ACKNOWLEDGEMENTS

I wish to thank several people who, through their assistance, have contributed to the completion of this essay. Professor Désirée Park who directed this work, inspired my interest in Empiricism in the first place. She provided clear, patient and valuable help throughout the writing of the thesis. She carefully read several versions of this essay and was instrumental in acquiring copies of rare papers which appear in Appendix I and II. I am most grateful for her support.

I also wish to thank the Bodleian Library, Oxford, for permission to quote from their Locke manuscript in Appendix I.

I am grateful to Professor Martin Reidy for helpful remarks. Professor William Shea of McGill University's Philosophy Department and Professor Paul Widdows of Concordia University's Classics Department, both assisted in referring me to appropriate texts. Maria Murphy, Supervisor of Interlibrary Loans and Reference at Georges P. Vanier Library helped me to acquire research material which is normally inaccessible. Professor Raymond Klibansky's assistance in providing the material appearing in Appendix II is also appreciated.

Also I am grateful to all my teachers and fellow students at Concordia University who provided personal encouragement through their expressed concern and lively discussions; among them Michael Assels, Earl Darlington, Grell Grant and Constance Groulx.

Finally, I wish to thank Mrs. Granich for preparing the final typed version of this thesis with attentiveness and skill. I thank the Hellenic Students' Association of Concordia University for permitting me to use their Greek typewriter.

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PREFACE

When John Locke made that incisive distinction between primary and secondary qualities he resurrected a very ancient philosophical question that had plagued the Greeks. The question is a familiar one: what is the relationship between appearance and reality? Since the seventeenth century this question has undergone a number of revisions and refinements in form, such as 'What is the relationship between the known and the knower?'; 'What is the relationship between ideas and objects?'. Whatever form the question took, its significance remained the same. The question in fact conceals an assumption about the world. It assumes that there is a distinction between the knower and the known, the idea and the object, the appearance of things as we see them and the nature of things as they exist in themselves. The question invites us to explain the nature of reality, to describe the nature of our knowledge and finally, to arrive at some satisfactory connection between the two. Some have maintained that this is a futile endeavour because a distinction between ideas and the external world is a conceptual distinction to begin with and such distinctions cannot be judged true or false by any other means than consistency. An objective criterion becomes necessary, but is impossible to attain because of our subjectivity. Others have held the position that there is a world which is different from our complex of ideas and that this world does provide verification to claims such as 'The sun is causally related to my perception of it'. This was the position that John Locke took. Those who addressed themselves to this position did so by developing

philosophical systems which either explained natural phenomena or analyzed the processes involved in human knowing or both. The Milesians were concerned primarily with discovering the natural principles which governed the mechanics of the universe. They developed the theory of atoms as a consequence. Locke was concerned with developing a philosophical system which described the principles governing human thought. He was also interested in an explanation of the physical world, but he did not need to build a philosophical system to do this. The 'master-builders' like Sir Robert Boyle and the Greek materialists had done the job for him with that invaluable theory — 'the corpuscular hypothesis'. The task that remained for the philosopher was that of linking science with epistemology, and Locke introduced the primary/secondary quality distinction as a theory which was capable of answering questions pertaining to the perceiver as well as those pertaining to the perceived.

My task in this thesis will be to place Locke in such a historical perspective that his primary/secondary quality distinction can be seen as an outcome of the available scientific knowledge of his time. Criticisms of the distinction will be reviewed and considered in the last section of the thesis.

To accomplish this objective we must explore the following issues: we must examine the 'corpuscular hypothesis' and trace its development from the Ancients to the seventeenth century. This comprises the first and second chapters of the thesis. The second chapter also examines Boyle's influence on Locke's theory of knowledge and how the corpuscular hypothesis gave rise to the primary/secondary quality distinction. The third chapter cites Locke's distinction and argues that the distinction

was supported by Locke on the basis of seventeenth-century scientific premises. Finally, the fourth chapter reviews a number of contemporary articles which relate to my own thesis about Locke's distinction.

Appendices I and II are designed to provide some of the empirical evidence available for the belief that Locke and Boyle were intellectually acquainted.

CHAPTER I

THE ATOMIST TRADITION

The atomic theory of matter was developed and exploited during an intellectual climate of scientific curiosity. Two periods in the history of philosophy are marked by this common interest. During the pre-Socratic era the metaphysical questions of 'how things come to be' and 'how things pass away' led some thinkers to seek an answer in atomism. After the age of Epicurus, scientific stagnation resulting from a zealous concern with the prospects of salvation and the origin of sin, led thinkers to wonder about 'how man comes to be' and 'what happens to man when he passes away'. Great concern developed about man's relationship to God, and man's relationship to the physical world was not considered so important. The seventeenth century brought with it a revived interest in science complemented by the view that man is subject to the laws of nature.

This new perspective allowed the Greek atomic theory to play a significant role in metaphysics once again. It also raised certain epistemological questions within the context of the atomic theory of matter. The primary/secondary quality distinction may be viewed historically, as a result of such metaphysical and epistemological inquiries.

In the first and second chapters I will trace the development of the atomic theory of matter (sometimes referred to by the 17th century term 'the corpuscular hypothesis') from the pre-Socratic era to

seventeenth-century philosophy. This will be done in order to provide the reader with an idea of the type of philosophical questions which the Greek and Roman philosophers of nature raised and how these questions persisted in seventeenth-century thought. The second objective is to show how the primary/secondary quality distinction was borne by the epistemological consequences and metaphysical assumptions inherent in the corpuscular hypothesis.

The corpuscular-kinetic theory or corpuscular hypothesis is that theory of nature which reduces all phenomena to two great principles of the universe — matter and motion. It is asserted by those who adhere to this theory that the universe is composed of minute imperceptible, innumerable and material particles which are constantly in motion.

The origin of the atomic theory can be traced to the philosophers Leucippus, Democritus, Epicurus and Lucretius. The founder of the atomic theory is believed to be Leucippus although very little is known about him and his writings have been lost. What we do know about him is acquired from the writings of Democritus. Democritus was born about 460 B.C. and resided in Abdera in Thrace, where he founded a school (it is said to have been in his garden). He was a contemporary of Socrates and the Sophists, but not very well known in Athens. His materialist philosophy was disliked by Plato despite the fact that he was known to Aristotle and Diogenes Laertius as a great mathematician and naturalist.

Epicurus (341-270 B.C.) founded a school in Athens and incorporated the atomic theory of Democritus into his own writings. Diogenes Laertius who wrote Lives of Eminent Philosophers, devoted one chapter to Epicurus, providing invaluable information to scholars. Lucretius was a

student of Epicurus and the author of the poem On the Nature of Things, which expresses the philosophy of Epicurus.

Section 1 — Greek Atomism

Let us now turn our attention to these philosophers and their speculations on the nature of matter. From fragments of writing, we know that for Democritus, the universe is composed of an infinite number of self-moving, qualitatively similar atoms and empty space. Every event is caused by atomic motion. Parmenides had rejected the concept of empty space or κενόν on the grounds that to say there exists space as a void is a paradox and a contradiction in itself:

> ... For thou couldst not know that which is — not (that is impossible) nor utter it; for the same thing can be thought as can be ....[1]

An important premise in this argument concerns the type of connection between Thought and Being. Thinking has Being for its content and has no content if there is no Being. Therefore non-Being cannot be thought or spoken of. Parmenides thought it tautological that that which is not, the void, cannot be; because he believed that one can think of things only as existing. Thus, while it may not be true that one can think of only those things that exist, it may, on the other hand, be true that one can think of things only as existing.

The manner in which Democritus employed the term 'void' does not

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[1] Parmenides, "The Way of Truth," translated by Zeller (after Diels) in The Presocratic Philosophers (Cambridge: Cambridge University Press, 1960), p. 269.
...οὔτε γὰρ ἂν γνοίη τό γε μὴ ἐὸν (οὐ γὰρ ἀνυστόν) οὔτε φράσαις , τὸ γὰρ αὐτό νοεῖν ἐστιν τε καὶ εἶναι....

suggest that he thought of it as a thing to which we could ascribe qualities and attributes, but rather as a hypothetical construct which was useful for describing the motion of bodies. It was κενόν (void); a kind of receptacle or background in which bodies move and parasitical for its existence on these bodies. This treatment of the void may be seen as a result of the fundamental difference in ontology between the Monists and the Pluralists. Being, which was originally defined by Parmenides as unchangeable, homogenous, indivisible and the content of thought, came to be identified with corporeal actuality by the Pluralists. The Eleatics spoke of Being as One, where the ὄν (Being) coincides with the πλέον (plenum) and the μη ὄν (non-Being) with the κενόν (void). Being as One is reality and truth; and apparent plurality, motion and change are illusion. Now the Eleatics did not wish to concern themselves with that which is false and they considered talking about nothing as fruitless. Hence the κενόν was an unnecessary and superfluous notion, used only as an example of absurdity in arguments with the Atomists when folly led them to entertain the idea of Being as anything but the One. But entertain this idea they did, and they reduced Being to two arch-principles — matter and void:

> His [Democritus'] opinions are these. The first principles of the universe are atoms and empty space; everything else is merely thought to exist ....[2]

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[2]Diogenes Laertius' historical collection, Lives of Eminent Philosophers, Vol. II, translated by R. D. Hicks (Cambridge, Mass.: Loeb Classical Library, Harvard University Press, 1965), pp. 452-453. Δοκεῖ δ'αὐτῷ τάδε· ἀρχὰς εἶναι τῶν ὅλων ἀτόμους καὶ κενόν, τὰ δ'ἄλλα πάντα νενομίσθαι ....

Furthermore, they wished to explain what matter is and how it moves:

> ... the whole of being consists of bodies and space. For the existence of bodies is everywhere attested by sense itself, and it is upon sensation that reason must rely when it attempts to infer the unknown from the known ... of bodies some are composite, others the elements of which these composite bodies are made. These elements are indivisible and unchangeable, and necessarily so, if things are not all to be destroyed and pass into non-existence, but are to be strong enough to endure when the composite bodies are broken up, because they possess a solid nature and are incapable of being anywhere or anyhow dissolved. It follows that the first beginnings must be indivisible, corporeal entities.[3] [Epicurus]

Epicurus thought that we know that matter exists because the senses provide us with information which leads us to infer that it exists, and he also thought that matter is necessarily constituted of atoms.

Democritus explained motion by referring to the principle of the vortex which he thought was the necessary cause of motion:

> All things happen by virtue of necessity, the vortex being the cause of the creation of all things, and this he calls necessity ....[4] [Democritus]

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3 ...τὸ πᾶν ἐστι σώματα καὶ κενόν· σώματα μὲν γὰρ ὡ ἔστιν, αὐτὴ ἡ αἴσθησις ἐπὶ πάντων μαρτυρεῖ, καθ' ἣν ἀναγκαῖον το ἄδηλον τῷ λογισμῷ τεκμαίρεσθαι... σωμάτων τὰ μέν ἐστι συγκρίσεις, τα δ' ἐξ ὧν αἱ συγκρίσεις πεποίηνται· ταῦτα δέ ἐστιν ἄτομα καί ἀμετάβλητα, εἴπερ μὴ μέλλει πάντα εἰς τὸ μὴ ὄν φθαρήσεσθαι, ἀλλ' ἰσχύοντα ὑπομένειν εν ταῖς διαλύσεσι τῶν συγκρίσεων, πλὴρη τὴν φύσιν ὄντα, ῥῖα δὴ οὐκ ἔχοντα ὅπη ἢ ὅπως διαλυθήσεται· ὥστε τὰς ἀρχὰς ἀτόμους ἀναγκαῖον εἶναι σωμάτων φύσεις·

Ibid., Vol. II, pp. 569-571.

4 Πάντα τε κατ' ἀνάγκην γίνεσθαι, τῆς δίνης αἰτίας οὔσης τῆς γενέσεως πάντων, ἣν ἀνάγκην λέγει....

Ibid., p. 455.

In contrast to Monism, the pluralistic concept of Being made the notion of a void a necessary presupposition; for the Atomists now had to speak of bodies moving in space.

The atoms themselves were considered to be indivisible and infinite in number. Their form (σχῆμα or ἰδέα) is what distinguishes them from one another.[5] It is interesting to note that Democritus distinguishes between the heaviness and lightness of atoms according to their size. Theophrastus writes that:

> Heaviness and lightness, to begin with, Democritus distinguishes in terms of size. For if we were to divide each substance into its ‹atomic› units, then even though these were to differ in shape, he contends, their reality would have as its standard ‹of weight› their size ....[6]

In the case of compounds, however, lightness and heaviness is determined by the degree of void contained in a compound:

> In the case of compounds, on the contrary, a substance that contains more of void is lighter; one that contains less is heavier. This at least is what he says in certain passages. In others, he holds that it is simply its fineness that makes a substance light.[7]

What is significant about this point is the apparent absence of the

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[5] Aristotle, The Physics, 2 Vols., translated by Philip H. Wicksteed and Francis M. Cornford (Cambridge, Mass.: Loeb Classical Library, Harvard University Press, 1957), Vol. I, pp. 15, 51.

[6] Βαρὺ μὲν οὖν καὶ κοῦφον τῷ μεγέθει διαιρεῖ Δ η μ ό κ ρ ι τ ο ς· εἰ γὰρ διακριθείη καθ' ἕν ἕκαστον, εἰ καὶ κατὰ σχῆμα διαφέροι, σταθμὸν ἂν ἐπι μεγέθει τὴν φύσιν ἔχειν.

Theophrastus and the Greek Physiological Psychology Before Aristotle, translated by George Malcolm Stratton, unchanged reprint of 1917 edition (Chicago: George Allen and Unwin Ltd., Argonaut, Inc., 1917), pp. 120-121.

[7] οὐ μὴν ἀλλ' ἔν γε τοῖς μεικτοῖς κουφότερον μὲν εἶναι τὸ πλέον ἔχον κενόν, βαρύτερον δὲ τὸ ἔλαττον. ἐν ἐνίοις μὲν οὕτως εἴρηκεν. ἐν ἄλλοις δὲ κοῦφον εἶναί φησιν ἁπλῶς τὸ λεπτόν.

Ibid.

notion of mass.[8]

I suggest that Democritus did mean that atoms are indivisible because there is no void in them. But the phrase 'more or less void' must be carefully apprehended. In his terms, 'contains more or less void' could be understood to mean that atoms occupy more or less space. The lighter atoms would occupy less space than the heavier ones. This is consistent with what has already been mentioned about the way in which Democritus spoke of the void; only in the sense of a space or background in which atoms can move. The atoms themselves are the opposite of void and thus cannot 'contain void' per se. The void was, for the Atomists, a necessary conceptual scheme in explaining the motion of atoms. The Eleatics, on the other hand, considered Being as unchangeable and because of this, motion was a paradox. Thus they did not require the idea of the void to explain how or where atoms changed their position. Furthermore, the Eleatics taught that the senses are

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[8] It is questionable that the Greeks had a word for the modern notion of mass. Max Jammer, in his book Concepts of Mass in Classical and Modern Physics (Cambridge, Mass.: Harvard University Press, 1961), pp. 7-15, traces the etymology of the word "mass" and informs us that the word most likely originates from the Greek word μᾶζα meaning barley cake or possibly from the Hebrew mazza (which means unleavened bread). But the current notion of mass as quantitas materiae or inertial mass does not come from the Greeks at all, but originates in the thirteenth century and the theological attempt to explain the Eucharistic transubstantiation of the Holy Bread.

The historical predecessor to the concept of mass was weight and volume. But the Greeks did not consider weight as a universal quantity or force proportional to the quantity of matter. Rather, it was seen as an inconstant property of bodies. For example, an atomist would not be surprised if the same piece of bread cost more from one day to the next solely on the basis of the fluffiness of the bread. There were attempts by Lucretius and the Stoics to make weight a universal attribute of matter, but such an idea never became a canon in Greek thinking. Consequently, we find an approximation of the notion of mass in the Greek notion of size and indivisibility.

deceptive. This led them to reject 'motion' as a real thing because it was witnessed by the senses.

The Atomists, however, believed that there was nothing illusory about motion and that perceived qualities of things are due to the effects of motion. At the same time, they did not believe that sensible qualities reflected the real essence of things, but only a relative reality which was nonetheless a necessary result of the basic essence of things. This relativistic outlook came from the perceptual theory of Protagoras and the empirical approach of the Milesians. It is at this point in the history of the Greeks that the genesis of the distinction between primary and secondary qualities took place.

Faced with the distinction between the Real and the less Real, Democritus had to describe what was real and what was less real. The real qualities of things, he considered to be spatial form, weight, solidity and hardness. Weight or βάρος signifies movableness of matter. Solidity and hardness depend on the distribution of matter and space. These qualities were said to belong to things in themselves. All other qualities can only properly be spoken of as belonging to things insofar as they affect the perceiving subject. Sense perception, which was also taken to be a configuration of atoms, was assumed to be receptive to certain combinations (for Epicurus, it was films surrounding the atoms) of atoms. Sensible qualities such as colour, taste, odour and texture were considered to be the effect of the interaction between the atoms and our senses. According to Democritus then, our sensory knowledge is limited to the effects of atoms on our senses. A sensible object,

> ... "by convention," he says, "is sweet, by convention bitter, by convention hot, by convention cold, by convention colour; but by verity atoms and void." (This means: Sensible objects are conventionally assumed and opined to exist, but they do not truly exist, but only the atoms and the void.) ... "But we in reality comprehend nothing invariable, but what shifts about according to the disposition of the body and of the things which enter into it and the things which oppose it ...."[9] [Democritus]

Sensation of colour, odour, texture, sound and taste is explained by referring to an interaction between the atoms of the soul, which were the finest in shape and size, and the atoms constituting objects. The way in which the senses react to this interaction is limited, selective and not indicative of things themselves. This seems to suggest that in order to get at the real essence of things, we should not rely on the senses but perhaps on the intellect:

> ... He expressly declares -- "Of knowledge there are two forms, the genuine and the bastard; and to the bastard belong all these — sight, hearing, smell, taste, touch; but the other form is distinct from this and genuine." Then, while thus preferring the genuine to the bastard, he proceeds: "Whenever the bastard kind is unable any longer to see what has become too small, or to hear or smell or taste or perceive it by touch, (one must have recourse to) another and finer (instrument) ..."[10]

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9 ..."νόμῳ" γάρ φησι "γλυκὺ καὶ νόμῳ πικρόν, νόμῳ θερμόν, νόμῳ ψυχρόν, νόμῳ χροιή· ἐτεῇ δὲ ἄτομα καὶ κενόν." ὅπερ ἐστι, νομίζεται μὲν εἶναι καὶ δοξάζεται τὰ αἰσθητά, οὐκ ἔστι δὲ κατ' ἀλήθειαν ταῦτα, ἄλλα τὰ ἄτομα μόνον καὶ τὸ κενόν...."ἡμεῖς δὲ τῷ μὲν ἐόντι οὐδὲν ἀτρεκὲς συνίεμεν, μεταπῖπτον δὲ κατά τε σώματος διαθήκην καὶ τῶν ἐπεισιόντων καὶ τῶν ἀντιστηριζόντων...."

