way of knowing the sensible world, this application is most difficult and rarely can we be sure of it. In the inorganic world which is studied by physics and chemistry

(1) - St. Thomas, In De Sensu et Sensato, lect. 1, n. 2.

today and which formerly was studied in the De Coelo et Mundo and the De Generatione et Corruptione, it is practically impossible for the human mind to determine the unum per se with certitude. As was noted in the previous chapter, the proper sensibles probably do not reveal to us the proper accidents of sensible substance and the common sensibles are limited to the field of quantity. Thus direct application of the doctrine of matter and form is most difficult in the inorganic world. It will be noted, too, that Aristotle when he makes the transition from accidental change to substantial change in the First Book of the Physics, turns to the example of living being.(1) In general, it may be said that it is more difficult to apply the general principles to the inorganic world. Nevertheless they may be applied with some generality. Although we do not know particular substantial forms, nevertheless we may establish what would be necessary for substantial change on the inorganic level. In this respect parts of the De Generatione et Corruptione may be helpful.

Although on the level of inorganic being, application of the general principles is less fruitful, on the level of organic being it is most useful. Here the application of general notions is very important. It would be impossible to study adequately the soul, its faculties and their objects were we not in possession of the general

(1) - "But that substances too, and anything else that can be said 'to be' without qualification, come to be from some substratum, will appear on examination. For we find in every case something that underlies from which proceeds that which comes to be; for instance, animals and plants from seed." Physics, I, c. 7, 190 b 1 - 5.

notions of matter, form, privation, nature, motion, action, passion and the other teaching of the Physics. These notions are applied time and again to the realm of quantitative motion.

b. - General Knowledge and Modern Mathematical-Physics.

Thus far we have shown the importance of the general notions of the Physics for all of our knowledge of nature. Here we wish to point out how these general notions might be helpful for mathematical-physics. As was pointed out in the previous chapter, modern mathematical-physics may be characterized by the fact that it concentrates on the common sensibles and that it uses symbols as its form of expression. Although the modern physicist would not consider either of these as steps in concretion from more universal knowledge, nevertheless it would seem that one of the surest ways of approaching a greater understanding of his methods would be for him to consider them as steps in concretion and to compare them to a more general knowledge such as that obtained in the Physics.

The common sensibles may all be reduced to quantity. Quantity is that which has parts outside of parts. Consequently when mathematical-physics concentrates on the common sensibles it concentrates on the quantitative aspects of natural being, on the fact that it has parts outside of parts. This reduces itself to a study of position in time and space. This tendancy has been accentuated by a physics influenced by Cartesian philosophy which has ignored the intrinsic principles of motion. There is no need for act, potency, finality in such a system.

Everything may be explained in terms of position in space and time. In this respect the modern scientist is similar to the ancients who described the universe in terms of causes which are prior in being, that is, those who explained everything in terms of material and efficient causality and who ignored final and formal causality.(1) If the mathematical-physicist wishes to stay within the limits of his own science which describes corporeal being in terms of space and time, he is perfectly correct in saying that the general principles of the Physics are trivial. They are of little help within the realm of symbol and common sensible. Proof of this is the modern scientist himself who quite adept in his own field has no need for these general principles. If, however, the mathematical-physicist wishes to see where his knowledge fits in the entire realm of human knowledge, he must consider something besides the position in space and time and the causes prior in being and must see what other possibilities of causality in nature exist. This is the task of the Second Book of the Physics where Aristotle establishes the existence of final causality in nature. He does not go into the question of the final cause of any particular being but he does show the necessity of final cause in general. Once embarked on the way of common sensibles and symbols, the idea of finality is indeed trivial.

(1) - "Postquam Philosophus ostendit quod Naturalis demonstrat ex omnibus causis; hic manifestat quaedam quae supposuerat, scilicet quod natura agat propter finem, et quod in quibusdam necessarium non sit ex causis prioribus inesse, quae sunt movens et materia, sed ex causis posterioribus, quae sunt forma et finis." St. Thomas, In II Physicorum, lect. 12, n. 486.