Democritus in Sextus Empiricus, Against the Logicians, translated by The Reverend R. G. Bury (Cambridge, Mass.: Loeb Classical Library, Harvard University Press, 1957), Vol. II, pp. 74-75.

10 ...λέγει δὲ κατὰ λέξιν "γνώμης δὲ δύο εἰσὶν ἰδέαι, ἡ μὲν γνησίη ἡ δὲ σκοτίη· καὶ σκοτίης μὲν τάδε σύμπαντα, ὄψις ἀκοὴ ὀδμὴ γεῦσις ψαῦσις, ἡ δὲ γνησίη, ἀποκεκριμένη δὲ ταύτης." εἶτα προκρίνων τῆς σκοτίης τὴν γνησίην ἐπιφέρει λέγων "ὅταν ἡ σκοτίη μηκέτι δύναται μήτε ὁρῆν ἐπ' ἔλαττον μήτε ἀκούειν μήτε ὀδμᾶσθαι μήτε γεύεσθαι μήτε ἐν τῇ φαύσει αἰσθάνεσθαι, ἀλλ' ἐπι λεπτότερον."...

Ibid., pp. 76-79.

It is difficult to ascertain how exactly Democritus thought we could acquire 'genuine knowledge' about atoms. This passage suggests that the real nature of atoms could be revealed if only we had the power to 'see more minutely'. However, since sensory knowledge is limited, Democritus must have thought that we must rely on rational inference to determine the nature of the atoms.

Section 2 — Lucretius

Lucretius, in expressing the Epicurean philosophy, is much more definite on the matter of 'genuine knowledge'. In his poem De Rerum Natura, he takes the view that certainty begins with sensation and that sensation, not judgement, is the criterion of truth.

> ... You will find that it is from the senses in the first instance that the concept of truth has come, and that the senses cannot be refuted. For some standard must be found of greater credit, able of itself to refute false things by true. What, moreover, must be held to be of greater credit than the senses? Or shall reasoning, derived from false sense, prevail against the senses, being itself wholly derived from the senses? For unless they be true, all reasoning is false ....[11]

If the senses cannot provide us with the criterion of truth, then we must rely on something else. We may rely on concepts or judgements, but because these are generated by sensation, if sensation is false then that falsity will be inherited by the concepts and the judgement.

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[11] Lucretius, De Rerum Natura, translated by W. H. D. Rouse (Cambridge, Mass.: Harvard University Press, 1974), Book IV, pp. 282-283.

> ... invenies primis ab sensibus esse creatam notitiem veri neque sensus posse refelli. nam maiore fide debet reperirier illud, sponte sua veris quod possit vincere falsa. quid maiore fide porro quam sensus haberi debet? an ab sensu falso ratio orta valebit dicere eos contra, quae tota ab sensibus orta est? qui nisi sunt veri, ratio quoque falsa fit omnis ....

This is the Epicurean argument for referring to sense-knowledge as the basic criterion for all knowledge.

There is the question, 'Why do Epicurus and Lucretius consider sense-knowledge irrefutable?' To answer it, we must deviate a little from this argument. The Epicureans accepted the Democritean theory of εἴδωλα (images). This theory explains the mechanics of perception by referring to films which are continuously emanating from objects and touching the sense organs. It is a very primitive sort of isomorphism and very useful in accounting for the claim that the senses are the criterion of truth.

The theory of εἴδωλα is also used in accounting for the imperceptibility of atoms. Lucretius reports that atoms are imperceptible for reasons of fact. We cannot see atoms. How then do we know of their existence and their nature? Concerning their existence, Lucretius gives two reasons. The one is no more than an appeal to the Epicurean doctrine that there are material bodies because nothing comes from nothing,

> Now mark me: since I have taught that things cannot be created from nothing and when brought forth cannot be brought back to nothing, that you may not by any chance begin nevertheless to distrust my words because the first-beginnings of things cannot be distinguished by the eye, learn in addition of bodies which you must yourself of necessity confess to be numbered amongst things and yet impossible to be seen [e.g. wind].[12]

and that because these material bodies touch our bodily senses, they

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[12] Ibid., Bk. I, pp. 20-21.
Nunc age, res quoniam docui non posse creari de nilo neque item genitas ad nil revocari, nequa forte tamen coeptes diffidere dictis, quod nequeunt oculis rerum primordia cerni, accipe praeterea quae corpora tute necessest confiteare esse in rebus nec posse videri.

therefore exist, "... For nothing can touch or be touched, save body."[13]

Concerning the nature of atoms, the problem of imperceptibility remains; yet the Epicureans describe their properties and their behaviour quite thoroughly. Lucretius teaches that the atoms are solid, indivisible, impenetrable, without void, and furthermore, that atoms have weight; there is a finite number of shapes and sizes of them though the number of atoms is infinite. They are without colour, scent, sound or taste.

The atoms are said to move through the void 'downwards' at the same speed. The reason why they collide with each other is that they have a tendency to swerve. As they swerve they clash and rebound into space, forming an infinite variety of groups; they are in perpetual motion and the qualities of things depend on their motion and particular nature.

Such an extensive description of atoms must depend on some knowledge about the atoms and in cases where the description is of what the atoms look like, we would expect Lucretius to be consistent and provide us with some evidence of sensory knowledge. This is not the case. The evidence that Lucretius gives for his knowledge of the nature of atoms is never sensory evidence. Atoms are imperceptible. Lucretius and Epicurus are much less sceptical than Democritus about what 'genuine knowledge' is, but they do not thereby resolve the problem of the imperceptibility of atoms.

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[13] Ibid., p. 22.
"... tangere enim et tangi, nisi corpus, nulla potest res."

The importance of the Greek and Roman Atomists as an influence on seventeenth-century thought, however, cannot be judged correctly simply by giving an analysis of their arguments. What is of philosophical and historical significance is the fact that the Greek atomic theory and the distinction between primary and secondary qualities were resurrected from early metaphysics by the natural philosophers of the seventeenth century, almost in their entirety.

We turn next to a discussion of seventeenth-century speculations on matter and its qualities, because it was not until the seventeenth century that systematic experimentation and observation took precedence over teleological explanations. We shall consider the seventeenth century as the proper starting point of the following discussion.

CHAPTER II

THE SEVENTEENTH CENTURY

The seventeenth century was remarkable. Such a profusion of philosophic and scientific inquiry, in such a short period of time, has not been seen since the Greeks.

There are many figures of natural philosophy in this era — Bacon, Hobbes, Gassendi, Descartes, Newton, Huygens, Boyle, Spinoza, Leibniz and Locke. I shall not discuss the views of all these philosophers but concentrate on the issue of matter and its qualities as treated by Newton, Descartes and particularly Boyle.

First, I should like to point out that what is characteristic of seventeenth-century natural philosophy is the fact that the methodology in answering metaphysical questions shifted from an emphasis on teleology to an emphasis on experimentation and observation. Observation, which was held in lower esteem within the Aristotelian framework in the Middle Ages, became an important step in progressing to the

theoretical level.[1] The second most important feature of seventeenth-century natural philosophy is the revival of the Greek atomic theory in more or less its original form.

Section 1 — Newton and Descartes

Let us now turn to a specific topic in the thought of the seventeenth century; that is, the distinction of primary from secondary qualities. It seems that anyone who concerned himself with this question was faithful to the Democritian view of atomic structure. They

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[1] I do not wish to neglect the great minds of the sixteenth century who were responsible for setting this course in scientific inquiry. For example, anthropocentric motives led Christian theology to assigning a privileged position to Earth in the solar system. Through patient observation with the aid of instruments available at the time, Copernicus found that the facts did not agree with the hypothesis that the Earth was the centre of the universe.

In 1543, De Revolutionibus Orbium Celestium was published putting forth the heliocentric theory as a hypothesis for which justification could be found, given the conditions that the eye be permitted to cooperate with the intellect. The work was dedicated to the Pope.

Galileo, too, used the method of observation and made many discoveries through the use of the telescope. The telescope had just been invented by the Dutchman Lippershey, and Galileo was quick to apply its revealing powers to scientific inquiry. He discovered the spots on the sun, the hills and valleys on the moon and through the use of the telescope, he established the general truth of the Copernican system. He also discovered the four satellites of Jupiter and found that they obeyed the laws of Kepler.

Galileo's views were opposed to the traditional ones. His discovery of Jupiter's moons was not accepted on the grounds that it challenged the 'sacred' number of heavenly bodies. It was believed at the time that there were five planets and the sun and moon. The number of heavenly bodies corresponded to other significant numbers such as the number of days completed on the Sabbath. Galileo's discovery of satellites added four more heavenly bodies. As a result of this discrepancy, the telescope was denounced. In 1633, Galileo stood before the Inquisition for his heretical beliefs and promised never to speak of the heliocentric theory again. See Bertrand Russell, History of Western Philosophy (London: George Allen & Unwin Ltd., 1961), p. 520.

all made a distinction between two types of qualities, although not all agreed on which qualities should be considered primary and which secondary.

In Book III of the Principia, Newton gives a rule to serve as a criterion by which to distinguish primary from secondary qualities:

Rule III

> The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within the reach of experiments, are to be esteemed the universal qualities of all bodies whatsoever.[2]

By this, Newton means that those qualities which cannot be spoken of in degrees are the universal or primary ones. Extension is a primary quality because something either has extension or it does not; an object will retain the quality of extension whether it is expanded or contracted, whereas colour will change according to degrees of light energy. Secondly, Newton thinks that primary qualities will be found in all objects universally. The qualities which have these two characteristics are extension, hardness, impenetrability, mobility and inertia.

This criterion meets the Epicurean and Democritean problems of 'imperceptibility', but it does not do so successfully because the existence of imperceptible qualities of atoms is assumed while the perceptible qualities are given in observation of objects. Thus, Newton is repeating the ancient mistake of talking about imperceptibles as if

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[2]Sir Isaac Newton, Mathematical Principles of Natural Philosophy, translated by Andrew Motte and Florian Cajori (Berkeley: University of California Press, 1934), p. 203.

they were perceptible.[3]

The secondary qualities are those which often provide a convenient way of speaking about the effects of the primary qualities on the percipient. Colour, for example, is not an inherent quality of objects but a result of the mechanics of motion:

> If at any time I speak of light and rays as coloured or endued with colours, I would be understood to speak not philosophically and properly, but grossly, and according to such conceptions as vulgar people in seeing all these experiments would be apt to frame. For the rays to speak properly are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour.[4]

There is very little deviation here from the Greek contention that atoms are not coloured. The secondary qualities are treated as the effects of atoms in motion. These effects are the sensations of blue or red. Whatever may be said of Newton's attempt to describe the motion of matter in a mathematical way, it is clear that when he describes the qualities of matter he is a thoroughgoing Corpuscularian.

Let us now consider Descartes' treatment of the distinction. For Descartes, it was a more difficult matter to speak of the distinction in scientific terms without also considering the nature of knowledge and its conditions. He did attempt both approaches and we shall take a look at these respectively. We find an explicit differentiation between properties in the fourth of the Principles of Philosophy :

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[3]Maurice Mandelbaum gives a thorough discussion of this problem in Rule III, in his book Philosophy, Science and Sense Perception (Baltimore: Johns Hopkins Press, 1966), pp. 79-88.

[4]Sir Isaac Newton, "Questions of Natural Philosophy," Newton's Philosophy of Nature: Selections From His Writings, edited by H. S. Thayer, Introduction by John Herman Randall, Jr. (New York: Hafner Press, 1953), p. 100.

> ... I have just shown that these [colour, odour, flavour, sound and tactile qualities] are nothing objective (at least as far as we can tell) apart from dispositions [of matter] constituted by size, shape, and motion ....[5]

Descartes gives several reasons for a distinction between colour, odour, flavour, sound, tactile qualities and size, shape, motion. The most unusual one is the suggestion that the secondary qualities are perceived respectively by individual senses; that is, that each sense is responsive to one and only one effect such as colour, whereas size, shape and motion are facts which are observable not just by one sense but by several. Furthermore, the conception of primary qualities is distinct, whereas that of the secondary is confused because we are ignorant of their real nature. This distinction is inseparably bound to Descartes' epistemological biases and we shall consider this point.

Another reason for considering the primary qualities as primary is illustrated through an analogy of machines. Descartes wants to assign size, shape and motion to insensible particles such as atoms despite their imperceptibility, on the grounds that it is these qualities which are the true causes of sensations of colour, etc. These causes are regarded as invisible parts of a machine which give rise to sensible phenomena:

> .... The only difference I can see between machines and natural objects is that the workings of machines are mostly carried out by apparatus large enough to be readily perceptible by the senses ... whereas natural processes almost always depend on

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[5] René Descartes, "Principles of Philosophy," Descartes: Philosophical Writings, translated and edited by Elizabeth Anscombe and Peter Thomas Geach, with Introduction by Alexander Koyré (London: The Nelson Philosophical Texts, Thomas Nelson & Sons Ltd., 1969), p. 234.

> parts so small that they utterly elude our senses. But mechanics, which is a part or species of physics, uses no concepts but belongs also to physics; and it is just as 'natural' for a clock composed of such-and-such wheels to tell the time, as it is for a tree grown from such-and-such seed to produce a certain fruit. So, just as men with experience of machinery, when they know what a machine is for, and can see part of it, can readily form a conjecture about the way its unseen parts are fashioned; in the same way, starting from sensible effects and sensible parts of bodies, I have tried to investigate the insensible causes and particles underlying them.[6]

It seems clear here that Descartes wishes to employ a scientific method to derive causes from observation and to consider motion, shape and size as properties as well as processes of insensible particles. He believes that such a methodology will provide us with distinct ideas of properties by the use of the understanding — something which mere observation cannot do. This is a significant point in epistemology for this reason: From what we have seen of the Greek philosophers and the seventeenth-century naturalists thus far, it seems that they have separated metaphysics and physics from epistemology. Descartes approaches the problem of what constitutes matter, not by appealing to an external reality but by examining the conditions of knowledge. It is these conditions that determine which qualities will be classified primary and which secondary. In his example of the melting wax he invites us to consider what it is that is so distinctly known about its nature when the secondary qualities have been removed:

> ... Well, what was in this wax that was so distinctly known? Nothing that I got through the senses; for whatever fell under taste, smell, sight, touch, or hearing has now changed; yet the wax is still there ....[7]

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[6] Ibid., pp. 236-237.

[7] Descartes, "Meditations," Descartes: Philosophical Writings, p. 72.

Extension, size and motion are left and these are deemed to be the primary qualities. But they are primary not because we can derive their properties from any type of observation but because size, shape and motion are the only clear and distinct ideas we have of matter. Descartes justified his position on primary qualities by an analysis of the concept of matter. What is essential to the concept of matter is the primary qualities.

Section 2 — The Honourable Robert Boyle (or The Sceptical Chymist)

Robert Boyle called himself a sceptical chymist.[8] He was sceptical of the rationalist approach to physical investigations and he devoted much of his life to demonstrating the truth of the "corpuscular philosophy" by conducting thousands of chemical experiments. Boyle was the sceptical or empirical chemist par excellence.

His experiments on air and the invention of the vacuum pump were published in 1660, entitled New Experiments Physico-Mechanicall Touching the Spring of the Air, and its Effects, (Made for the most part, in a New Pneumatical Engine) Written by way of a Letter to the Right Honorable Charles Lord Viscount Dungarvan, Eldest Son to the Earl of Corke. These experiments led to the formulation of what we know as Boyle's Law: The volume of a gas varies inversely to the pressure, the temperature remaining constant.

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[8] Robert Boyle, The Sceptical Chymist, Introduction by M. M. Pattison Muir (London: Everyman's Library, J. M. Dent & Sons Ltd., last edition, 1911).

Boyle's work on pneumatics was not immediately accepted. For example, among many of his discoveries and inventions, Boyle modified Otto von Guericke's vacuum pump and produced a vacuum in which the pressure was less than one-hundredth of the atmospheric pressure. With elaborate and ingenious techniques he injected and then transferred artificial air from one container into another and was thus able to experiment with materials created in near-vacuum conditions. By using diminished pressure, Boyle also showed that liquids could be distilled at temperatures below the boiling point. These new techniques were not embraced by many contemporaries even though they became essential in nineteenth and twentieth-century chemistry. Distillation in vacuo was a procedure which became regularly employed in the nineteenth century and experimentation with gases required the use of evacuated vessels in every twentieth-century laboratory. The reason for this lag in adopting Boyle's techniques in chemistry was most probably the very expensive and meticulous art of vacuum technique. Furthermore, experimental philosophy had its beginnings in seventeenth-century thinking, and speculators of that time were still habitually relying on deductive reasoning and abstraction in inquiries about natural philosophy. Boyle and his friends were really novices in these methods; experiments took place in private homes and because of the rather expensive demands of the apparatus used, it was not surprising that these inquisitive gentlemen were usually members of the nobility. The Royal Society of London for Improving Natural Knowledge, began as an eclectic organization formed to meet the demands of thinkers who had the time and money to delve into the New Philosophy or Experimental Philosophy.

The Royal Society, of which Boyle was a founding member, was the intellectual force responsible for the introduction of the experimental method into the universities and, through the Philosophical Transactions, to Continental Europe.

Boyle also wrote a number of works on theology, attempting to show that the new philosophy was not incompatible with religion. He was a prolific writer as a perusal of his Works will show. The number of subjects he treated is too immense to list here.

In the Sceptical Chymist he refutes the Aristotelian theory of elements (fire, air, earth, and water) and the alchemical theory of elements (salt, sulphur and mercury). In their stead, he introduces "simple substances" (salt, acids, metals) as the most fundamental elements. Unfortunately, this led him to a futile search of a formula for the recomposition of gold, and he had the formidable task of categorizing a multitude of substances without the modern notion of elements.

He was familiar with the works of Aristotle and declined the traditional reliance on the Peripatetic school because he believed that Aristotle had omitted a proper study of qualities in his work. Aristotle gave a general definition of quality and treated of the general effects of natural things, but went no further in the matter. Similarly, Descartes spoke of what effects bodies have on our senses, but not of what effects bodies have on one another. Furthermore, Descartes had interwoven his treatment of qualities so tightly with the rest of his philosophy that it is difficult to accept one part of his philosophy without accepting the other.

In the "Author's Discourse to the Reader" of The Works, Vol. III,[9] he gives three reasons for his abstinence from the philosophical influence of the "Greats." The most important one is that he wishes to conduct his inquiry without prejudice. Secondly, the interpretations of some philosophical doctrines, such as those of Aristotle, can be misleading due to the obscurity, both of the writer and the commentator. And thirdly, so little has been said on the matter of qualities that it is either useless or irrelevant. Furthermore, there is another reason underlying all these three which should compel a scientist to rely on his own ingenuity in inquiries concerning qualities, and that is, that in most philosophical speculations about qualities, the experimental approach is absent. Boyle does give credit to some insights acquired through the works of the pre-Socratics but finally dismisses them as incomplete and imperfect.

Boyle gives a summary of his intentions in the writing of "The Origin of Forms and Qualities" in the preface of The Works. It is to be understood that throughout the study of qualities, the soul of man or animal will not be investigated; the reason for this being that Boyle thinks that little can be discovered about the nature of soul by reference to matter because of the difficulty in establishing a relationship between soul and matter. Furthermore, Boyle thought that the experiments required to discover the physiological aspects of the

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[9]The Honourable Robert Boyle, "The Origin of Forms and Qualities, According to the Corpuscular Philosophy," in The Works of the Honourable Robert Boyle, 6 Vols., edited by Thomas Birch, 1772; reprinted by Georg Olms Verlagsbuchhandlung, Hildesheim, Germany, 1966, Vol. III, pp. 3-10.

psyche would necessarily involve the use of live animals and this he considered too cruel an undertaking. We are also informed that Boyle will assume the role of a 'corpuscularian' (or one who accepts the theory that material atoms exist) throughout this part of his Works. Finally, Boyle makes explicit the method he intends to use in his examination of the nature of qualities. He hopes to give an explanation of the nature of qualities by generating these qualities in bodies. That is, assuming that the mechanical operations of matter can be altered and that specific alterations result in particular qualities, Boyle hopes to show that qualities can be produced mechanically:

> "That then which I chiefly aim at, is to make it probable to you by experiments (which I think hath not yet been done) that almost all sorts of qualities, most of which have been by the schools either left unexplicated, or generally referred to I know not what incomprehensible substantial forms may, be produced mechanically; I mean by such corporeal agents, as do not appear either to work otherwise than by virtue of the motion, size, figure, and contrivance of their own parts (which attributes I call the mechanical affections of matter, because to them men willingly refer the various operations of mechanical engines): or to produce the new qualities exhibited by those bodies, their action changes by any other way, than by changing the texture or motion, or some other mechanical affection of the body wrought upon. And this if I can in any passable measure do, though but in a general way, in some or other of each of these three sorts into which the Peripateticks are wont to divide the qualities of bodies, I hope I shall have done no useless piece of service to natural philosophy;[10]

Through the employment of such a method, Boyle embarks on the scientific investigation entitled "Considerations and Experiments touching the Origin of Forms and Qualities"[11] the purpose of which is to construct an

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[10]Boyle, The Works; Vol. III, p. 13.

[11]Ibid.; see experiments, pp. 76-112.

explicit theory of qualities.

The attempt to generate qualities in bodies is also described in his "Experiments and Considerations Touching Colors."[12] He tries to analyze color mechanically by mixing powdered chemicals and solutions. This method was important in that it led him to make a distinction between acid and alkali substances, and it enabled him to produce qualities mechanically.

Let us now turn to a more detailed consideration of Boyle's treatment of primary and secondary qualities. Boyle was well read in the philosophical speculations of his predecessors and his contemporaries. He accepted three principal things which had been hypothesized about the nature of matter: that the 'catholick' or universal matter, which is common to all bodies, is extended substance, divisible and impenetrable; that matter is One and that the diversity we notice in bodies is not an inherent diversity of matter itself but results from motion, which as Descartes said, originates in God; that matter is divided into parts because of motion and that these parts have the essential properties of magnitude or size, motion and shape. Size and shape are inseparable accidents because despite alteration through physical agents the essence of matter remains undestroyed.

Boyle's writings provide at least two examples of the phrase 'primary and secondary qualities':

> I say not that there are no other accidents in bodies than colours, odours and the like; for I have already taught that

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[12] Ibid., Vol. I, pp. 668-774.

> there are simpler and more primite affections of matter, from which these secondary qualities, if I may so call them, do depend ....[13]

and later in the work, in the chapter entitled 'Nature of Physical Qualities', the term 'primary' appears:

> ... and since those qualities, as we have seen already, do themselves proceed from those more primary and catholick affectations of matter, bulk, shape, motion or rest ....[14]

What concerns us most at this point is why Boyle makes the distinction. He gives several arguments for the distinction and we will take a look at them.

In the chapter 'An Excursion about the relative Nature of Physical Qualities', he invites us to consider this example as an analogy for the way we speak about sensible or secondary qualities: A lock and key are nothing more than pieces of iron contrived into certain shapes, but once the one is applied to the other, they both acquire a new capacity which could be called attributes of the lock and key. Now of these new attributes nothing 'real or physical' was added to either the lock or the key:

> And proportionably, hereunto, I do not see why we may not conceive, that as to those qualities (for instance) which we call sensible, though, by virtue of a certain congruity or incongruity in point of figure (or texture or other mechanical attributes) to our sensories, the portions of matter they modify are enabled to produce various effects, upon whose account we make bodies to be endowed with qualities; yet they are not in the bodies that are endowed with them, any real or distinct entities, or differing from the matter itself ....[15]

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[13]Ibid., pp. 23-24. (Italics mine).

[14]Ibid., p. 28. (Italics mine).

[15]Ibid., p. 18.

Boyle is giving a mechanical explanation of secondary qualities here. The analogy is this. We have two bits of matter, both of which have the same basic properties, but the interaction between the two lumps of matter will vary according to their shape. This variation is not properly speaking a property of matter, but gives rise to something we perceive in it. We give to this perceptible effect the name 'secondary qualities'.

Now there is a multiplicity of secondary qualities which is encountered in the same natural bodies. For example, a mirror will appear to be red at one time and green at another, but this is no reason for thinking that these qualities are anything other than the mechanical affections of matter. For a body cannot be considered as an isolated part of matter, but as part of the universe and consequently as subject to effects of other parts of matter, effects which men may fancy to be inherent qualities, which they are not. Considering the many possible relations between particles, we should expect to find many apparently diverse qualities in the same objects for this is a necessary result of the several relations between atoms. But these relations need not be mistaken for real, physical qualities and it is important for Boyle to distinguish the primary from the secondary.

Thus far, Boyle has given an explanation of what secondary qualities are -- relations in the form of motion -- and has accounted for the diversity of these qualities. Boyle believes that his explanation is not definitive of secondary qualities but descriptive. He refrains from giving a definition of secondary qualities for two reasons: he believes that secondary qualities can be more easily understood by men

if they are given, what we would now call, an 'operational' account with reference to the primary qualities of matter: Secondly, the genus of qualities has yet to be adequately explicated. Aristotle himself defines 'accidents' as that by which a thing is said to be qualis, thereby in Boyle's opinion, giving a circular definition of quality. What Boyle does not realize, or does not accept, is that he, too, is speaking of accidents — the accidents of primary qualities.

It is typical of Boyle throughout his works to resist a classification of substantial forms and encourage an operational definition or description of qualities. This approach was essential to his outlook on chemical analysis. For example, he argued against the notion of substantial forms as a universal species, saying that natural substances are not essentially different from man-made ones. This is one of the basic presuppositions which led him to speculate on the possibility of producing gold from simpler elements. The only universal substance is matter and all that is necessary to synthesize a new substance is the application of chemical operations. When a substance is classified, it is done by virtue of accidents and chemical properties alone.

As far as secondary qualities are concerned this empirical approach will suffice in describing them since their nature can be understood by observation and explained by motion and mechanical interaction. But what of the primary qualities? How does Boyle treat these? First, it is important to take this point into account before answering this question. Boyle did not make the distinction between primary and secondary qualities on a purely empirical level, and indeed it is difficult to conceive how anyone could. Rather, he used empirical

examples to show that all qualities are affections of matter. The attribution of qualities to matter is really a convenient way of classifying an object so as to distinguish it from other species of bodies. Take for example Form: Boyle tells us that Form (or shape) is not something substantial and separate from matter, but matter itself, considered in a particular mode of existence, and likewise the other qualities are ways of talking about sensible things. Nevertheless, a nominal account is not an adequate explanation for the distinction. The important question is, why does Boyle consider the primary qualities as distinct and in what sense? Here, I think that we shall find that his distinction necessarily rests on the Atomists' metaphysical presuppositions; that is, on the existence of indivisible, imperceptible and single atoms, which Boyle calls minima or prima naturalia. To these minima he attributes the qualities of determinate shape and solidity. He accepts the proposition that atoms are indivisible, have shape and size and through this premise, he infers shape and solidity to argue for these as necessary primary qualities. Boyle does allow the possibility that mentally at least, we can imagine atoms to be divisible. He thinks it possible that by divine Omnipotence they may become divisible but, save for this miraculous possibility, we must accept that due to the smallness and solidity of atoms, nature never divides them.

Boyle was also concerned with the problem of how new forms come to be and pass away. He argued that matter and the accidents of matter are sufficient to explain phenomena and he regarded a search for immaterial forms as superfluous and uneconomic. Either things come into

existence from nowhere or they do not come into existence at all. New forms do come into existence, however, and the best way for him to account for them is through the corpuscular-mechanical hypothesis.

That there are particles of matter, too small to be seen, indivisible and necessarily solid and with a particular shape, is an axiom for which Boyle has no empirical confirmation, but because this hypothesis is useful and most efficacious in explaining phenomena, Boyle finds it expedient and acceptable.

In his discussion of the nature of physical qualities, Boyle gives an explicit account of his corpuscular hypothesis. His first and fundamental principle is, as we have seen, that there are atomic corpuscles or minima naturalia. Secondly, there are other corpuscles made from the coalition of minima naturalia. These, too, are insensible, but they are divisible, as in the case of mercury which can undergo many alterations but still remain mercury. Both the particles made from the coalition of the minima naturalia and the minima naturalia have their own determinate shapes. But when these adhere to one another, the resulting particle will have a different size and shape as well as a difference in the direction of motion. When a number of these bodies cluster together so as to become visible or sensible and are in motion, that motion may produce great changes and new qualities in the body without causing alterations in the component parts. For example, air has the same composition under many varying circumstances but when it is in the state we call wind, it may feel colder to the touch. Similarly, iron when rubbed feels hot. Water may turn into ice and still be essentially the same. All these changes are due to motion,

and motion may be considered the grand or efficient among second causes, God being the primary one.

From what has been said, it is evident that colour, odour, taste and other secondary qualities are derived from size, shape and motion of the small parts of matter. Boyle agrees with the atomistic attempt to deduce generation and corruption of bodies from σύγκρισις κ' διάκρισις (convention and dissolution) thereby giving a mechanical and material account of how new forms come into existence. We may conclude then, that the use of various names to describe a parcel of matter is simply a reference to a new modification or mode of existence of matter. Nothing is new substantially. Boyle uses the Cartesian example of the watch to illustrate this. The springs, wheels, spring balance and indicator which are scattered about do not change when their arrangement is altered to make a watch. Rather, the order of the parts is changed. 'Generation' of a thing means nothing more than a denomination for a new arrangement of matter. 'Corruption' is the act by which a body comes to lose all accidents necessary to the constitution of that body. Nothing corporeal or substantial (Boyle uses the terms interchangeably) perishes in the change. Matter can neither be created nor destroyed ('Corruptio unius est generatio alterius; & e contre.)

All these considerations about matter lead Boyle to believe that the mechanical hypothesis is a very useful and enlightening one. According to the mechanical philosophy, the world we live in is in constant motion. Bodies are so closely set to one another that they either have no vacuities between them or at least these are very few and far between. Since the manner of coalition of bodies is sufficient to give

the secondary qualities, which are always varying, it follows that these parts will sometimes join with one cluster, sometimes with another. Now if we consider that the shapes, sizes and motions of these particles are various and that their variety and combination is, theoretically, indefinitely large, it follows that the observable qualities resulting from such a profusion of combinations will be very great indeed. Boyle believed that the variety of combinations of letters in the alphabet will not be adequate to describe them because he wrongly thought that the number of combinations was finite. This final insight led Boyle to believe that by the intervention of some very small addition or subtraction of matter, in principle, any thing inanimate can be made, including gold. It is not surprising that Boyle would be led to such a conclusion considering the following attack on the traditional concept of elements and substantial forms.

> But as to this affair I observe, that if (for instance) you ask a man what gold is; if he cannot shew you a piece of gold, and tell you this is gold, he will describe it to you as a body that is extremely ponderous, vary malleable and ductile, fusible, and yet fixed in the fire, and of a yellowish colour; and if you offer to put off to him a piece of brass for a piece of gold, he will presently refuse it, and (if he understands metals) tell you, that though your brass be coloured like it, it is not so heavy nor so malleable, neither will it like gold resist the utmost brunt of the fire, or resist aqua fortis ... whatever men talk in theory of substantial forms, yet that, upon whose account they really distinguish any one body from others, and refer it to this or that species of bodies, is nothing but an aggregate or convention of such accidents as most men do by a kind of agreement (for the thing is more arbitrary than we are aware of) think necessary or sufficient to make a portion of the universal matter belong to this or that determinate genus or species of natural bodies. And therefore not only the generality of chymists, but divers philosophers, and, what is more, some schoolmen themselves, maintain it to be possible to transmute the ignobler metals into gold.[16]

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[16] Ibid., pp. 27-28.

Elements and chemical substances exist in the sense that they are convenient and agreed upon entities to describe the various effects and modifications of matter, and in actuality only minima naturalia or atomic corpuscles exist.

To recapitulate Boyle's analysis of matter let us summarize his basic points:

1. The matter of all natural bodies is the same; namely, a substance, extended and impenetrable.
2. Because all bodies are substantially the same, their distinction is due to accidents which diversify them.
3. Motion, not belonging to the essence of matter and not being produced originally by other accidents, may be regarded as the first and chief affection of matter.
4. Motion divides matter into parts; the division making the parts singly imperceptible.
5. These minima naturalia have bulk, figure and motion or rest (there being no mean between the last two) and the bulk, figure and motion or rest, are the most "catholick moods" or affections of matter.
6. Clusters of atoms will have a fixed position in reference to a plane; and according to how they are positioned, whether some horizontally or others vertically, their position will result in what we sense as texture.
7. Perceptions are given several names by men, according to the sense that is fitted to receive impressions from external objects, when actually all these sensible

qualities are but the effects or consequences of the primary affections of matter.

8. A body is generated when, either by accession or recess of corpuscles, or the transposition of what it is constituted from, or both, happens to obtain a concurrence of all those qualities which men consider and commonly agree to be necessary and sufficient to denominate the body which has them.

9. The form of a thing is a peculiar state of matter; and the concurrent qualities of matter, which are accidental, are necessary to a particular body in the sense that, without these accidents the body would not be of denomination x but of some other, e.g. y.

10. A body is capable of many other qualities besides those which make up its form and the acquisition or loss of such other qualities is called alteration; for example, a change in colour is an alteration. If these qualities are lost or destroyed, the change is called corruption. Nothing substantial is destroyed in corruption because nothing new is produced in generation and because matter is incorruptible.[17]

From this account of matter and its power to generate qualities, what can be said of the primary qualities? Unfortunately, Boyle is not concerned with an analysis of the ontological status of primaries

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17 Ibid., pp. 35-37.

and directs his attention to how perceptible qualities can be reduced to changes in motion and the arrangement of the minima naturalia. These changes may alter the specific size, shape and motion of bodies as well as their colour, odour and taste, but the smallest natural corpuscles will always have some shape, some size and some motion. For this reason they are considered primary. Other than this, Boyle offers no criterion for the primary qualities, and wishing to abstain from metaphysical issues, he probably did not think it necessary to offer one.

But the issue of primary and secondary qualities is most intimately connected to metaphysical presuppositions about matter, and even more so to epistemological problems and questions of scientific method. As well as Boyle's great contributions to Empiricism and Chemistry, he raised many epistemological questions; for example, how is the nature of substance to be known; what criterion is necessary to distinguish the primary and secondary qualities; and what is the relationship between matter and the knower? We shall see that Locke addressed himself to the philosophical aspects of Boyle's corpuscular hypothesis in the following sections.

CHAPTER III

IDEAS AND THINGS.

At the time of completing the baccalaureate at Christ Church, Oxford, in 1652[1], John Locke had already acquired an interest in scientific matters, especially in iatrochemistry. This diversion from purely philosophical questions was a result of Locke's intellectual and affiliative attachment to a number of scientifically inclined colleagues at Oxford, namely, Robert Boyle, John Wilkins, Jonathan Goddard, William Petty, Richard Lower and Thomas Willis.[2] After graduating from Oxford, Locke remained there, extending his interest in iatrochemistry by attending chemistry lectures and participating in experiments on circulation and respiration which were conducted by Hooke, Boyle and Lower. Although he lectured in Latin and Greek as a master in philosophy, he was not content with the study of Scholastic philosophy and soon entered the faculty of medicine. He was greatly influenced by Robert Boyle's corpuscular theory and the new experimental and empirical methods in science. Kenneth Dewhurst lists the following works by Boyle which Locke was familiar with: Certain Physiological Essays (1661), The Sceptical Chymist (1661), Usefullnesse of Experimental

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[1]Maurice Cranston, John Locke, A Biography (London: Longmans, Green and Co., 1957), p. 29.

[2]Ibid., pp. 39-40; 75-76.

Natural Philosophy (1663), Experimental History of Colours (1665), and Origin of Forms and Qualities (1666). Locke also edited Boyle's The General History of the Air designed and begun, which appeared after Boyle's death. (Appendix II of this thesis should also provide a good view of Boyle's works that Locke may have been familiar with). During his training in medicine, Locke's interest in chemistry was concentrated on the preparation of drugs, the study of blood circulation and the discovery of causes of epidemic diseases. By 1671, he had already begun writing the Essay Concerning Human Understanding. This twofold interest in philosophy and science was quite significant in influencing Locke's treatment of 'substance' and 'primary and secondary qualities'.

In this part of the thesis, I wish to examine this influence from science. I shall confine myself to a discussion of 'substance' and 'primary qualities distinguished from secondary ones' in the light of the corpuscular hypothesis.

Let us begin our inquiry by considering Locke's objectives in writing An Essay Concerning Human Understanding. In the Introduction Locke wishes to make it clear to his readers that his concerns are predominantly about epistemology and not the accumulation of facts available to the understanding or the metaphysical speculations concerning such knowledge:

> This, therefore, being my Purpose, to Enquire into the Original, Certainty, and Extent of humane Knowledge; together with the Grounds and Degrees of Belief, Opinion, and Assent; I shall not at present meddle with the Physical Consideration of the Mind; or trouble myself to examine, wherein its Essence consists, or by what Motions of our Spirits, or Alterations of our Bodies, we come to have any Sensation by our Organs, or

> any Ideas in our Understandings; and whether those Ideas do in their Formation, any, or all of them, depend on Matter, or no.[3]

The amount of scientific knowledge available in the seventeenth century was, in Locke's view, sufficiently immense to justify an analysis of the foundations of knowledge and a search for more facts was deemed unnecessary:

> The Commonwealth of Learning, is not at this time without Master-Builders, whose mighty Designs, in advancing the Sciences, will leave lasting Monuments to the Admiration of Posterity; But every one must not hope to be a Boyle, or a Sydenham; and in an Age that produces such Masters, as the Great — Huygenius, and the incomparable Mr. Newton, with some other of that Strain; 'tis Ambition enough to be employed as an Under-Labourer in clearing Ground a little, and removing some of the Rubbish, that lies in the way of Knowledge; ....[4]

Locke found himself in the midst of a 'scientific storm' and he sought to put philosophy to its proper task of examining the foundations of knowledge through an inquiry into the human understanding and its limits. He wished to confine his inquiries to how we know rather than what we know. This priority nevertheless presupposed an acceptance of what we know, and it was the metaphysical presuppositions of science in the seventeenth century that were instrumental in shaping Locke's ideas of what we know. This is particularly evident in Locke's acceptance of the corpuscular hypothesis. He respects the theory on the grounds that it is the most intelligible one in explaining the qualities of matter:

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[3]John Locke, An Essay Concerning Human Understanding, Bk. I, Ch. I, Sec. 2, edited with an Introduction, Critical Apparatus and Glossary by Peter H. Nidditch (Oxford at the Clarendon Press, 7th edition, 1975), p. 43. All citations refer to this edition unless otherwise noted.