The modern scientists are perfectly within their rights when they ignore finality and formal causality. Granted the method they use and the causes in which they are interested, finality would probably confuse the issue. But if beyond ignoring finality, they go further and deny it, then they are mistaken and then, too, they are showing by their error what happens when the natural order of knowledge is ignored. As was mentioned above, science is a work of reason and should consequently be ordered. As was further shown, there is a natural order. If that order is not followed grave consequences can be expected. Now in the natural order of the study of nature, finality should be established in the beginning, then no matter what methods of concretion are used, it will always be remembered though probably not always used. If, however, the general study of nature is ignored and if more concrete methods are employed from the very beginning, the important principles of natural being will be ignored and finally denied. Disorder will lead to positive error.

From another point of view, too, the general notions of the Physics may prove helpful to mathematical-physics. The language of mathematical-physics is the language of symbol. It is not the language of words. The great progress made by modern science has been progress in terms of number, law, theory and symbol. The inorganic world seems impervious to a qualitative study. It is more open to a quantitative study. This is made in terms of measure, number and symbol. Sooner or later, however, the scientist must express himself in words in order to explain the significance of his symbols. Evidence for this

may be seen in the long list of works on the philosophy of science by eminent scientists. Eddington, Einstein, De Broglie, Heisenberg, Oppenheimer have all made the attempt. These attempts must be considered more than mere popularizations. They are attempts at explanation. They are, however, written not with symbols but with words. During the detour by means of common sensibles and symbols, the scientist has no need for words but once he tries to return and to explain, he must have recourse to the proper sensibles and to words. It is only by comparing his symbols with words, his common sensibles with proper sensibles, that the scientist can ultimately explain their significance.

Now the question arises as to where the scientist will learn the meaning of words, the distinction between common and proper sensibles etc. This knowledge is acquired in a study of logic, in a study of the general notions of the Physics and in a study of some of the non-mathematical steps of concretion of natural science. The brief analysis made of 'names' and 'symbols' in the previous chapter was based on the discussion of 'names' as found in the Peri Hermeneias. The very meaning of nature, natural science and middle sciences are discussed in the Physics. The difference between common and proper sensibles is discussed in the De Anima. These are all in a way general knowledge. Each of these treatises may make progress without a slide rule but he who uses the slide rule must know them if he wishes to explain his own investigations.

There is one final word to be said about the relation between

mathematical-physics and the order of concretion. It would seem that the order of mathematical-physics is the exact opposite of the order of concretion. Mathematical-physics goes from particular experiment to law to theory. The order seems to be one of greater and greater generalization. The most general ordering which has been reached to date is that of Einstein's Theory of Relativity. But even this is considered to be subject to greater generalization. Newton's laws of motion which formerly reigned supreme have been superseded by the more general theory of Relativity. This procedure would seem contrary to that of the order of concretion in which we go from the universal to the particular. There is, however, a difference which distinguishes the two procedures and makes them reconcilable. The universal of the order of concretion is the universal in predication. The 'general' of mathematical-physics seems to be more of a dialectic approach to the universal cause. It is not potential. It is not based on a general experience but on long and detailed experiment. Did these experiments reveal differentiating qualities instead of common sensibles, the general theories of scientists would reveal true universal causes. Limited, however, to the quantitative aspects of mobile being, they reveal to us a universality that approaches universal causes asymptotically. These theories and generalities lead us closer and closer to the elements which will be the universal causes but due to the limits of method they never reach them. It remains true nevertheless that the starting point is always the universal in predication.

2. - General Notions and Metaphysics.

In his commentary on the Sixth Book of the Ethics, St. Thomas indicates the order to be followed in education of the young. This order is based on the text in the Ethics where Aristotle shows that young men are capable of studying mathematics but are incapable of studying natural science and metaphysics because these latter require the experience of age.(1) Mathematical objects are intelligible to young men but metaphysical concepts since they transcend the imagination are not. With this text of Aristotle as guide, St. Thomas orders the disciplines.