[4]Locke, "The Epistle to the Reader," An Essay Concerning Human Understanding, pp. 9-10.

> ... I have here instanced in the corpuscularian Hypothesis, as that which is thought to go farthest in an intelligible Explication of the Qualities of Bodies; and I fear the Weakness of humane Understanding is scarce able to substitute another, which will afford us a fuller and clearer discovery of the necessary Connexion, and Co-existence, of the Powers, which are to be observed united in several sorts of them. This at least is certain, that which ever Hypothesis be clearest and truest, (for of that it is not my business to determine,) our Knowledge concerning corporeal Substances, will be very little advanced by any of them, till we are made [sic] see, what Qualities and Powers of Bodies have a necessary Connexion or Repugnancy one with another; which in the present State of Philosophy, I think, we know but to a very small degree: And, I doubt, whether with those Faculties we have, we shall ever be able to carry our general Knowledge (I say not particular Experience) in this part much farther. Experience is that, which in this part we must depend on. And it were to be wish'd, that it were more improved. We find the advantages some Men's generous pains have this way brought to the stock of natural Knowledge. And if others, especially the Philosophers by fire, who pretend to it, had been so wary in their observations, and sincere in their reports, as those who call themselves Philosophers ought to have been, our acquaintance with the bodies here about us, and our insight into their Powers and Operations had been yet much greater.[5]

He is wary of the inability of the corpuscular theory to carry us further in the knowledge of the connection of the several qualities and the nature of substance. But he thinks that it is the limits of the human understanding which are responsible for this, for ultimately the questions depend on the human understanding for the answers.

Section 1 -- Substance

Although it is true that Locke states in the Introduction of his Essay that one of the purposes of his work is to "enquire into the original certainty and extent of human knowledge" and not to meddle with

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[5]Locke, Essay, Bk. IV, Ch. III, Sec. 16, pp. 547-548.

such speculations as whether ideas "depend on matter or no", it would be a mistake to consider the Essay as a philosophical work devoid of a scientific substructure.

Now, when Locke states that the question of matter is beyond his design, it should not be understood that he has no opinions on the question of matter. Rather, he thought that the discoveries and ideas in science of that time, were great enough in number and in quality for his purposes, and instead of challenging the metaphysics of the "master-builders", he chose to humble himself to the role of an "underlabourer".

Bearing these considerations in mind, we should not find it surprising that Locke employs the materialist hypothesis throughout the Essay:

> ... I will not dispute, whether this acceptation of the Word solid be nearer to its Original Signification, than that which Mathematicians use it in: It suffices, that I think, the common Notion of Solidity will allow, if not justifie, this use of it; but if anyone think it better to call it Impenetrability, he has my Consent. Only I have thought the Term Solidity, the more proper to express this Idea ... because it carries something more positive in it, than Impenetrability, which is negative, and is, perhaps, more a consequence of Solidity, than Solidity itself. This of all other seems the Idea most intimately connected with, and essential to Body, so as no where else to be found or imagin'd, but only in matter: and though our Senses take no notice of it, but in masses of matter, of a bulk sufficient to cause a Sensation in us; Yet the Mind, having once got this Idea from such grosser sensible Bodies, traces it farther; and considers it, as well as Figure, in the minutest Particle of Matter, than can exist; and finds it inseparably inherent in Body, where-ever, or however modified.[6]

Matter is presupposed here in order to explain the acquisition of the idea of solidity. Again, in Bk. II of the Essay, we can cite various passages where Locke explicitly asserts the existence of material

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[6]Ibid., Bk. II, Ch. IV. Sec. 1, p. 123.

objects:

> To discover the nature of our Ideas the better, ... it will be convenient to distinguish them, as they are Ideas or Perceptions in our Minds; and as they are modifications of matter in the Bodies that cause such Perceptions in us:[7]

This distinction between 'ideas in our minds' and 'modifications of matter in the bodies' is a very important premise for the distinction between primary and secondary qualities and for Locke's adherence to the corpuscular hypothesis. In the following passage he accepts the metaphysical assumptions of the corpuscular hypothesis explicitly:

> For it being manifest, that there are Bodies, and a good store of Bodies, each whereof is so small, that we cannot, by any of our Senses, discover either their bulk, figure, or motion, as is evident in the Particles of the Air and Water, and other extremely smaller than those, ... Let us suppose at present, that the different Motions and Figures, Bulk, and Number of such Particles, affecting the several Organs of our Senses, produce in us those different Sensations, ...[8]

Though Locke is aware of the metaphysical difficulties inherent in the corpuscular hypothesis, he regards the idea of matter and substance as a necessary requirement for the causal explanation of ideas. On May 16, 1669, he writes to Samuel Bold:

> ... I agree with you, that the ideas of the modes and actions of substances are usually in our minds, before the idea of substance itself; but in this I differ from you, that I do not think the ideas of the operations of things are antecedent to the ideas of their existence, for they must exist before they can affect us, or make us sensible of their operations, and we must suppose them to be before they operate.[9]

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[7] Ibid., Bk. II, Ch. VIII, Sec. 7, p. 124.

[8] Ibid., Bk. II, Ch. VIII, Sec. 13, p. 136.

[9] John Locke, The Works of John Locke, London: Printed for Thomas Tegg, W. Sharpe & Son, G. Offor, G. & J. Robinson, J. Evans & Co.; also R. Griffin & Co., Glasgow and J. Cumming, Dublin, 1823, Vol. X, p. 320. Reprinted in 1963.

Here, Locke seems to be relying on one of Aristotle's senses of substance, that is, substance as an independent existent. In this context, substances can exist on their own while qualities and relations have a parasitic mode of being.

There is a problem of interpretation in this last passage. It may be pointed out that Locke is making a distinction between the idea of X and the existence of X. Locke could also be interpreted as saying that a distinction should be made between the idea of substance and the idea of the existence of substance, in which case he would be treating existence as a predicate. Locke is a bit unclear, however.. He seems to be saying that although it may be true that the ideas of modes and actions of substance are antecedent to the idea of substance in general, these ideas are not antecedent to the ideas of the existence of things. The passage is better understood if we concede to the possibility that Locke is making grammatical errors, and that what he really means to say is that "things must exist before they can affect us or make us sensible of their operations."

By making this distinction between things and ideas he is further led to conclude that the existence of X is the cause of the idea of X. It is my view that this presupposition is central to his distinction between contents of the mind and contents of the world. It is the object of Berkeley's complaint and the epistemological subject of the corpuscular hypothesis. Locke believes that material objects exist, that modifications in matter cause perceptions in us and that we can be perceptually acquainted with matter if matter is in sufficient bulk for our senses to notice it. But Locke was not so uncritical a thinker

as to omit the question 'What proof do we have for the existence of matter?' His preoccupation with this question is evident in the pains he took to demonstrate the practical advantages of holding the materialist hypothesis in contrast to the notion of an immaterial knowing substance. In a paper entitled "Of Ethics in General,"[10] Locke confesses that no idea of matter that he may have is a sufficient premise from which he can deduce the existence of matter:

> I have the complex idea of substance, solidity, and extension joined together, which I call matter; does this prove matter to be? No. I, with Descartes, add to this idea of matter a bulk as large as space itself; does this prove such a bulk of matter to be? No. I add to it this complex idea, the idea of eternity; does this prove matter to be eternal? No. I add to it the idea of necessary existence; does this prove matter necessarily to exist? No. Try it in spirit, and it will be just so there.[11]

The problem is, that no amount or combination of ideas can prove the existence of matter or spirit because ideas alter nothing in the reality of things; nor do ideas offer evidence of the real existence of anything out of our minds. The only thing that can confirm "real existence," according to Locke, is "real existence."[12] In modern terms, one could say that existential conclusions may be derived (validly) only from existential premises.

Locke was well aware that this argument created a great gap between appearance and reality. He wanted to reduce it for two reasons:

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[10]Lord King, The Life and Letters of John Locke (New York: Burt Franklin, 1884; later published by Lenox Hill Publishing & Distributing Co., New York, N. Y., 1972), p. 315.

[11]Ibid.

[12]Ibid., p. 316.

(a) the existence of God had to be maintained as a feature of his philosophical beliefs, and (b) the existence of matter had to be presupposed in order to account for the cause of our ideas. A cause was considered necessary by Locke because he established the claim that ideas are not innate and therefore, in his view, they must originate from or be caused by something.

Concerning the question of God's existence, he criticized Descartes' argument from the idea of necessary existence, but came to the same conclusion that God exists. His reasons were different, however:

> Real existence can be proved only by real existence; and therefore, the real existence of a God can only be proved by the real existence of other things. The real existence of other things without us can be evidenced to us only by our senses; but our own existence is known to us by a certainty yet higher than our senses can give us of the existence of other things, and that is internal perception, a self-consciousness, or intuition; from whence therefore may be drawn, by a train of ideas, the surest and most incontestable proof of the existence of a God.[13]

Both claims, the one for the existence of God and the other for the existence of matter exhibit a common difficulty:

> So that, in short, the Idea we have of Spirit, compared with the Idea we have of Body, stand thus: The substance of Spirit is unknown to us: and so is the substance of Body, equally unknown to us ....[14]

The idea of material substance and the idea of God are both complex ideas, and as such they do not carry with them the absolute certainty for knowledge of existence that comes from sensation. However, Locke

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[13]Ibid., p. 316.

[14]Locke, Essay, Bk. II, Ch. XXIII, Sec. 30, p. 313.

makes the idea of God an exception:

> The Knowledge of the Existence of any other thing we can have only by Sensation: For there being no necessary connexion of real Existence, with any Idea a Man hath in his Memory, nor of any other Existence but that of GOD, with the Existence of any particular Man; no particular Man can know the Existence of any other Being, but only when by actual operating upon him, it makes it self perceived by him.[15]

The idea of substance is a complex idea made up of general ideas which are ultimately creations of the understanding:

> I never said that the general idea of substance comes in by sensation and reflection; or that it is a simple idea of sensation or reflection; though it be ultimately founded in them: for it is a complex idea, made up of the general idea of something, or being, with the relation of a support to accidents. For general ideas come not into the mind by sensation or reflection, but are the creatures or inventions of the understanding.[16]

These creatures of the understanding are quite removed from the empirical certainty acquired through sensation and hence much more difficult to verify as real and independent entities. The best we can do, according to Locke, is to suppose the existence of matter without empirical or observational verification. In Bk. II of the Essay, he writes "... if anyone will examine himself concerning his Notion of pure Substance in general, he will find he has no other Idea of it at all, but only a Supposition of he knows not what support of such Qualities, which are capable of producing simple Ideas in us."[17] Matter is equivalent to the idea of pure substance in general, and Locke believes that we cannot verify the existence of something in the external world from our

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[15] Ibid., Bk. IV, Ch. XI, Sec. 1, p. 630.

[16] Locke, Essay, (Works), IV, p. 17.

[17] Locke, Essay, Bk. II, Ch. XXIII, p. 245 (Fraser ed.).

complex ideas. Thus we cannot verify the existence of matter or substance through our complex ideas.

As a result of this scepticism concerning substance, a controversy developed. Edward Stillingfleet, the Bishop of Worcester, accused Locke of almost having done away with substance with his new way of reasoning and denounced some of Locke's principles as heretical, in a work entitled A Discourse in Vindication of the Trinity, published in 1696. Bishop Stillingfleet argued that Locke's treatment of substance was in conflict with the doctrine of the Trinity and complained about Locke's new treatment of the word 'idea':

> When new terms are made use of by ill men to promote scepticism and infidelity and to overthrow the mysteries of our faith, we have then reason to enquire into them and examine the foundation and tendency of them .... The world has been strangely amused with 'ideas' of late; and we have been told that strange things might be done by the help of 'ideas'; and yet these 'ideas', at last, come to be only common notions of things, which we must make use of in our reasoning. You say in that chapter about the existence of God you thought it most proper to express yourself in the most usual and familiar way, by common words and expressions. I would you had done so quite through your book; for then you would have never given that occasion to the enemies of our faith to take up your new way of 'ideas' as an effectual battery, as they imagined, against the mysteries of the Christian faith. But you might have enjoyed the satisfaction of your ideas long enough before I had taken notice of them unless I had found them employed about doing mischief.[18]

Locke did little to alter his mischievous 'ideas' but he did try to appease Bishop Stillingfleet by pointing out to him the independent status that faith enjoys:

> Faith stands by itself, and upon grounds of its own, nor can be removed from them and placed on grounds of knowledge. Their grounds are so far removed from being the same or having

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[18] Maurice Cranston, J. Locke: A Biography (repr. from Lovelace Collection), pp. 413-414.

> anything in common, but when it is brought to certainty faith is no longer .... Let now such methods of knowledge or certainty be started as to leave men's more doubtful than before; let the grounds of knowledge be resolved into what every one pleases, it touches not my faith; the foundation of that stands as sure as before, and cannot be at all shaken by it .... Whether then I am or am not mistaken in the placing certainty in the perception of the agreement or disagreement of ideas; whether this account of knowledge be true or false, enlargens or straitens the bounds of it more than it should, faith stands still upon its own basis, which is not at all altered by it; and every article of that has just the same unmoved foundation and the very same credibility that it had before.[19]

Locke does not discuss the question of exactly how much certainty we may extract from faith in contrast to knowledge but we may guess, by the ironic tone of this letter, that it is not very much. Stillingfleet may have suspected this when in a further letter he challenges Locke to decide which is stronger: the certainty of faith or the certainty of knowledge. The controversy continued until Stillingfleet's death. Bishop Stillingfleet lost most arguments to Locke but he did raise some important questions, thereby inducing Locke to specify his use of the term 'substance'.

Locke wishes to give a nominal account of substance in order to avoid that Scholastic misconception, which both he and Boyle wished to eradicate, that essences exist in nature:

> Thus when we say, that Animal rationale is, and Animal implume bipes latis unguibus, is not a good definition of a Man; 'tis plain, we suppose the Name Man in this case to stand for the real Essence of a Species, and would signifie, that a rational Animal better described that real Essence, than a two-leg'd Animal with broad Nails, and without Feathers ....[20]

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[19] Ibid., p. 414.

[20] Locke, Essay, Bk. III, Ch. X. Sec. 17; p. 500.

This talk of essences as defining a type of animal is but a misuse of words which makes men suppose that 'essence' is a word which refers to a thing in nature. Locke does not wish to deny that 'essence' has some signification, but he wants to distinguish real essence from nominal essence:

> The measure and boundary of each Sort, or Species, whereby it is constituted that particular Sort, and distinguished from others, is that we call its Essence, which is nothing but that abstract Idea to which the Name is annexed: So that every thing contained in that Idea, is essential to that Sort. This, though it be all the Essence of natural Substances, that we know, or by which we distinguish them into Sorts; yet I call it by a peculiar name, the nominal Essence, to distinguish it from the real Constitution of Substances, upon which depends this nominal Essence, and all the Properties of that Sort; which therefore, as has been said, may be called the real Essence ....[21]

This distinction between real and nominal essences is a very important departure from Aristotle. It introduces the division of the human world of perception, language, appearance; from the world of real substances, real properties and extramental reality.

With regard to substance and its nominal essence, Locke describes it in the following way. Nominal essences he holds to be abstract, general ideas of substance created by the understanding:

> ... The Learning and Disputes of the Schools, having been much busied about Genus and Species, the Word Essence has almost lost its primary signification; and instead of the real Constitution of things, has been almost wholly applied to the artificial Constitution of Genus and Species. 'Tis true, there is ordinarily supposed a real Constitution of the sorts of Things; and 'tis past doubt, there must be some real Constitution, on which any Collection of simple Ideas co-existing, must depend. But it being evident, that Things are ranked under Names into sorts or Species, only as they agree to certain abstract Ideas, to which we have annexed those Names, the

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[21] Ibid., Bk. III, Ch. VI, Sec. 2, p. 439.

> Essence of each Genus, or Sort, comes to be nothing but that abstract Idea, which the General, or Sortal (if I may have leave so to call it from Sort, as I do General from Genus,) Name stands for ....[22]

Nominal essences then, signify or are signs of abstract ideas in the mind. The way in which we are able to identify them one from the other is through a kind of collective agreement in speech where the abstract idea is annexed to the right name:

> ... For the having the Essence of any Species, being that which makes any thing to be of that Species, and the conformity to the Idea, to which the name is annexed, being that which gives a right to that name, the having the Essence, and the having that Conformity, must needs be the same thing: Since to be of any Species, and to have a right to the name of that Species, is all one. As for Example, to be a Man, or of the Species Man, and to have a right to the name Man, is the same thing. Again, to be a Man, or of the Species Man, and have the Essence of a Man, is the same thing.[23]

To be a man then, or to have the essence of man is the same as to have the right to the name 'man'. The name stands for the abstract idea, and men agree on when to use the name 'man' when that name conforms with the abstract idea of 'man'.

The ultimate source of these ideas is grounded in sensation, but the original simple idea, coming from sensation, is so transformed and conjoined with other simple ideas, that the final product, the name 'man' for example, has absolutely no resemblance to the original simple idea. We shall return to this point again.

For now, we may reiterate Locke's position on essence by saying that the scholastic doctrine of substantial forms is criticized on

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[22]Ibid., Bk. III, Ch. III, Sec. 15, p. 417.

[23]Ibid., Bk. III, Ch. III, Sec. 12, pp. 414-415.

psychological grounds. This criticism has two important implications in the scope of his philosophy. He introduces a type of nominalism which destroys any previously asserted connection between a general term and its real essence, confining the construction of general terms to the workings of the human understanding. Secondly, he preserves the notion of real essence and gives it a special application according to a corpuscularian hypothesis.