The first thing to be studied is logic because it teaches the mode of all science. Secondly comes mathematics which does not require long experience and which does not transcend the imagination. Thirdly comes the natural sciences which require experience. Next comes moral science which require both experience and a certain control of the passions. Finally comes metaphysics which transcends the imagination and which requires well developed powers of abstraction.

> Erit ergo congruus ordo addiscendi ut primo quidem pueri logicalibus instruantur, quia logica docet modum totius philosophiae. Secundo autem instruendi sunt in mathematicis quae nec experientia indigent, nec imaginationem

(1) - "Indeed one might ask this question too, why a boy may become a mathematician, but not a philosopher or a physicist. Is it because the objects of mathematics exist by abstraction, while the first principles of these other subjects come from experience, and because young men have no conviction about the latter but merely use the proper language, while the essence of mathematical objects is plain enough to them." Nicomachean Ethics, VI, c. 8, 1142 a 16 - 20.

> transcendunt. Tertio autem in naturalibus; quae etsi non excedunt sensum et imaginationem, requirunt tamen experientiam. Quarto in moralibus quae requirunt experientiam et animum a passionibus liberum, ut in primo habitum est. Quinto autem in sapientalibus et divinis quae transcendunt imaginationem et requirunt validum intellectum. (1)

In this text, St. Thomas gives us but a general idea of the order to be followed and the reason for this order is found in the very nature of the young men. For example, the intellect of a young man is not ready for more abstract considerations because it has not been trained for them both because of lack of time and because of the changes inherent in the process of growing up. "Quia nondum habent intellectum exercitatum ad tales consideratione, tum propter parvitatem temporis, tum propter plurimas mutationes naturae."(2) However, even from this general consideration it is obvious that natural science should precede metaphysics. And even though the general notions of natural science do not require the experience which is given as the reason for its order in the disciplines, nevertheless since the general notions order the experience, they, too, should be considered before metaphysics.

There are, however, further reasons why natural science should precede metaphysics, which reasons are at the root of those given in the commentary on the Ethics and which we shall consider now. These reasons we shall reduce to three. First of all, most of the words used in metaphysics have their first imposition in natural science. Secondly

(1) - St. Thomas, In VI Ethicorum, lect. 7, n. 1211.
(2) - Ibid., n. 1210.

the resolution and demonstration of natural science is a preparation for that of metaphysics. Finally, included in the subject of metaphysics is separated substance, the knowledge of which depends to a great extent on natural science. We shall examine each of these points.

The Fifth Book of the Metaphysics is a study of the meanings of the words which will be used in the study of the subject of metaphysics. There is no resolution or demonstration involved here. It is merely a question of meanings of words. The importance, however, which Aristotle attaches to these meanings is evidenced by the precision with which he determines each word and each imposition. Now, merely from the point of view of imposition of words, the Physics is very important for it is there that these words are first studied. Examples are many, cause, principles, element, nature, motion, passion, action. All of them have already been studied on the level of the Physics. First studied in the Physics, they have been applied with more or less success and certainly with enrichment of meaning throughout the steps of concretion. If the metaphysician is familiar with these first impositions and their applications in the sensible world, he will be that much more ready to use them correctly in his own science where he abstracts from sensible matter. "In rebus ordinatis oportet primum modum includi in secundo."(1)

Not only the words but even the demonstrations and resolution of natural science prepare for metaphysics. It is true that the resolution of natural science is in the senses while that of metaphysics is in the intellect. Since, however, the senses are the permanent principle of our knowledge, resolution in them will be a good preparation for metaphysics. The example was cited above of the use of the words 'act' and 'potency' in natural science and in metaphysics. It is not, however, merely the use of the word which must precede but also a resolution in the senses. It is by such a resolution that the intellect becomes sufficiently exercised in preparation for metaphysics. St. Thomas tells us in the Ethics that the intellect of the young man is not sufficiently exercized for metaphysical considerations. "Quia nondum habent intellectum exercitatum ad tales considerationes."(1) It is natural science which will supply this exercise. And it will be especially the first part of natural science which will be most helpful,in respect, because it is there that are treated the notions which are later treated in metaphysics. Granted the nature of our knowledge, if the resolution has first been made in the senses, there is less danger that later on young men will use the words without understanding them. "Non attingunt mente, licet dicant ore."(2)