We find that Boyle too is critical of the doctrine of substantial forms and rejects it on much the same grounds as Locke does:

> We may now advance somewhat further, and consider, that men having taken notice that certain conspicuous accidents were to be found associated in some bodies, and other conventions of accidents in other bodies, they did for conveniency, and for the more expeditious expression of their conceptions, agree to distinguish them into several sorts, which they call genders or species, according as they referred them, either upwards to a more comprehensive sort of bodies, or downward to a narrower species, or to individuals; as, observing many bodies to agree in being fusible, malleable, heavy and the like, they gave to that sort of body the name of Metal, ... Now when any body is referred to any particular species (as of a metal, a stone, or the like) because men have for their convenience agreed to signify all the essentials requisite to constitute such a body by one name, most of the writers of physicks have been apt to think, that besides the common matter of all bodies, there is but one thing that discriminates it from other kinds, and makes it what it is, and this, for brevity's sake, they call a form: ....[24]

Like Locke, he thought that it was a futile endeavour to look for these forms anywhere except in our thoughts. And like Locke, Boyle thought that the only signification that these words have is that of identifying an aggregate of qualities. By a kind of mutual agreement men use these words

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[24] R. Boyle, "Origin of Forms and Qualities," Works, Vol. III, p. 27.

and often mistake what the words really signify.

> ... And if you ask men, what they mean by a ruby, or nitre, or a pearl, they will still make you such answers, that you may clearly perceive, that whatever men talk in theory of substantial forms, yet that, upon whose account they really distinguish any one body from others, and refer it to this or that species of bodies, is nothing but an aggregate or convention of such accidents as most men do by a kind of agreement (for the thing is more arbitrary than we are aware of) think necessary or sufficient to make a portion of the universal matter belong to this or that determinate genus or species of natural bodies ....[25]

Boyle thinks that the fact that men do by agreement call a thing metal for example, is not an adequate reason from which to conclude that there exists such a thing as metal outside of their own conceptions, vocal utterances and sensory evidence.

We come now to a most important definition of substance by Aristotle and that is substance as a substratum or hypokeimenon. It is with this sense of substance that Locke has the most difficulty; we find him vascillating between a phenomenalist definition and an ontological description according to the real essence or qualities of matter. In Aristotelian philosophy, the hypokeimenon besides signifying logical subject, also refers to an undifferentiated primitive material force from which all forms and changes in the world are derived.

Before discussing the nature of substance specifically as substratum, Locke traces the development of our ideas and classifies them into specific sorts. First, he impresses upon the reader by various arguments that there are no innate ideas. How do we acquire our ideas then? The answer is unquestionably 'by experience'. Experience begins

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[25]Ibid., p. 27.

with two types of observation: observation of internal operations of the mind and observations of external sensible objects. In this distinction Locke already assumes at least the existence of sensible objects.

Our observation of external sensible objects comes to us through two types of sensation: sensation through several senses, and sensation through one sense only.

On the other hand, our observation of internal operations, which is considered by Locke as a kind of internal sense, is acquired through Reflection.

> ... By REFLECTION then, in the following part of this Discourse, I would be understood to mean, that notice which the Mind takes of its own Operations, and the manner of them, by reason whereof, there come to be Ideas of these Operations in the Understanding. These two, I say, viz. External, Material things, as the Objects of SENSATION; and the Operations of our own Minds within, as the Objects of REFLECTION, are, to me, the only Originals, from whence all our Ideas take their beginnings ....[26]

Reflection provides the Understanding with ideas of its own operations. These operations are described by Locke generally as:

> ... The other Fountain, from which Experience furnisheth the Understanding with Ideas, is the Perception of the Operations of our own Minds within us, as it is employ'd about the Ideas it has got; which Operations, when the Soul comes to reflect on, and consider, do furnish the Understanding with another set of Ideas, which could not be had from things without: and such are, Perception, Thinking, Doubting, Believing, Reasoning, Knowing, Willing, and all the different actings of our own Minds; ....[27]

More specifically, he treats them under the names of Perception, Retention, Discerning, Compounding, Enlarging and Abstracting. These

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[26] Locke, Essay, Bk. II, Ch. I, Sec. 4, p. 105.

[27] Ibid.

treatments are to be found under the following chapters respectively:

In Bk. II, Ch. IX of the Essay, Locke speaks of Perception as the simplest idea we have from Reflection and he sometimes calls it Thinking:

> ... Perception, as it is the first faculty of the Mind, exercised about our Ideas; so it is the first and simplest Idea we have from Reflection, and is by some called Thinking in general ....[28]

In Bk. II, Ch. X, he discusses Retention as the act of keeping ideas which have been gotten from Sensation and Reflection:

> The next Faculty of the Mind, whereby it makes a farther Progress towards Knowledge, is that which I call Retention, or the keeping of those simple Ideas, which from Sensation or Reflection it hath received. This is done two ways. First, by keeping the Idea, which is brought into it, for some time actually in view, which is called Contemplation.
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> The other way of Retention is the Power to revive again in our Minds those Ideas, which after imprinting have disappeared, or have been as it were laid aside out of Sight: And thus we do, when we conceive Heat or Light, Yellow or Sweet, the Object being removed. This is Memory, which is as it were the Store-house of our Ideas.[29]

In Bk. II, Ch. XI, Locke describes the operations of Discerning, Compounding and Abstracting. Discerning aids us in distinguishing one idea from another:

> Another Faculty, we may take notice of in our Minds, is that of Discerning and distinguishing between the several Ideas it has. It is not enough to have a confused Perception of something in general: Unless the Mind had a distinct Perception of different Objects, and their Qualities, it would be capable of very little Knowledge; though the Bodies that affect us, were as busie about us, as they are now, and the Mind were continually employ'd in thinking. On this faculty of Distinguishing one thing from another, depends the evidence and certainty of several, even very general Propositions, which have passed for innate Truths; ....[30]

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[28] Ibid., Bk. II, Ch. IX, Sec. 1, p. 143.

[29] Ibid., Bk. II, Ch. X, Sec. 1, p. 149.

[30] Ibid., Bk. II, Ch. XI, Sec. 1, p. 155.

Compounding is the operation whereby simple ideas received from sensation and reflection are put together:

> The next Operation we may observe in the Mind about its Ideas, is COMPOSITION; whereby it puts together several of those simple ones it has received from Sensation and Reflection, and combines them into complex ones.[31]

Enlarging is another operation which is very similar to compounding:

> ... Under this of Composition, may be reckon'd also that of ENLARGING, wherein though the Composition does not so much appear as in more complex ones, yet it is nevertheless a putting several Ideas together, though of the same kind. Thus by adding several Unites together, we make the Idea of a dozen; and putting together the repeated Ideas of several Perches, we frame that of a Furlong.[32]

Finally, we have the operation of Abstracting which condenses our use of names:

> The use of Words then being to stand as outward Marks of our internal Ideas, and those Ideas being taken from particular things, if every particular Idea that we take in, should have a distinct Name, Names must be endless. To prevent this, the Mind makes the particular Ideas, received from particular Objects, to become general; which is done by considering them as they are in the Mind such Appearances, separate from all other Existences, and the circumstances of real Existence, as Time, Place or any other concomitant Ideas. This is called ABSTRACTION, whereby Ideas taken from particular Beings, become general Representatives of all of the same kind; and their Names general Names, applicable to whatever exists conformable to such abstract Ideas ....[33]

What interests us most here is the idea of substance and its status as a substratum. First, let us establish what kind of idea the idea of substance is in Locke's epistemology. In Bk. II, Ch. XXIII,

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[31]Ibid., Bk. II, Ch. XI, Sec. 6, p. 158.

[32]Ibid., Bk. II, Ch. XI, Sec. 6, p. 158.

[33]Ibid., Bk. II, Ch. XI, Sec. 9, p. 159.

Locke defines substance in general as a complex idea:

> The Mind being, as I have declared, furnished with a great number of the simple Ideas, conveyed in by the Senses, as they are found in exteriour things, or by Reflection on its own Operations, takes notice also, that a certain number of these simple Ideas go constantly together; which being presumed to belong to one thing, and Words being suited to common apprehensions, and made use of for quick dispatch, are called so united in one subject, by one name; which by inadvertency we are apt afterward to talk of and consider as one simple Idea, which indeed is a complication of many Ideas together; Because, as I have said, not imagining how these simple Ideas can subsist by themselves, we accustom our selves, to suppose some Substratum, wherein they do subsist, and from which they do result, which therefore we call Substance.[34]

Our idea of substance in general, then, is a complex idea. As a complex idea it has this characteristic:

> ... The Acts of the Mind wherein it exerts its Power over its simple Ideas are chiefly these three, [I cite only the first] 1. Combining several simple Ideas into one compound one, and thus all Complex Ideas are made.[35]

The operation of compounding simple ideas then gives us our complex idea of Substance. The simple ideas which are compounded represent the impressions that the material world makes on our mind:

> ... These simple Ideas, when offered to the mind, the Understanding can no more refuse to have, nor alter, when they are imprinted, nor blot them out, and make new [simple] ones in it self, than a Mirror can refuse, alter, or obliterate the Images or Ideas, which, the Objects set before it, do therein produce. As the Bodies that surround us, do diversly affect our Organs, the mind is forced to receive the Impressions; and cannot avoid the Perception of those Ideas that are annexed to them.[36]

These simple ideas, which are acquired through the senses provide us with

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[34] Ibid., Bk. II, Ch. XXIII, Sec. 1, p. 295.

[35] Ibid., Bk. II, Ch. XII, Sec. 1, p. 163.

[36] Ibid., Bk. II, Ch. I, Sec. 25, p. 118.

knowledge which agrees with the reality of things:

> 'Tis evident, the Mind knows not Things immediately, but only by the intervention of the Ideas it has of them. Our Knowledge therefore is real, only so far as there is a conformity between our Ideas and the reality of Things. But what shall be here the Criterion? How shall the Mind, when it perceives nothing but its own Ideas, know that they agree with Things themselves? This, though it seems not to want difficulty, yet I think there be two sorts of Ideas, that, we may be assured, agree with Things.
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> First, The first are simple Ideas, which since the Mind, as has been shewed, can by no means make to it self, must necessarily be the product of Things operating on the Mind in a natural way, and producing therein those Perceptions which by the Wisdom and Will of our Maker they are ordained and adapted to. From whence it follows, that simple Ideas are not fictions of our Fancies, but the natural and regular productions of Things without us, really operating upon us; ....[37]

The simple ideas represent things as they really are because they are gotten directly from the world. They are like impressions which imprint themselves upon a surface.

The complex ideas, of substance in particular, however, cannot enjoy the same status:

> But though Definitions will serve to explain the Names of Substances, as they stand for our Ideas; yet they leave them not without great imperfection, as they stand for Things. For our Names of Substances being not put barely for our Ideas, but being made use of ultimately to represent Things, and so are put in their place, their signification must agree with the Truth of Things, as well as with Men's Ideas. And therefore in Substances, we are not always to rest in the ordinary complex Idea, commonly received as the signification of that Word, but must go a little farther, and enquire into the Nature and Properties of the Things themselves, and thereby perfect, as much as we can, our Ideas of their distinct Species; or else learn them from such as are used to that sort of Things, and are experienced in them. For since 'tis intended their Names should stand for such Collections of simple Ideas, as do really exist in Things themselves, as well as for the complex Idea in other Men's Minds, which in their

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[37] Ibid., Bk. IV, Ch. IV, Secs. 3, 4, pp. 563-564.

> ordinary acceptation they stand for: therefore to define their Names right, natural History is to be enquired into; and their Properties are, with care and examination, to be found out ....[38]

Locke is suggesting here, that an inquiry into the nature of things might extend our knowledge of substance. It is this type of inquiry to which we shall presently turn our attention.

We have seen that Locke gives both a nominalistic and a material account of substance. In what follows, I will suggest that the reason he holds these two views is because he is caught between the scientific knowledge of his time, which he respects, and the epistemological analysis of the words he employs. The two are not always in harmony.

This becomes particularly evident in his primary/secondary quality distinction. To see how Locke handled this subject, I shall adopt a framework in which the discussion can be formulated. I am indebted to Margaret Jo Osler, for a very useful approach to the discussion of matter.[39] She suggests that the problem of matter can be regarded as a problem arising at three different levels — the empirical level, the theoretical level and the metaphysical level. The observational or empirical level has to do with events of phenomenal experience; the theoretical level with scientific theories with regard to such unobservables as chemical bonds which can be evidenced indirectly, the metaphysical level deals with such questions as, 'Is the world composed of atoms and the void?', the answers to which provide a general

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[38] Ibid., Bk. III, Ch. XI, Sec. 24, pp. 520-521.

[39] Margaret Jo Osler, "John Locke and Some Philosophical Problems in the Science of Boyle and Newton," Indiana University Ph.D., University Microfilms, Inc., Ann Arbor, Michigan, 1968, pp. 30-39.

background to scientific inquiry but which can never be empirically tested.

It is not at all extravagant to view some of Locke's problems as arising out of his conflation of these different levels of discourse. Specifically, there is his primary/secondary quality distinction which is sometimes grounded on the corpuscular hypothesis, and sometimes on Locke's own radical empiricism.

Section 2 — Primary and Secondary Qualities

In Bk. II, Ch. VIII of the Essay, Locke distinguishes between the psychological source of all our ideas and their external or extra-mental source. We know that all the ideas we have are ultimately grounded in sensation, but what the causes are that produce these sensations,

> ... is an Enquiry not belonging to the Idea, as it is in the Understanding; but to the nature of the things existing without us. These are two very different things, and carefully to be distinguished; it being one thing to perceive, and know the Idea of White or Black, and quite another to examine what kind of particles they must be, and how ranged in the Superficies, to make any Object appear White or Black.[40]

We have then, two very different types of inquiry: an inquiry concerning human understanding and an inquiry concerning the nature of things. Locke distinguishes the two types by identifying one as having to do with perceptions and the other with explanation. On Osler's scheme, this distinction would be analogous to empirical observation on the one hand, and theoretical and metaphysical explanation, on the other. Unfortunately, Locke does not discuss the problems that may arise in

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[40] John Locke, Essay, Bk. II, Ch. VIII, Sec. 2, pp. 132-133.

moving from one level to another. He immediately attempts to connect the two levels by introducing causation. He speaks of External Objects agitating our 'animal spirits' and thereby causing sensations in us. It is possible that he acquired this idea when he engaged himself in iatro-chemical studies at Oxford. In any case, the mind-body problem is not here given any great importance:

> ... That all Sensation being produced in us, only by different degrees and modes of Motion in our animal Spirits, variously agitated by external Objects, the abatement of any former motion, must as necessarily produce a new sensation, as the variation or increase of it; and so introduce a new Idea, which depends only on a different motion of the animal Spirits in that Organ.[41]

Locke attempts to describe the nature of these objects which cause sensations in us. He does this by making a very important distinction between idea and quality:

> Whatsoever the Mind perceives in it self, or is the immediate object of Perception, Thought, or Understanding, that I call Idea; and the Power to produce any Idea in our mind, I call Quality of the Subject wherein that power is ....[42]

Qualities then, are the powers to produce ideas in us and these powers come from external objects. Locke speaks of power in two ways. In Bk. II, Ch. XXI of the Essay, power is an idea of reflection which comes to the mind, when it observes that simple ideas are in constant alteration. As for example, when we say that the sun has the power to melt wax, what we mean is not that we can observe this power as a quality in the sun, but rather we acquire a general idea of power by observing

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[41] Ibid., Bk. II, Ch. VIII, Sec. 4, p. 133.

[42] Ibid., Bk. II, Ch. VIII, Sec. 8, p. 134.

changes in simple ideas such as extension, hardness and colour. This sense of power is very much like Hume's idea of causality. In Bk. IV, Ch. III of the Essay, however, Locke also speaks of the powers of substances which change the sensible qualities of bodies, and this kind of power is not an idea at all but rather the ultimate physical cause of qualities.

Thus Locke speaks of power as an idea and he also speaks of it as an external force. When he speaks of it as something outside the mind, he has moved, once again, from straightforward observation to scientific or theoretical explanation. For Locke supports his contention that qualities are powers that produce ideas by referring us to the corpuscular hypothesis for an explanation:

> ... Because the Active and Passive Powers of Bodies, and their ways of operating, consisting in a Texture and Motion of Parts, which we cannot by any means come to discover: 'Tis but in very few Cases, we can be able to perceive their dependence on, or repugnance to any of those Ideas, which make our complex one of that sort of Things. I have here instanced in the corpuscularian Hypothesis, as that which is thought to go farthest in an intelligible Explication of the Qualities of Bodies; and I fear the Weakness of human Understanding is scarce able to substitute another, which will afford us a fuller and clearer discovery of the necessary Connexion, and Co-Existence, of the Powers, which are to be observed united in several sorts of them ....[43]

As far as scientific explanation goes, then, Locke favours the corpuscularian hypothesis. The corpuscularian hypothesis, as represented by Boyle, treats power not as a quality inherent in either subject or object, but rather as a mechanical relation between bodies which we are apt to consider, mistakenly, as possessing ontological significance. In

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[43] Ibid., Bk. IV, Ch. III, Sec. 16, pp. 547-548.

his metaphor of the lock and key, Boyle suggests that we should not look upon 'the power of fit or opening' as a new property which has emerged from the lock and key, but rather as a relationship. Similarly, a secondary quality must not be regarded as an essential attribute of a thing but as a phenomenon, available to sentient, sensible beings, which results from a specific arrangement and motion of insensible corpuscles.

Boyle was not bound to give a philosophical analysis of qualities. He wanted to classify properties according to those chemical alterations of bodies which he could observe. He had to rely on observation; for example, colour changes, because at that time there was no system of elements upon which to found the description of bodies. For his purposes, the mechanical description of matter and the observational classification of qualities were preferable alternatives to the scholastic doctrine of forms.

Locke, however, undertook an explanation of how the physical world affected our senses, and this involved him in a description of the qualities which was more far-reaching than Boyle's observation of chemical phenomena.

When Locke speaks of power as an idea of reflection, he is on comparatively safe ground. But when he speaks of power as a physical cause, he is drawn into metaphysical speculation about the nature of objects, which no direct observation, such as that of simple ideas, can support. This conflation of levels of discussion is borne by Locke's discussion of power as well as by his discussion of the qualities. We will presently examine how this is so.

He first discusses qualities in the chapter entitled 'Some

farther Considerations concerning our simple Ideas', in Bk. II of the Essay:

> Qualities thus considered in Bodies are, First such as are utterly inseparable from the Body, in what estate soever it be; such as in all the alterations and changes it suffers, all the force can be used upon it, it constantly keeps; and such as Sense constantly finds in every particle of Matter, which has bulk enough to be perceived, and the Mind finds inseparable from every particle of Matter, though less than to make it self singly be perceived by our Senses. v.g. Take a grain of Wheat, divide it into two parts, each part has still Solidity, Extension, Figure, and Mobility; .... These I call original or primary Qualities of Body, which I think we may observe to produce simple Ideas in us, viz. Solidity, Extension, Figure, Motion, or Rest, and Number.[44]

The primary qualities are here considered primary by virtue of the fact that (a) whatever alteration, be it chemical or mechanical, the object suffers, these qualities are still maintained, and (b) every particle of matter, if it be big enough to be perceived at all, appears to have these qualities, and (c) they have the power to produce ideas. What Locke calls secondary qualities are:

> ... Such Qualities, which in truth are nothing in the Objects themselves, but Powers to produce various Sensations in us by their primary Qualities, i.e. by the Bulk, Figure, Texture, and Motion of their insensible parts, as Colours, Sounds, Tasts, [sic] etc. These I call Secondary qualities ....[45]

Two questions may arise in this context: (1) Do both primary and secondary qualities have the power to produce ideas in us? (2) If so, how do we distinguish the powers of the secondary qualities from the power of the primary qualities? In Bk. II, Ch. XXI, Locke discusses power as a simple idea which is a 'principal ingredient' which makes

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[44] Ibid., Bk. II, Ch. VIII, Sec. 9, pp. 134-135.