It is the task of metaphysics to consider those things which do not come under the consideration of particular sciences. Thus it has as its subject ens commune and those things which follow immediately on it such as the one and the many, act and potency. Further it is the task of metaphysics to consider the separated substances which

(1) - St. Thomas, De Veritate, loc. cit.

(1) - St. Thomas, In VI Ethicorum, loc. cit.
(2) - Ibid.

transcend the study of any of the particular science. Thus it is that in the Eleventh Book of the Metaphysics, Aristotle begins his consideration of the separated substances.

> Quia particulares scientiae quaedam eorum quae perscrutatione indigent praetermittunt, necesse fuit quamdam scientiam esse universalem et primam, quae perscrutetur ea, de quibus particulares scientiae non considerant. Hujusmodi autem videntur esse tam communia quae sequuntur ens commune (de quibus nulla scientia particularis considerat, cum non magis ad unam pertineant quam ad aliam, sed ad omnes communiter), quam etiam substantiae separatae, quae excedunt considerationem omnium particularium scientiarum. (1)

Aristotle places the study of the separated substances at the end of the Metaphysics for it is toward knowledge of these that is ordered the knowledge of the Metaphysics and all of the knowledge gathered in the particular sciences. Thus, before studying them in the Twelfth Book, he summarizes the findings of the particular sciences.

> Et ideo Aristoteles hujusmodi scientiam nobis tradens, postquam perscrutatus est de communibus, accedit ad tractandum specialiter de substantiis separatis, ad quarum cognitionem ordinantur non solum ea quae in hac scientia tractata sunt, sed etiam quae in aliis scientiis tractantur.
>
> Et ideo ad manifestiorem considerationem de substantiis separatis habendam primo sub quodam compendio recolligit ea quae dicta sunt tam in hoc libro, quam in libro Physicorum, utilia ad cognitionem separatarum. (2)

However, in the present state of human knowledge there is no strict science of separated substances because their essences are unknowable to the human intellect. They are attainable by the ways of

(1) - St. Thomas, In XI Metaphysicorum, lect. 1, n. 2146.
(2) - Ibid.

causality, negation and eminence.(1) Beginning with a confused knowledge, that is, with the quid nominis, the human intellect is capable of proving the existence of separated substance by its effects in this world. The demonstration is demonstration of the fact (demonstratio quia). Further determination of the essence by means of contraction of a genus to its species by the differences is impossible for the separated substances are in no natural genus but merely in a logical genus. Nor is it possible to determine the essence of separated substances by their accidents. First of all, God has no accidents and secondly the accidents of other separated substances are unknowable to us. Granted, then, knowledge of the existence of separated substances, how may the human intellect proceed from confused knowledge to distinct ?
St. Thomas gives a brief but clear answer to this question. In place of contraction of genus by differences, there is a clarification of confused knowledge by means of negation. Thus, separated substances are called immaterial, incorporeal, infinite. The way is a way of negation in which are denied the imperfections of corporeal substance.

> sed loco cognitionis generis habemus in istis substantiis cognitionem per negationes, ut cum scimus quod hujusmodi substantiae sunt immateriales et incorporeae, non habentes figuras et alia hujusmodi. (2)

In place of knowledge by accidents there is knowledge by relation to sensible substance whether that relation be one of causality or comparison according to excess.

(1) - St. Thomas, Expositio in Boethium de Trinitate, q. VI, a. 2.
(2) - Ibid., a. 3.

> Loco autem accidentium habemus in substantiis praedictis habitudines earum ad substantias sensibiles vel secundum comparationem causae ad effectum vel secundum comparationem excessus. (1)

Concerning the way of negation, it should be noted that the more one knows negations, the more distinct becomes the knowledge. It is analogous to the process by which the mind proceeds from remote genus through many differences to the infima species.

> Et quanto plures negationes de eis cognoscimus, tanto minus confusa est earum cognitio nobis, eo quod per negationes sequentes prior negatio contrahitur et determinatur, sicut genus remotum per differentias. (2)

Since knowledge of the separated substances depends on negations, it is obvious that this knowledge will be more distinct according as the knowledge of that which is denied is more distinct. Negation may be of two kinds. First of all, there is negation of a name of which is had only a confused knowledge. Secondly, there is negation of a name of which the definition is known. This distinction is based on the distinction of name and definition as explained by St. Thomas at the end of the first lesson of his commentary on the Physics.(3) The first apprehension of the name 'man' involves only a confused knowledge. Further investigation will reveal the parts of the definition. If that which is denied of the separated substances is merely a name which rests in confusion, not very much is known. If, however, that which is

(1) - St. Thomas, Expositio in Boethium de Trinitate, q. VI, art. 3.
(2) - Ibid.
(3) - St. Thomas, In I Physicorum, lect. 1, n. 26.

denied is known clearly and distinctly, the knowledge of the separated substances is that much more perfect. For example, separated substances are incorporeal. What does this mean ? If only a nominal definition of body (corpus) is possessed the corresponding negation is not very revealing. If, however, the nature of body has been studied as in the Sixth Book of the Physics, the knowledge is that much more distinct. Further, the more that is known about sensible substances, the more can be denied when the considerations turn toward the separated substances. A striking example of this is St. Thomas's treatment of the infinity of God in the Summa Theologica.(1) His treatment there will be understood only in terms of the treatment of infinity in the Third Book of the Physics. That is the starting point for his discussion. From what has been said, it should be obvious how necessary is an organized knowledge of sensible substance for knowledge of separated substance. It is in the Physics that this knowledge is organized.

It would be wrong, however, to say that before metaphysics is possible, it is necessary to have completely exhausted the study of sensible substance. Were this true, there would be no metaphysics since the study of sensible being approaches some sort of infinity in so far as the elements of nature are approached asymptotically by a form of dialectic. What is necessary before metaphysics, is a consideration of the general notions of the Physics and some applications in the order of concretion.

(1) - Summa Theologica, Ia, q. 7.

It is not only the way of negation which is aided by knowledge of sensible substance but also the way of causality. The better we know that which has been caused, the better will we know the cause. Thus Aristotle will push his investigation of nature to the humblest members of the animal kingdom for the simple reason that they reveal to us the artist who made them.

> Having already treated of the celestial world, as far as our conjectures could reach, we proceed to treat of animals, without omitting, to the best of our ability, any member of the kingdom, however ignoble. For if some have no graces to charm the sense, yet even these, by disclosing to intellectual perception the artistic spirit that designed them, give immense pleasure to all who can trace links of causation, and are inclined to philosophy. (1)

Here, Aristotle is speaking of the more concrete parts of natural science rather than of the common and general notions. However, it is in the general part that the concrete parts are organized and it is in the general section that we learn of the finality in nature and of the unmoved mover.

This dependance of metaphysics on natural science in the order of learning in no way is contrary to the fact that it is metaphysics which proves the principles of natural science. It is the function of Wisdom to defend the principles of the particular sciences and consequently it defends the principles of natural science. However, those principles of natural science which metaphysics uses are not dependant on

(1) - De Partibus Animalium, I, c. 5, 645 a 4 - 11.

metaphysics but are per se nota. Further, the principles by which metaphysics defends the principles of natural science, in no way depend on natural science. They are per se nota to the metaphysician. Thus there is no vicious circle. The order, however, in which they are to be studied requires that natural science precede metaphysics.