[45] Ibid., Bk. II, Ch. VIII, Sec. 10, p. 135.

up our complex ideas of substance. At present, however, we are not interested in its epistemological status. To answer the above questions we must look to the end of this chapter and the chapter on 'Our Ideas of Substances'. At the end of the chapter on 'Power' he says:

> And thus I have, in a short draught, given a view of our original Ideas, from whence all the rest are derived, and of which they are made up; which if I would consider, as a Philosopher, and examine on what Causes they depend, and of what they are made, I believe they all might be reduced to these very few primary, and original ones, viz.
>
> Extension,
> Solidity,
> Mobility, or the Power of being moved;
>
> Which by our Senses we receive from Body:
>
> Perceptivity, or the Power of perception, or thinking;
> Motivity, or the Power of moving;
>
> which by reflection we receive from our Minds. I crave leave to make use of these two new Words, to avoid the danger of being mistaken in the use of those which are aequivocal. To which if we add
>
> Existence,
> Duration,
> Number;
>
> which belong both to the one, and the other, we have, perhaps, all the Original Ideas on which the rest depend. For by these, I imagine, might be explained the nature of Colours, Sounds, Tastes, Smells, and all other Ideas we have, if we had but Faculties acute enough to perceive the severally modified Extensions, and Motions, of these minute bodies, which produce those several Sensations in us ....[46]

Locke does not respond to these two questions directly, and we must extract an answer from this passage. Concerning the question, Do both primary and secondary qualities have the power to produce ideas in us? Locke suggests, in this passage, that primary qualities do. He treats

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[46] Ibid., Bk. II, Ch. XXI, Sec. 73, pp. 286-287.

the primary qualities as having the power to produce the sensible secondary qualities. But secondary qualities are, what could be called, the manifestations of these powers. Locke often speaks of secondary qualities as powers, and by this he means that were we to give a scientific explanation of the nature of the secondary qualities, we would find that they are no more than the manifestation of powers:

> I have in what just goes before, been engaged in Physical Enquiries a little farther than, perhaps, I intended. But it being necessary, to make the Nature of Sensation a little understood, and to make the difference between the Qualities in Bodies, and the Ideas produced by them in the Mind, to be distinctly conceived, without which it were impossible to discourse intelligibly of them; I hope, I shall be pardoned this little Excursion into Natural Philosophy, it being necessary in our present Enquiry, to distinguish the primary, and real Qualities of Bodies, which are always in them, (viz. Solidity, Extension, Figure, Number, and Motion, or Rest; and are sometimes perceived by us, viz. when the Bodies they are in, are big enough singly to be discerned) from those secondary and imputed Qualities, which are but the Powers of several Combinations of those primary ones, when they operate, without being distinctly discerned; ...[47]

Our answer to the first question then is: Only primary qualities have the power to produce ideas in us. Our second question was: How do we distinguish the powers of the primary qualities from the powers of the secondary qualities? Our answer must be: We do not have to distinguish them. The secondary qualities do not have the power to produce ideas in us. They are simply the manifestation of power.

Thus far, Locke has been talking science. He has simply reiterated the corpuscular theory of matter as Boyle presented it. In Osler's terms, he has been talking about qualities on the theoretical

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[47] Ibid., Bk. II, Ch. VIII, Sec. 22, p. 140.

level.

Problems arise in his distinction between primary and secondary qualities when he talks about them on the level of non-theoretical observation. For on this level, the qualities are not just powers and the manifestation of powers, but ideas too. Locke attempts to keep the two levels apart when in the above passage, he excuses himself for engaging in physical inquiries a little farther than perhaps he intended, but the levels are already interconnected. The distinction between primary and secondary qualities as treated by Locke and Boyle on the scientific level, is pregnant with epistemological difficulties.

The difficulties rest primarily in the treatment of secondary qualities as the manifestations of powers of the primary qualities. For consider the way in which these powers are manifested. They are manifested to the perceiver, and they are manifested as ideas. They are ideas of colour, texture, scent, etc. and not ideas of power. 'Power' is a word which has explanatory, but not descriptive value. It does not describe our ideas of secondary qualities; it explains how we get them.

The problem becomes plain when Locke tells us what the nature of the primary qualities is. They have something in common with the secondary qualities; they are also ideas. But primary qualities are more than just ideas:

> ... The First of these, as has been said, I think, may be properly called real Original, or primary Qualities, because they are in the things themselves, whether they are perceived or no: and upon their different Modifications it is, that the secondary Qualities depend ....[48]

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[48] Ibid., Bk. II, Ch. VIII, Sec. 23, p. 141.

They are qualities inherent in a thing as it is in itself, and regardless of our perception of the thing. To justify this proposition Locke only has to look to the corpuscular theory for support, for that theory entails Locke's claims. Locke's difficulties emerge when he tries to defend the above proposition on an epistemological level, and this will not do. For all we have to ask is 'How do you know that the primary qualities are inherent in things?' If we answer 'Because we perceive them' and that is the criterion, then the same criterion must apply to the secondary qualities.

Locke was not unaware of this difficulty. He tolerated it because he was sensitive to the revival of the corpuscular theory of matter in the seventeenth century. His acceptance of the theory created many philosophical problems, but it also encouraged philosophers of that era to contemplate the nature of things without turning a deaf ear to the discoveries of science.

CHAPTER IV

DISCUSSION OF LOCKE'S DISTINCTION AND THE CORPUSCULAR HYPOTHESIS

In the first three chapters of this study, I have attempted to place Locke's development of the primary/secondary quality distinction in what I consider to be the proper historical context. This I have done in order to avoid that common approach of historical commentators which is simply to look at Locke's distinction as an error. If one's purpose is to give an inventory of the mistakes made in the history of Empiricism then this approach has its advantages. It treats a philosophical problem or issue such as the primary/secondary quality distinction as a well-defined problem to which philosophers from various schools and eras can address themselves. This may provide scholars with the opportunity to perform a kind of dialectical operation on an issue and thereby to resolve the matter, or to reveal it as a pseudo-problem.

Yet this approach also has its disadvantages. The greatest of these is that it often misrepresents the philosophical problem as originally posed, and the philosopher's position on it. This happens as a result of abstracting the issue from its historical circumstances and defining it in inapplicable terms, or worse, of imagining that the problem is <u>given</u> in some Platonic sense and that it is our responsibility to solve it. In fact the solution to a problem is always

related to the way in which the problem is formulated, and is designed to answer specific questions that the problem poses. For Locke the problem was formulated like this: "How can we reconcile the facts of perception with the facts of the world, given that both are equally real?"

In discussing the primary/secondary quality distinction then, the most accurate representation of Locke's position will be the one which takes into consideration the state of physics and philosophy at that time.

In what follows, I shall maintain that the primary/secondary quality distinction was regenerated and supported by seventeenth-century natural philosophy. I will also argue that Locke's justification for the distinction rested on the corpuscular hypothesis, and that any criticism which attacks the distinction must do so by first attacking the corpuscular hypothesis. A number of articles have been written on the distinction and in the course of our discussion we shall examine them with the corpuscular hypothesis in mind. But first let us establish the claim that seventeenth-century science supported the distinction.

The 'corpuscular' hypothesis is that hypothesis which asserts the existence of two great principles in the universe -- matter and motion. Its respectability as a scientific theory came from the fact that it could be subjected to the test of strength for all scientific theories and meet the demands of such a test. This test is similar to the hypothetico-deductive model of modern science and is the most characteristic feature of the seventeenth century's departure from rationalism

in science. The most adamant advocate of this new method in science is Robert Boyle.

There was a belief that the hypothesis could be confirmed by the observation of facts, but this belief always rested on the hope that the development of the microscope would confirm the theory. For example, Newton suggested that improvements in the miscroscope would allow us to perceive some of the larger corpuscles. Locke and Descartes believed that the best possible confirmation of the corpuscular hypothesis of matter could come from the microscope. But because the microscope was not powerful enough, other means of observation had to be sought. In Part IV of the Principles, Descartes invites the reader to consider how a plant becomes larger and larger in the course of its growth.[1] He concludes that despite the inability of our senses to perceive the addition of small parts in the plant, it must, nevertheless, be the addition of these minute particles which is responsible for the plant's growth. Newton, in Rule III of the "Rules of Reasoning in Philosophy" in the Principia suggests a generalization from observable facts to non-observable entities:

> The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.[2]

There is a problem here with observation and the inability of the

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[1]René Descartes, "Principles of Philosophy," Philosophical Works, pp. 235-236.

[2]Isaac Newton, Mathematical Principles of Natural Philosophy, translated by Andrew Motte and Florian Cajori (Berkeley: University of California Press, 1934), p. 398.

senses to provide empirical confirmation for scientific principles. We may say, however, that support for the corpuscular hypothesis was measured in terms of its success in explanation. It was successful because it provided predictions and because it worked. Locke did not attempt to justify the hypothesis nor did he attempt to support it by examining the nature of our cogitations. He accepted it for the same reasons that science found it acceptable.

Section 1 -- Interpreting Locke's Distinction

It has been fifty years since Reginald Jackson published his paper "Locke's Primary and Secondary Qualities" in which he analyzed Locke's distinction and arrived at the correct conclusion that Locke's distinction has been persistently misrepresented.

The conclusion he reaches results from an analysis of the primary/secondary quality distinction which is consistent with my interpretation of Locke's distinction in the third chapter of my thesis. In this section we shall assign the role of a starting point to this interpretation.

Jackson's objective in determining the nature of Locke's distinction between primary and secondary qualities is what concerns us here. He objects to that view of Locke's doctrine which represents the distinction between primary and secondary qualities as a distinction between qualities and ideas respectively. In opposition to this, he contends that what Locke means by primary qualities is:

> ... simply qualities of bodies, that he calls them "primary" to distinguish them, not from other qualities as a kind of qualities, but from what are on his view only wrongly thought

> to be qualities, and that ... by "secondary qualities" he means, neither qualities nor ideas, but a third set of entities, which he calls "powers of bodies to produce ideas by means of (primary) qualities"....[3]

From this account it follows that we can neither be perceptually acquainted with the qualities of matter; that is, primary qualities, nor be perceptually acquainted with the effects of primary qualities; that is, secondary qualities. 'Secondary qualities' is the phrase we use to describe the configuration of primary qualities that may have some sensible effect. When we speak of these effects as powers, what we mean to do is to describe a process of interaction between different states of matter and the effect that these states have on our senses. It is only after the senses have been affected that we can even begin to speak of ideas.

If this is a correct interpretation of what Locke is saying, then any consideration of secondary qualities as mind-dependent ideas is wrong because secondary qualities are not ideas. We may have an idea of 'blue', but on this view to say that this idea of 'blue' is an idea of a secondary quality is equivalent to saying that this idea of 'blue' is an idea of power. Clearly, there is a distinction to be made between the idea -- 'blue' and the secondary quality -- power, which produced it.

What this analysis allows us to say is that our ideas produced by the secondary qualities or powers do not resemble these powers

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[3]Reginald Jackson, "Locke's Distinction Between Primary and Secondary Qualities," eds. C. B. Martin and D. M. Armstrong, Locke and Berkeley, A Collection of Critical Essays (New York: MacMillan Press, 1968), pp. 55-77.

perceptually. The ideas of the primary qualities, on the other hand, do resemble these qualities themselves although we never actually see them in microscopic corpuscles. Locke believes that it is possible in principle to discern the primary qualities of atoms if only progress could be made in physical science or in the development of the microscope. In any event, Locke accepts the doctrine that primary qualities are 'real' qualities of the insensible parts of matter. That is, shape, extension, 'motion and rest', are qualities which we directly perceive in macroscopic objects, and which would resemble the qualities of microscopic particles if we could but see them. Secondary qualities are not seen in fact and could not be observed in principle because they are powers that cause our ideas.

The resemblance between primary qualities and our ideas of them is this: The words we use to describe a primary quality are the same words we use to describe our ideas of the primary quality. No such resemblance exists between the words we use to describe a secondary quality and the words we use to describe our idea of a secondary quality.

The important questions here would be 'Why is Locke making such a distinction; if he is?; 'On what grounds can he support the theory that one set of qualities resembles our ideas of them while another set does not?' Locke does not pose or answer the question directly. We can, however, glean some information from the following passage:

> The particular Bulk, Number, Figure, and Motion of the parts of Fire, or Snow, are really in them, whether any ones Senses perceive them or no; and therefore they may be called real Qualities, because they really exist in those Bodies. But Light, Heat, Whiteness, or Coldness, are no more really in them, than Sickness or Pain is in Manna. Take away the Sensation of them; let not the Eyes see Light, or Colours, nor the Ears hear Sounds; let the

> Palate not Taste, nor the Nose Smell, and all Colours, Tastes, Odors, and Sounds, as they are such particular Ideas, vanish and cease, and are reduced to their Causes, i.e. Bulk, Figure, and Motion of Parts.[4]

Locke is not so much making an argument here for the case of resemblance, as he is repeating the major assertions of the corpuscular hypothesis. In this passage he is consistent in his treatment of the secondary qualities as mere powers.

My own view is that Locke made the distinction between primary and secondary qualities before examining how it is that we come to know them and not after. I also maintain that he adopted the distinction from Boyle, and consequently found himself in the position of building a theory of knowledge of qualities on the foundations of the corpuscular hypothesis.

The corpuscular hypothesis was, from Locke's point of view, a new paradigm in science. Its goal was to reduce all phenomena to mechanical explanations. This model of explanation treated the secondary qualities as phenomena which had to be explained with reference to the primary or 'catholick' properties of matter. These primary qualities were to be considered as the causes of the constant alteration we see in things. And it was the natural philosopher's dearest aspiration to find a constant regularity between the changes in matter and the changes we perceived in things.

The way these causes operated is of considerable importance to the primary/secondary quality distinction. The explanation is very close to the Democritean theory of εἴδωλα (see p. 11 of this essay).

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[4] Locke, Essay, Bk. II, Ch. VIII, Sec. 17, pp. 137-138.

Causation involves one body touching or moving another. The primary qualities, which are constitutive of matter, affect our senses by causing motions in them. Locke calls these effects powers. Our senses are touched by the powers, or as Democritus would have put it, εἴδωλα or films, emanating from the primary qualities. [The secondary qualities, on the Democritean model are but the phenomenal manifestation of these powers.][5] The different ontological status given to the primary and secondary qualities by Locke, is related to this mechanical explanation of perception and the material world.

There are many critics who disagree with Locke's distinction and their criticism usually ignores implications of the corpuscular hypothesis. In such cases, the onus probandi rests on those who wish to speak of Locke's distinction without considering the hypothesis as a major premise. My interpretation of Locke's distinction is influenced by the historical considerations and thus accounts for his distinction in the light of the hypothesis. My argument then for Locke's distinction is basically this:

1. The corpuscular hypothesis provides the best explanation of natural phenomena. We thus accept this hypothesis as the starting point in any inquiry into the nature of the material world.
2. If we accept the hypothesis then we are obliged to accept also its epistemological implications which include the primary/secondary quality distinction. The corpuscular hypothesis

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[5] I am grateful to Professor Martin Reidy for stressing the importance of 'touch' in Greek theories of perception to me in a casual conversation.

carries with it the primary/secondary quality distinction.

3. We have accepted the hypothesis. Therefore we accept the epistemological implications of the theory.

Section 2 — Contemporary Discussions of Locke's Choice

In the past several years the subject of Boyle's corpuscular hypothesis and its relationship to Locke's distinction has received considerable attention. As a result we find a small controversy brewing in a number of articles, I should like to review some of the salient points in these articles and respond to them.

a) Peter Alexander and the Problem of 'Illusion' and 'Resemblance'

In a paper entitled "Boyle and Locke on Primary and Secondary Qualities" (1972), Peter Alexander urges Locke scholars to take Boyle's influence on Locke seriously. His main thesis is that Locke was not attempting to make the primary/secondary quality distinction, but was accepting it along with the corpuscular hypothesis from Boyle. He points out that neither Boyle nor Locke regarded the corpuscular hypothesis as finally established and that nevertheless both accepted it on the grounds that it was a good mechanical explanation of natural phenomena. The only alternatives left to them when explaining natural phenomena, other than the hypothesis, would have been the scholastic way of speaking about substantial forms or outright scepticism. And this is precisely what Boyle and Locke wished to avoid.

On the basis of these remarks, Alexander proceeds to show that some orthodox criticisms of Locke, specifically the claim that Locke

fails to provide an adequate philosophical justification of the distinction, are misplaced and miss the point. For this is not what Locke was trying to do. He addresses himself to the following criticisms:

1. The first one is that Locke is often taken to be arguing for the distinction on the basis of the illusion-free perceptions of primary qualities contrasted to our perceptions (presumably illusory) of secondary qualities.

Alexander meets this criticism by saying:

> ... But Locke could not have missed either the fact that the shape and size of an object may appear differently from different points of view or the significance of this fact for his argument. He mentions illusions about primary qualities at II, ix, 8; II, xiv, 6; and II, xxi, 63. His claim, I suggest, is that our ideas of both primary and secondary qualities, and of the variations in them may all be explained in terms of the corpuscles.[6]

I think that Alexander's point is correct, but it does not get to the heart of the matter. The problem with this objection is, as he suggests, that it is misguided in the first place. There are two ways in which we can speak of illusions. One is to say that by illusions we mean that something is seen as other than it really is. Those who make this objection against Locke rely on this meaning of 'illusion' and thus can make their case. But in fact this use of 'illusion' is not the only one, and furthermore it is not the most sensible one given the facts of perception and the corpuscular hypothesis.

My point is that it makes sense to speak of illusions when speaking about our perceptions. In such cases illusions can occur in our

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[6]Peter Alexander, "Boyle and Locke on Primary and Secondary Qualities," (1972) in Locke on Human Understanding: Selected Essays, edited by I. C. Tipton (Oxford: Oxford University Press, 1977), pp. 62-76.

perceptions of 'primary qualities' as well as in our perceptions of 'secondary qualities'. To illustrate, consider the following examples: I see a table under two different conditions. In the first, the table is nearer to me and looks larger than in the second;

P.Q. Table is large at 10 ft.

illusion Table is small at 50 ft.

Similarly, under different lighting conditions, say dawn and noon, the leaves of a tree look different in colour.