> Nec tamen oportet quod sit circulus, quia ipsa supponit ea, quae in aliis probantur, cum ipsa aliarum principia probet, quia principia quae accipit alia scientia, scilicet naturalis, a prima philosophia, non probent ea quae idem philosophus primus accipit a naturali, sed probantur per alia principia per se nota; et similiter philosophus primus non probat principia, quae tradit naturali, per principia quae ab eo accipit, sed per alia principia per se nota. Et sic non est aliquis circulus in definitione. (1)

(1) - St. Thomas, Expositio in Boethium de Trinitate, q. V, a. 1, ad 9.

method. My method invariably is to start from something vague but puzzling, something which seems indubitable but which I cannot express with any precision. I go through a process which is like that of first seeing something with the naked eye and then examining it through a microscope. I find that by fixity of attention division and distinctions appear where none at first was visible, just as through a microscope you can see the bacilli in impure water which without the microscope are not discernible. There are many who decry analysis, but it has seemed to me evident, as in the case of the impure water, that analysis gives new knowledge without destroying any of the previously existing knowledge. This applies not only to the structure of physical things, but quite as much to concepts. "Knowledge," for example, as commonly used is a very imprecise term covering a number of different things and a number of stages from certainty to slight probability.

It seems to me that philosophical investigation, as far as I have experience of it, starts from that curious and unsatisfactory state of mind in which one feels complete certainty without being able to say what one is certain of. The process that results from prolonged attention is just like that of watching an object approaching through a thick fog : at first it is only a vague darkness, but as it approaches articulations appear and one discovers that it is a man or a woman, or a horse or a cow or what not. It seems to me that those who object to analysis would wish us to be content with the initial dark blur. Belief in the above process is my strongest and most unshakable prejudice as regards the methods of philosophical investigation.[1]

The similarity between this passage and the *Prooemium* of the *Physics* is evident. However, although it is evident, it should not surprise us. For as Aristotle says, this method of proceeding from the confused to the distinct is 'natural' to us. Perhaps, it is precisely because it is 'natural' to us, that for Russell it is the most important and unshakable of philosophic prejudices.

It should be noted that Russell not only tells us that the process is from the vague to the distinct but that the certainty with which one begins is not destroyed by subsequent discovery. This is a very important point which we shall discuss more at length in another article.

The general notions with which Aristotle begins his study of nature are certain. Later discoveries do not destroy them. The truth of what is proposed in the *Physics*, is in no way compromised by errors which may arise in the steps in concretion nor by the new truths which may be found in these steps. The certainty of general knowledge in no way depends on what further investigation reveals. This, I think, is a very important principle to be remembered when one is discussing the relationship between the traditional philosophy of

1. Bertrand Russell, "My Philosophical Development," in *Encounter*, February, 1959, Vol.XII, n.2, p.25.

nature and modern science, and it is a principle to which I think Russell would adhere.

It is interesting to note, too, that just as Aristotle concludes his *Prooemium* with three signs which manifest the general principles, Russell concludes his comment on this the sixth of his philosophical prejudices with the example of somebody coming out of a fog. Had Aristotle been familiar with the London fog, he probably would have used the same example.[1]

CONCLUSION

In the *Prooemium* to the *Physics*, Aristotle tells us that it is *natural* for us to proceed from that which is more known to us toward that which is more knowable in itself. He then points out that that which is more known to us, is a confused whole, a universal and that we proceed from this to that which is distinct, the particular. By way of conclusion to this article we shall make some remarks not on the process itself but on the fact that it is *natural*.

If it is natural for the human mind to proceed from the general and confused, any departure from this procedure will be unnatural. Further, this unnatural procedure will come at a time when it can have very grave consequences for it comes at the beginning, at the starting point. As Aristotle points out in the *De Coelo et Mundo*, a small error in the beginning is multiplied ten thousand times as the process continues. "Since the least initial deviation from the truth is multiplied later a thousandfold." [2] The reason for this is that "a principle is great rather in power than in extent ; hence that which was small at the start turns out a giant at the end." [3] St. Thomas in his commentary on this passage compares the principle to the seed which grows into a tree.[4] Small error at the starting point can involve great error at the end.