S.Q. Colour is green in bright light

illusion Colour is blue in low light

In the world of perception 'illusion' is a relative term and has no reference to what size or colour a thing really is. In the world of unperceived objects the question of 'illusion' does not arise. Neither primary nor secondary qualities reveal their 'hidden' natures to us. The question of 'illusion' becomes a relevant problem when we attempt to make a connection between the mental and the material world. It just so happens that the corpuscular hypothesis relieves our ignorance of them by assuring us that perceptual shape is nothing other than perceptual shape in both microscopic and macroscopic objects, but this assurance does not come from perceptual knowledge and Locke knew this. To have an illusory perception of X, one must first have a real perception of X and since our perceptions just are, we cannot speak of illusory perceptions of either set of qualities.

2. A second objection to which Alexander directs his attention is that which claims that an empiricist, like Locke, cannot hold that ideas of sensation represent, and are caused by

unperceived external objects such as the corpuscles.

The question here is, 'On what grounds does Locke, as an empiricist, establish the existence of the corpuscles?' The answer is that Locke does not establish their existence . He does not assume that we can know of their existence empirically. Thus the objection is natural although its foundations are questionable. It assumes that the historical label of 'empiricist' attached to Locke is a title that Locke should have strictly respected. Locke was I think more concerned with basing parts of his philosophy on what he thought was a good hypothesis and at times, he did deviate from his image as an empiricist.

3. A third criticism concerns the alleged resemblance between primary qualities and our ideas of them.

Alexander responds to this by saying that Locke was misusing the word 'resemblance' and that what he really wanted to say was that we have accurate ideas of primary qualities.

This objection is similar to the first objection. The first objection claims that Locke was arguing for the distinction by pointing out the illusory nature of our perceptions of secondary qualities as contrasted with the non-illusory character of our perceptions of primary qualities. Our response to that objection was that Locke was aware of the fact that illusions occur with our perceptions of both primary and secondary qualities, but not in the way his critics would suggest. He gives the set of qualities a clear ontological status which is supported by the corpuscular hypothesis and is quite distinct from his account of our ideas. To speak metaphorically, we could say that Locke is sitting on a fence. On one side of the fence he faces—

the world of ideas. On the other side of the fence he rests his back on a network of scientific theory. In this situation 'illusions' take place in the world of ideas and not in the world of scientific descriptions.

But what of the 'resemblance' between primary qualities and our ideas of them? Do resemblances occur in the world of ideas or do they occur in the world of primary qualities of bodies? Or is there perhaps a third possibility; that is, that resemblances occur between the world of ideas of primary qualities and the world of primary qualities as they are described by scientific theory. The third possibility is what this objection takes Locke to be saying and Locke does say this in Sec. 15, Bk. II, Ch. VIII of the Essay. This places him in serious difficulty for there is no difference between ideas of primary qualities and primary qualities as described by scientific theory. If this is true, Locke is knocking down the fence and thereby defeating the purpose of its original construction.

Alexander maintains that what Locke meant by 'resemblance' was a resemblance between descriptions of ideas of primary qualities and the description of objects having these qualities. On this account, the description of the idea of shape, for example, would resemble a description of shape of an object. This would vindicate Locke of the charge that he was constructing an argument on the basis of resemblance between qualities and ideas. Critics certainly have grounds for believing what Locke meant by resemblance is something like the third possibility. He says, for example, that:

> ... the Ideas of Primary Qualities of Bodies, are Resemblances of them, and their Patterns do really exist in the Bodies themselves; but the Ideas, produced in us by these Secondary Qualities, have no resemblance of them at all. There is nothing like our Ideas, existing in the Bodies themselves ....[7]

Notice how Locke is using the word 'resemblance' here. When he speaks of the ideas of primary qualities of bodies, he says that the resemblance of these ideas are to be found in the bodies themselves. Thus there is a resemblance between the ideas of primary qualities and primary qualities as things in themselves. Ideas produced by secondary qualities, on the other hand, have no resemblance 'of them' or to the secondary qualities.

Notice also, Locke's use of the term patterns. The patterns refer to a state that the corpuscles can be in. A cluster of corpuscles can rearrange their path, position and motion and whatever state this cluster is in is called their pattern. This pattern, along with the primary qualities, can, according to the corpuscular hypothesis, explain the phenomenal or secondary qualities that we sense. So that, if we were to ask Boyle or Locke for a scientific account of the phenomenon of texture, they would tell us that texture is nothing in the thing itself but that it does correspond to the particular configuration, path and motion of the corpuscles. In this sense, there is a 'resemblance' between the primary qualities in bodies and the ideas of primary qualities as well as a 'correspondence' between the state of the corpuscles and the secondary qualities.

There still remains a problem with the primary qualities which is this: We notice a resemblance if and only if two things can be judged

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[7] Locke, Essay, Bk. II, Ch. VIII, Sec. 15, p. 137.

as being the same or similar. This is not so difficult a matter when speaking about ideas or perceptions. My idea of red is the same as my idea of red and similar to your idea of red. Alternatively, my idea of length resembles my idea of length as well as your idea of length. But my idea of anything does not and cannot resemble anything but an idea, as Berkeley says. Now, when we speak of primary qualities our discussion of resemblance, according to Locke, is not confined to a discussion of ideas. 'What resembles what?' is the important question. Two possibilities exist:

(i) our ideas of primary qualities resemble our ideas of primary qualities

(ii) our ideas of primary qualities resemble the primary qualities

If we accept the position that only ideas can resemble ideas, then (ii) is false unless primary qualities are ideas.

There are two ways for Locke to meet this difficulty. Both require a sympathetic interpretation of Locke's ambiguous use of the term 'resemblance'. The first is Alexander's point; that what Locke was groping for when using the word 'resemblance' was an account of an accurate idea which would allow him to speak about accurate ideas of primary qualities and inaccurate ideas of secondary qualities:

> ... He [Locke] seldom, if ever, uses 'idea' in the way in which more recent empiricists use, or ought to use, 'sense-datum'; for him, an idea is, nearly always, an idea of something. What follows 'of' is a description and, in a sense, it is descriptive of the idea. We describe an idea by saying that it is an idea of red or of an extension of one foot. This is how, in speech, we distinguish our ideas. Now primary qualities are such that the words we use in describing our ideas of them are also appropriate words for describing the qualities; secondary

> qualities are such that the words we use in describing our ideas of them will not do for describing the qualities. The description of an idea of a primary quality is of the form 'of x' and the description of the object having the quality is 'has x' or 'is x'; the resemblance is in the description ....[8]

Alexander's account exonerates Locke from a misuse of the term 'resemblance', but it does not reveal the significance of Locke's mistake.

My suggestion is that Locke did want to speak of 'resemblance' when he spoke of ideas. But when speaking of object and idea, he meant to use, and should have used the term 'correspondence'. In other words, he makes the term 'resemblance' do too much work for his purposes. And in the midst of confusion about what was meant or was not meant by Locke's use of the word 'resemblance', commentators easily forget why Locke adhered to the distinction between primary and secondary qualities in the first place. Locke was searching for a relationship between the world and our ideas and 'resemblance', as his critics point out would not do. Had he used the term 'correspondence' his task would not have been so difficult and misunderstood, although the difficulties of dualism still remain.

Let us consider the point about 'correspondence' more closely. When Locke says that our ideas of primary qualities resemble the primary qualities, he is discussing something on two levels. On the level of ideas he used the word 'resemblance'. On the level of physical objects, he again uses the word 'resemblance'. But Locke also uses the word 'resemblance' in a way which would signify a correspondence between our idea of X and the scientific description given to X; so that our ideas

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[8] Peter Alexander, "Boyle and Locke on Primary and Secondary Qualities," p. 75.

of primary qualities correspond to the scientific description given to those qualities by the corpuscular hypothesis -- whereas our ideas of secondary qualities do not.

Had Locke used the word 'correspondence', he would have been talking about a relation between ideas of primary qualities and the description of primary qualities given by science. That is, he would have said something like this:

I is a class of ideas.

Q is a class of qualities of physical objects.

I' is a sub class of ideas of primary qualities.

Q' is a sub class of primary qualities of physical objects.

Each member of class I' bears a definite relation to each member of class Q'.

Therefore, primary qualities of physical objects may be said to correspond to ideas of primary qualities.

There is a problem with 'definite relations' but this issue does not presently concern us.[8.5]

If this suggestion about when Locke should have used the word 'correspondence' and when he should have used the word 'resemblance' resolves some difficulties concerning his vocabulary, it does not relieve him from some difficulties concerning his metaphysical assumptions.

Had Locke ended his search for 'idea-quality' relations by using the notions of 'resemblance' and 'correspondence' respectively, the problem of the definite relation would be less aggravating. But he also claimed that all our ideas are ultimately caused by matter or the

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8.5 The purpose of this account is to state clearly Locke's opinion rather than to comment on it.

configurations and patterns of matter. He claimed this, but he could not explain how corpuscles could effect ideas. It remained for him a mystery which could be only partly revealed by future scientific developments for he supposed that ultimately the problem was a philosophical one. The corpuscular hypothesis raised the philosophical problem, but it could not solve it and Locke as an advocate of the 'new philosophy' left certain questions unanswered.

In beginning this review of criticisms directed to Locke's primary/secondary quality distinctions, I have started with Alexander's paper because his approach puts the discussion in the proper perspective. That is, although Locke's distinction is very often confusing and ambiguous, it is possible to resolve these difficulties by tracing them back to the assumptions inherent in the corpuscular hypothesis.

b) E. M. Curley on the Problem of 'Power' and 'Causal Law'

Some commentators like Alexander, have been concerned to trace Locke's ambiguities to their source. Others have attacked the ambiguities, and others still have argued against the corpuscular hypothesis.

I would now like to consider some criticisms which rest on a consideration of the corpuscular hypothesis.

In a paper entitled "Locke, Boyle and the Distinction Between Primary and Secondary Qualities,"[9] E. M. Curley is concerned to show that certain arguments attributed to Locke caricature his views about primary and secondary qualities. Since, however, such attributions as

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[9] E. M. Curley, "Locke, Boyle and the Distinction Between Primary and Secondary Qualities," Philosophical Review, LXXXI (1972): 438-464.

Curley reviews have already been considered and found to be misleading, we shall not be concerned with this part of his essay.

We shall take up that part of his essay which is devoted to a criticism of one aspect of Boyle's corpuscular hypothesis. That aspect is Curley's suggestion that there is a "genuine ambivalence about the concept of power," and that Boyle reveals this ambivalence when he wavers between two uses of the term 'power'.

The two passages from Boyle which Curley cites as those which show this ambivalence are the following: the first has to do with Boyle's example of the lock and key:

> ... these two pieces of iron might now be applied to one another after a certain manner, and that there was a congruity betwixt the wards of the lock and those of the key, the lock and the key did each of them now obtain a new capacity; and it became a main part of the notion and description of a lock, that it was capable of being made to lock or unlock by that piece of iron we call a key, and it was looked upon as a peculiar faculty and power in the key, that it was fitted to open and shut the lock; and yet by these new attributes there was not added any real or physical entity either to the lock or to the key, each of them remaining indeed nothing but the same piece of iron, just so shaped, as it was before ....[10]

Curley sees this account of power to be inconsistent with a later passage where Boyle uses the notion of power to acknowledge

> ... that bodies may be said in a very favourable sense to have those qualities we call sensible, though there were no animals in the world; for a body in that case may differ from those bodies which now are quite devoid of quality, in its having such a disposition of its constituent corpuscles, that in case it were duly applied to the sensory of an animal, it would produce such a sensible quality which a body of another texture would not:....[11]

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[10] Boyle, "The Nature of Physical Qualities," in The Works of the Hon. Robert Boyle (Vol. III, 1772), p. 18.

[11] Ibid., p. 24. [Italics mine.]

Obviously Locke does not say that he himself considers the view extravagant but that most men would judge this view as extravagant, at first glance. I think that what Locke is doing here is introducing the reader to what we would call the naive realist's position and then offering an objection to it.

Thirdly, if Locke does not deny that the ideas of secondary qualities resemble their causes on the grounds of the corpuscular hypothesis, I fail to imagine what other grounds he could have had. Palmer offers some suggestions but because they are all based on this elementary misinterpretation of Locke, I will not consider them.

d) Martha Brandt Bolton on the Origin of Locke's Distinction

Some very relevant and interesting research on the origin of the primary/secondary quality distinction in Locke has been conducted by Martha Brandt Bolton in a paper entitled "The Origins of Locke's Doctrine of Primary and Secondary Qualities."[21]

She reviews the doctrine as found in Draft A and Draft B of the Essay as well as the doctrine as found in the published versions of the Essay (hereafter referred to as 'the Essay').[22] In comparing the early

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[21]Martha Brandt Bolton, "The Origins of Locke's Doctrine of Primary and Secondary Qualities," The Philosophical Quarterly, Vol. 26, No. 105 (October 1976), pp. 305-317.

[22]Draft A has been published as "An Early Draft of Locke's Essay together with excerpts from His Journals," ed. by R. I. Aaron and Jocelyn Gibb (Oxford, 1936). Draft B has been published as "An Essay Concerning the Understanding, Knowledge, Opinion and Assent," ed. by Benjamin Rand (Cambridge, Mass., 1931). Bolton has maintained the spelling which appears in these drafts. The edition of the Essay which she uses to compare Draft A and Draft B is the John W. Yolton edition (New York, 1965).

drafts and the Essay, she finds that the primary/secondary quality doctrine is not present in the early drafts. The question which would concern most Locke scholars in the light of this discovery would be why Locke chose to include the doctrine only in the published versions of the Essay. Bolton tells us that the question becomes even more intriguing when we consider that Locke was familiar with Boyle's work at the time that he wrote the early drafts and Boyle's Works contain a lengthy discussion on the doctrine.

Bolton develops the hypothesis that the primary/secondary quality distinction was introduced in the published versions of the Essay by Locke in order to solve some difficulties and inadequacies which existed in Drafts A and B. This hypothesis, according to Bolton, shifts the emphasis which has sometimes been placed on Boyle's influence on Locke's doctrine of the distinction. She proceeds to test this hypothesis by delineating carefully the doctrine of primary and secondary qualities which is found in the drafts and the published versions of the Essay.

The doctrine which Bolton refers to in the Essay makes three major points: (1) that primary qualities are inseparable from bodies, both in perception and thought, (2) that secondary qualities are mere powers to produce ideas by means of the primary qualities of the insensible particles, and (3) that the ideas of primary qualities are "resemblances of bodies," but that there is nothing in bodies that resembles the ideas produced by secondary qualities.

It is this doctrine, Bolton maintains, which does not appear in Drafts A and B. In certain passages where something on the subject exists, she finds that Locke maintains the same meaning for qualities

in Draft A as he does in the Essay:

> Soe that Idea when it is spoken of as being in our understanding is the very perception or thought we have there, when it is spoken of as existing without is yet cause of that perception, and is supposed to be resembled by it, and this also I call quality, whereby I meane any thing existing without us which affecting any of our senses produces any simple Idea in us ....[23]

But unlike the Essay, what follows this definition of qualities in Draft A is a different distinction between sorts of qualities:

> I ... destinguish qualities into actuall and potential v.g. all the actuall qualitys in hony suger salt are those which any way affect our senses being duely applied to them and soe cause simple Ideas in us as its tast colour and smell and tangible qualitys, the potential qualitys in it are all the alteration it can of its actual qualitys receive from any thing else, or all the alteration it can make in other things v.g. solution in water, fusion in a strong fire corrosion of Iron &c.[24]

The distinction made here between 'actuall' qualities and 'potential' qualities, is different from the one appearing in the Essay.

There are other passages where Locke repeats Boyle's view that bodies produce effects on other bodies by the mechanical interaction of the insensible particles of matter that compose them. But nowhere does Bolton find a passage where Locke gives the qualities different ontological statuses as he does in the Essay. Other differences are also found when one gleans all the relevant passages and, when Bolton completes the task, there remain the following salient differences between the early drafts and the published versions of the Essay, on the

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[23]Draft A, p. 73. Locke says much the same thing here as he does in the Essay, II, VIII, 8 of the J. W. Yolton edition.

[24]Ibid., p. 73. Compare this to what appears in the Essay, II, VIII, 9-10, 15. A distinction is made between primaries and secondaries instead of "actuall" and "potential" qualities.

primary/secondary quality distinction:

1) in Draft A there is a distinction between actual and potential qualities instead of primary and secondary qualities.[25]

2) In Draft B Locke disclaims certain knowledge of the essence of bodies, and calls some properties "primary" according to their epistemic status. We have clear and distinct ideas of primary qualities. No ontological distinction is made between the primaries and the secondaries.[26]

3) In Draft B, the "primary" qualities are contrasted with others by pointing out that the others are modifications of the primary ones.[27]

4) No claim about resemblance between primary qualities and our ideas of them is made in the second draft.[28]

Out of these differences, Bolton sees certain difficulties arising. Specifically, the accounts of the ideas of material substances like gold, for example, are found to be inadequate because Locke says in Draft B, that whatever causes a simple idea in us is a quality. This gives the unfortunate implication that if gold is never looked upon, then gold does not have the quality of yellowness. Locke, if he is to make sense, must

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[25]Ibid., Draft A, p. 73.

[26]This is evidenced both by the passage quoted by Bolton in Draft B, pp. 199-200 and the fact that the doctrine of real and nominal essence found in the Essay, III, iii, 15-17 is (according to her research) nowhere mentioned in the early drafts.

[27]Draft B, p. 198.

[28]Notice that such a claim is made in Draft A, however, p. 73.

be understood to mean that whatever has the power to cause a simple idea in us is a quality, Bolton argues. But even so understood, Bolton finds this account inadequate in three respects.

First, the account implies that several powers can belong to the same thing. One can understand this account if one knows what it means to say that several powers can belong to the same thing, but Locke has not provided a way to understand this. If we are to look to the idea of a substratum, we still remain in the dark, for the idea of substratum is nothing more than the idea of several qualities.

Secondly, if we accept that a quality is whatever has the power to cause a simple idea in us, then a spirit that has the power to produce the appropriate ideas in us, could be considered to be a piece of gold.[29] Pressed to a logical extreme, one could say that God is gold if God has the power to produce the appropriate ideas of gold in us.

Thirdly, because the early accounts do not specify what it is in virtue of which a body has a power, they do not adequately show the differences between material substances of various kinds.

Bolton finds that these difficulties disappear under the primary/secondary quality doctrine in the Essay and she suggests that the doctrine was "introduced to solve these difficulties and should be understood in that light."

I agree with the first part of her conclusion and perhaps something should be said briefly on how these difficulties do not arise with the new distinction in the Essay. First, by stating at the outset that

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[29]See Draft A, p. 73 or p. 95 of this thesis.

only bodies have primary qualities, the second difficulty above does not arise. God is saved from being a material substance. Second, the third difficulty arose because any thing was permitted to have the power to produce any idea. Under the new account, secondary qualities are not just powers, but powers which produce ideas by means of the primary qualities of insensible particles. Thus some uniformity of nature and predictability of natural events can be expected.

Finally, the first difficulty disappears by resolution of the other difficulties. In the Essay we have a clearer definition of what a body is and thus we need not rely on an ambiguous notion of substratum.