The starting point for human knowledge is the universal in predication. It is not the universal cause nor is it the universal in representation. This is due to the fact that knowledge has the senses as its abiding principle. Since, however, the most perfect form of human knowledge is the scientific demonstration and since demonstration involves a resolution into first principles, there is always the temp-

1. *Signum*, as well as *exemplum*, is a type of argument. The difference between these and their respective values, is a rather subtle one. We shall have occasion to return to these subject elsewhere.

2. *De Coelo et Mundo*, I, chap.5, 271 b 9.

3. *Ibid.*

4. "Et hujus causa est, quia principium, etsi sit modicum magnitudine, est tamen magnum virtute, sicut ex modico semine producitur magna arbor : et inde est quod illud quod est modicum in principio, in fine multiplicatur, quia pertingit ad totum id ad quod se extendit virtus principii, sive hoc sit verum sive falsum." St. Thomas, *In I De Coelo et Mundo*, lect.9, n.97.

tation for the human mind to seek as its starting point a universal cause. In the *De Veritate*, St. Thomas points out that prophetic knowledge cannot be a *habitus* in the strict sense because it cannot be resolved into first principles. The object of prophetic knowledge is the future contingent which can only be resolved in the essence of God. Since the prophet cannot make this resolution, his knowledge is not a *habitus*. As long as human knowledge is not resolved into its principles, the knowledge is not confirmed in one, consequently there rests but probability. "Quamdiu enim non fit resolutio cognitorum in sua principia, cognitio non *firmatur in uno*, sed apprehendit ea quae cognoscit secundum probabilitatem quamdam utpote ab aliis dicta."[1] The words '*firmatur in uno*' in this text correspond to the '*ἐπίστασθαι*' of the first sentence of the *Physics*. "The terms 'knowing' and 'understanding' imply that the intellect has reached a state of rest and come to a standstill."[2] The resolution of mathematics is in the imagination. The resolution of natural science is in the senses and that of metaphysics is in the intellect. The ultimate resolution of all science is in the principles of being, consequently mathematics and natural science await for their ultimate resolution in metaphysics. It is metaphysics which orders all. "*Nam sapientis est alios ordinare.*"[3] And it is metaphysics which is the ultimate judge. Judgment is imperfect till it has been resolved in the ultimate principles.

Est autem considerandum quod in omni judicio ultima sententia pertinet ad supremum judicatorium ; sicut videmus in speculativis quod ultima sententia de aliqua propositione datur per resolutionem ad prima principia. Quandiu enim remanet aliquod principium altius, adhuc per ipsum potest examinari id de quo quaeritur ; unde adhuc est suspensum judicium, quasi nondum data finali sententia.[4]

It would be a mistake to think that since the ultimate resolution is in metaphysics, human science should begin with it. The unity of sciences will be found in metaphysics but before arriving at metaphysics, the human mind because of its extrinsic dependance on matter must be satisfied with an inferior unity, the unity of the universal in predication. Beginning with this unity which comes by an abstraction from the given of sensation, the human intellect proceeds by way of concretion toward more distinct knowledge of the sensible world. It then proceeds by way of demonstration of the fact (*demonstratio quia*) toward the separated substances and an analysis of being as such. It is here that the final resolution takes place. But this is not the starting point.

1. St. Thomas, *De Veritate*, q.12, a.1.
2. *Physics*, VII, chap.3, 247 b 10.
3. St. Thomas, *In I Metaphysicorum, Prooemium.*
4. *Ia IIae*, q.74, a.6.

And if the starting point is not the universal causes neither is it a detailed knowledge of sensible substance. Detailed knowledge as detailed is but fragmentary and is unintelligible except in terms of broader categories. The broader categories are not the universal causes but rather the general notions of the *Physics* with which Aristotle begins his natural science and for that matter all of his science in so far as logic is not considered as science but rather the instrument of science.

In a further article we shall continue the discussion of the order to be followed in natural science by pointing out both the certitude and importance of general and confused knowledge.

George J. McMahon, s.j.