I have no objections to Bolton's claim that the doctrine of primary and secondary qualities as it appears in the Essay is an improvement over what appears in the early drafts. However, I think that Bolton's claim that the distinction was introduced to solve these difficulties is an overstatement. It seems to me that the very possibility of making a comparison of the primary/secondary quality distinction in the drafts and in the Essay depends on some form of the distinction existing in the drafts first and then in the Essay. Therefore the doctrine could not have been suddenly introduced in the Essay to solve certain difficulties, as Bolton claims. The doctrine was revised in the Essay, but it was already there, in some form, in the drafts. This, I will soon indicate.

What I find particularly questionable are her references to the primary/secondary quality doctrine as being somehow non-Boylean in the early drafts of the Essay and more Boylean in the revised versions of the doctrine. This is suggested in the first part of her paper, where

she expresses surprise at the fact that the primary/secondary quality doctrine does not appear in the early drafts despite the fact that historians tell us that Locke was well acquainted with Boyle's work at the time.

In fact, the relevant passages in the early drafts which she cites do not stand in opposition to Boyle's primary/secondary quality distinction, as she suggests. I maintain that her surprise comes as a result of a case of misreading the evidence. That is, Bolton mistakenly identifies the primary/secondary quality doctrine in the Essay as the Boylean version, and then contrasts this with a supposed absence of the doctrine in the early drafts.

The evidence shows the contrary. A closer examination of Boyle's works will reveal not only the seeds of the distinction in the early drafts, but a closer version of Boyle's distinction than the one appearing in the Essay. Consider, for example, Boyle's description of the secondary qualities as dispositional which runs:

> I Do not deny but that bodies may be said in a very favourable sense to have those qualities we call sensible, though there were no animals in the world: for a body in that case may differ from those bodies which now are quite devoid of quality, in its having such a disposition of its constituent corpuscles, that in case it were duly applied to the sensory of an animal, it would produce such a sensible quality which a body of another texture would not: as though if there were no animals there would be no such thing as pain, yet a pin may, upon the account of its figure, be fitted to cause pain, in case it were moved against a man's finger; whereas a bullet, or other blunt body, moved against it with no greater force, will not cause any such perception of pain. And thus snow, though, if there were no lucid body nor organ of sight in the world, it would exhibit no colour at all (for I could not find it had any in places exactly darkened) yet it hath a greater disposition than a coal or foot, to reflect store of light outwards, when the sun shines upon them all three. And so we say, that a lute is in tune whether it be exactly played upon or no, if the

> strings be all so duly stretched as that it would appear to be in tune, if it were played upon. But as if you should thrust a pin into a man's finger, both a while before and after his death, though the pin be as sharp at one time as at another, and maketh in both cases alike a solution of continuity; yet in the former case the action of the pin will produce pain, and not in the latter, because in this the pricked body wants the soul, and consequently the perceptive faculty: so if there were no sensitive beings those bodies that are now the objects of our senses would be but dispositively, if I may so speak, endowed with colours, tastes, and the like; and actually, but only with those more catholick affections of bodies, figure, motion, texture, &c.[30]

This is very similar to Locke's statements about 'actuall and 'potential' qualities quoted earlier from Draft A. The similarity is so striking that one cannot help but suspect that Locke swerved away from Boyle in the Essay in order to avoid the difficulties of which Bolton speaks.

To illustrate, we shall take the four major differences which Bolton outlines from the early drafts and compare them to Boyle's account of the qualities as I have just outlined it.

The first one concerns the distinction between actual and potential qualities instead of primary and secondary qualities. Here, it should be understood that the actual and potential qualities are not intended to take the place of primary and secondary qualities. The distinction between actual and potential qualities can be easily reconciled with Boyle's mechanical explanation of secondary qualities. Boyle spent much ink in stressing his view that secondary qualities are not static, but are relations in the form of motion which are constantly changing. He advises us not to be surprised at the diversity and multiplicity of secondary qualities encountered in the same object. In this light,

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[30]Boyle, "The Origin of Forms and Qualities," Works, Vol. III, pp. 24-25.

Locke's distinction between actual and potential qualities can be regarded as a distinction between actual states of matter, which are presently affecting our senses, as well as other bodies and the potential states of matter which can occur when atoms are rearranged in a different order by motion.

The second difference which Bolton finds in Draft B is the lack of an ontological distinction between primary and secondary qualities. This too is in accord with the Boylean account. Boyle gave an operational definition of qualities wherever possible. He thought that the qualities we attribute to matter are really convenient ways of classifying an object. Form, for example, is for him nothing but matter itself considered in a particular mode of existence. Indeed, Boyle wished to do away with the habit of classifying matter according to non-experimental distinctions.

The third difference is also consistent with Boyle's explanation that secondary qualities are nothing but the modification of matter which according to the pre-Socratics have certain primary qualities. Finally, Bolton's fourth discovery -- that no claim about resemblance between primary qualities and our ideas of them is found in the second draft -- is a claim which is also absent in Boyle's works, as he seemed to be striving for an explanation of the activity of matter.

> Nor do I say that all qualities of bodies are directly sensible; but I observe that when one body works upon another, the knowledge we have of their operation proceeds either from some sensible quality, or some more catholick affection of matter, as motion, rest, or texture, generated or destroyed in one of them; for else it is hard to conceive how we shall come to discover what passes betwixt them.[31]

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[31] Boyle, Works, Vol. III, p. 24.

Whether the primary qualities resemble our ideas of them was a question which concerned Locke more than it did Boyle. In this passage, it is clear that Boyle is primarily interested in discovering the operations of matter. Later, Locke found it necessary to analyze the epistemological nature of this discovery.

After considering Boyle's account of the matter, it seems reasonable to conclude that although Bolton is correct in pointing out that Locke improved on the distinction in the Essay, she is mistaken in suggesting that the doctrine of primary and secondary qualities was altogether absent in the early drafts. Moreover, I believe that she has overstated her case when she says that the doctrine was introduced to deal with certain difficulties. What Locke says in those passages of the early drafts not only suggests that he was influenced by Boyle's distinction but that at the time, he wrote about this doctrine in its unadulterated form.

CONCLUSION

The primary/secondary quality distinction had its primitive beginnings in the atomic theory of the Greek and Roman materialists. It was characteristic of thinkers like Democritus, Epicurus and Lucretius to conclude that atoms must exist because this conclusion was consistent with their metaphysical theories. The qualities of matter were conjectured without any attempt to prove experimentally that such qualities must exist.

When Boyle adopted the atomic theory of matter, he distinguished between qualities, but he also tried to reproduce them under experimental conditions. He differed from the Ancients in method. The metaphysical assumptions about corpuscles, causal laws and substance were still operating, but a strong emphasis on observation marked the Boylean era as a scientific one.

Locke's account of the distinction does not differ significantly from Boyle's in that the metaphysical assumptions are the same. Where we find a difference is in Locke's analysis of observable qualities. This analysis involved Locke in epistemological questions about the qualities; a consideration which was necessary, but not of primary concern to Boyle.

It has been a commonplace observation that Locke's difficulties begin where Boyle's corpuscular hypothesis ends. This thesis maintains that Locke accepts the corpuscular hypothesis quite willingly because

he considers it the best scientific explanation of matter. The epistemological difficulties that arise from this hypothesis should not be regarded as an unfortunate result which Locke later discovered. The primary/secondary quality distinction was part of the corpuscular theory. Locke chose to accept the theory with the distinction despite the difficulties which he himself revealed.

These difficulties are predominant on the epistemological level. On this level of the discussion of primary and secondary qualities there arises a problem of the proper criterion to be used. As Berkeley argues, it is inconsistent to use one criterion for what are to qualify as primary qualities, and another for what are to qualify as secondary qualities. This is inconsistent for Berkeley because his immaterialist position requires the use of only one criterion. Locke's account is a result of his theoretical presuppositions. Given the choice between Berkeley's criterion and the acceptance of the corpuscular hypothesis, Locke would have chosen the corpuscular hypothesis. The reason for this is not difficult to see: his primary/secondary quality distinction was consistent with the scientific theories of his day and it allowed him to give a comprehensive explanation of both the material and the mental world.

The research conducted in this study reveals several things. First that the metaphysical origins of the atomic theory and the distinction appear in the speculations of the Ancients. Secondly, that this theory was revived in the seventeenth century. Thirdly, that Boyle and his contemporaries significantly influenced Locke's treatment of matter and our knowledge of it.

Finally, it should perhaps be noted that we need not be overly sympathetic to the view that Locke was anachronistic in relation to more radical empiricists. The approach of common-sense realism is still supported by scientific theory today. For example, scientific evidence supports the theory that electrical stimulation of the brain causes sensation. This is compatible with the dualistic position that the primary/secondary quality distinction is embedded in. Common-sense realism also accounts for hallucinations and illusions and in general provides us with a consistent explanation of the world.

Both Locke and contemporary common-sense realists have found the primary/secondary quality distinction attractive for similar reasons. The distinction has stood the test of time in that it remains a fundamental issue. Locke must be credited for raising the issue from its previously atomistic and scientific level to the level of philosophical analysis.

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APPENDIX I

BOYLE'S LETTER TO LOCKE

This is a typescript of MS Locke c.4 fol. 150^{r} - 152^{v} which is kept in the Bodleian Library, Oxford. This is the only extant letter from Boyle to Locke although de Beer's Correspondence of John Locke includes about a dozen letters from Locke to Boyle. This letter from Boyle also appears in the de Beer collection with modernized spelling.

It is unfortunate that the "Receipt" alluded to in this letter is no longer with the letter, but we have good reason to believe that it is a 'recipe' for making gold. In a letter to Locke, dated August 2nd, 1692 (see The Life and Letters of John Locke by Lord King, p. 222), Sir Isaac Newton warns Locke not to be too optimistic about the possibility of multiplying gold. He tells Locke that he himself is very sceptical about the success of such an experiment but concedes that his scepticism may be a result of the incomplete knowledge of the original 'recipe'. This 'recipe' was in Locke's hands and Newton had received only part of it from Boyle.

MS Locke c.4 fol. 150[r] :

"Lees In Essex June 2[d]
1666

S[r]

If your Letter had found me at London, this Returne of it would have been brought you much earlyer to Oxford. And though I now write in a place where a Crowd of such Persons whose Qualitys or Beauty re-quires a great deale of attendance, reduces me to make this Letter short & hasty; yet I cannot but snatch time to returne you my deserv'd Thanks for y[e] favor of yo[s] at some passages of w[ch] I could not but smile as well as you did, thô I was troubled y[t] soe much Curiosity & Industry as you expressd, should by soe grosse a want of it in others

be made soe unsuccessfull. But I
hope this will not discourage you
from embraceing, & seeking future
opportunitys to search into y^e^ nature
of Mineralls, in order to W^ch^, I wish
fol.150^v^ I had time & conveniency to send
you some sheets of Articles of Inqui
-rys about Mines in generall, w^ch^ I
once drew up, for y^e^ use of some freinds
& partly for my owne. My absence
fro~ London kept me fro~ receiving yo^r^
Acc.^t^ of y^r^ Barometricall observation, till
it was some days too late to make y^e^ use of it you
allow. But I hope I may have another
occasion to mention it pertinently as
it deserves. The Receipt I promisd
you is soe plaine & simple a thing
y^t^ as I would not comunicate to
every Body a Remedy of y^t^ appro
-ved Efficacy soe I should fear y^t^ its
seeming meanesse would make you

dispise it, if y^e Person tis now inclosed
to, were not lookd up on
as a Virtuoso by

S^r, Your very Affect: Freind
& humble Servant,
RO:Boyle."

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

fol. 150^r (in margin and at Rt. angles to 150^r MS):

"My humble service, to D^r Wallis, D^r Lower, M^r Thomas
& y^e rest of my Freinds at Oxford "

(address: fol. 151^v; [note: 151^r is blank])

"These
To my much Esteemd
Freind M^r John Lock
A.M. at Christ Church
Coll. Present
y^e 2^d Jn Oxford
post pd. "

(note on related items in NS:)

fol. 152[r] now states (in a contemporary hand different from both Locke and Boyle):

"These Receipts were taken out
of y[e] Box intitled
Chym-medical
Perused
To be sent to D[r] Lock for-prsal."

fol. 152[v]
in Locke's hand reads: (as a record he kept)

"Boyle
A paper I recd
with some of
M[r] Boyles papers
Nov. 92 "

APPENDIX II

BOYLE'S WORKS IN LOCKE'S LIBRARY

Entries 413.-473. list Boyle's works in Locke's library. This is an extract from The Library of John Locke by John Harrison and Peter Laslett, published for The Oxford Bibliographical Society by The Oxford University Press, 1965.

sages de la version du Nouveau Testament de Mons. [By N. Toinard.] 12° Par [16]93. p 214 $\frac{7}{242}$a. Oak Spring.

Les entretiens d'Ariste et d'Eugène. Nouvelle éd. 1682. *See* 1056.

404. Boullaye le Gouz [François de la]. Voiages 4° Par: [16]57. p. 338 $\frac{9}{33}$.

Boulton, Richard

405. Boulton, Ri: A treatise of the reason of muscular motion 12 Lon. [16]97. p 116 $\frac{6}{171}$b.
Another entry. Boulton. Ri A treatise of the reason of muscular motion 12° Lond. 97. p 116 $\frac{6}{171}$b. Oak Spring.

406. A treatise concerning the heat of the blood & y^e^ use of the lungs 12° Lon: [16]98. p. 204. $\frac{6}{143}$. Oak Spring.
See also 473.

Bounds (The) & bonds of publique obedience . . . [By F. Rous.] 2nd ed. 1650. *See* 2114.

407. Bourges, J[acques] d[e]. Relation du Voyage de Mons^r^ l'Eveque de Beryte. 8° Par. [16]66. p 245. $\frac{8}{136}$.
Oak Spring. 3-line page list in pencil.

407a. Boussingault, Adam. La guide universelle de tous les Pais-Bas . . . 12°, Paris, 1668.

407b. Boutauld, Michel. Les conseils de la sagesse . . . 12°, Paris 1677.

408. Bouvet, J[oachim]. Portrait historique de l'Empereur de la Chine 12° Par [16]97. p. 264 $\frac{7}{213}$b.

Bowchier, Joshua. *See* 936a.

409. Bowles [Joseph]. A discourse of the species order and governm^t^ of Christian Churches 12° Lon [17]01. p. 135 $\frac{7}{462}$c.

410. Boyer, A[bel]. French Dictionary. 4° Lon. [16]92 $\frac{11}{13}$a.

411. Boyer, P[aul]. Voyage a l'Amerique 8° Par 54. p. 463. $\frac{7}{13}$.

Véritable relation de tout ce qui s'est fait et passé au voyage que M. de Bretigny fit à l'Amérique Occidentale . . . 8°, Paris, 1654.

Boyle, Charles, *Earl of Orrery*

412. Boyle, C. D^r^ Bentley's dissertations on the Epistles of Phalaris and the Fables of Æsop examined 8° Lond [16]98. p. 290 $\frac{8}{45}$d.
See also 270.

Boyle, Robert

413. The origine of formes and qualities, according to the corpuscular philosophy . . . 8°, Oxford, 1666.
104. Lo: 66. p. 433 $\frac{7}{424}$ L.

414. A continuation of New experiments physico-mechanical touching the spring and weight of the air and their effects. 4°, Oxford, 1669.
104. Lo: 69. $\frac{9}{67}$ L.

415. Hydrostatical paradoxes, made out by new experiments . . . 8°, Oxford, 1666.
104. Lo: 66. 247 $\frac{7}{5}$ L.
Sr Geoffrey Keynes.

416. A discovery of the admirable rarefaction of the air. 4°, London, 1671.
104. Lo: M 22. p. 28 [*sic for* 1–10] L. *Forms pt. of* 472.

417. New observations about the duration of the spring of the air. 4°, London, 1671.
104. Lo: M 22. p. 28 [*sic for* 11–17] L. *Forms pt. of* 472.

418. New experiments touching the condensation of the air by meer cold . . . 4°, London, 1671.
104. Lo: M 22. p. 28 [*sic for* 18–23] L. *Forms pt. of* 472.

419. The admirably differing extension of the same quantity of air rarefied and compressed. 4°, London, 1671.
104. Lo: M 22. p. 28 [*sic for* 24–28] L. *Forms pt. of* 472.

420. Boyle, Rob. B: Tracts of flame & air hydrostatical. 8° Lond. [16]72 $\frac{7}{39}$.

421. New experiments about explosions ib $\frac{8}{68}$. *Forms pt. of* 420.

422. New experiments of the positive or relative levity of bodys under water. ib $\frac{8}{68}$. *Forms pt. of* 420.

423. New experiments about the pressure of the airs spring on bodys under water. ib $\frac{8}{68}$. *Forms pt. of* 420.

424. An hydrostaticall discourse ag^{t}: D^{r} More. ib. $\frac{8}{68}$. *Forms pt. of* 420.

425. Tracts [consisting of observations about the saltness of the sea . . .] 8° London [16]74. viz. $\frac{7}{32}$.

426. A new experiment & other instances of the efficacy of the airs moisture. 8° London. [16]73. *Forms pt. of* 425.

427. Of the positive or privative nature of cold. ib $\frac{8}{68}$. *Forms pt. of* 425.

428. Two problems about cold. ib. *Forms pt. of* 425.

429. Observations & experiments about the saltnesse of the sea. ib $\frac{8}{68}$. *Forms pt. of* 425.

430. Relations about the bottom of the sea ib $\frac{8}{68}$. *Forms pt. of* 425.

431. A staticall hygroscope 8° London. [16]73 ib. *Forms pt. of* 425.

432. [Tracts: containing I.] Suspitions about some hidden Qualityes in the air ib [8°, London, 1674.] $\frac{8}{68}$.

433. Observations about the growth of Metalls 8° Lond. [16]74 ib $\frac{8}{63}$. *Forms pt. of* 432.

434. Of the causes of Attraction by Suction 8° London. [16]74 $\frac{8}{68}$. *Forms pt. of* 432.

435. Additional experiments about hidden qualityes of the air. 8° London. [16]74 $\frac{8}{68}$. *Forms pt. of* 432.

436. Animadversions upon Hobbes's problemata de vacuo. 8° Lond: [16]74 $\frac{8}{68}$. *Forms pt. of* 432.

437. New Experiments about the preservation of bodies in Vacuo Boyliano. 8° London. [16]74. *Forms pt. of* 432.

438. The Aerial Noctiluca. 8° London. [16]80 A.E: 82 $\frac{51}{402}$ - [i.e. reviewed in Acta Eruditorum, 1682, p. 53.] $\frac{8}{167}$.

439. Certain physiological Essays 4° Lon. [16]61 $\frac{7}{51}$a $\frac{8}{59}$.

440. [Medicinal experiments; or] A Collection of choyce remedies 12° Lon. [16]92. p. 88.

441. The excellency of Theology compared with nāal philosophie. 8° Lon. [16]74. p. 232 $\frac{7}{124}$.

442. [Some occasional thoughts] About the excellency & grounds of the mechanical hypothesis. ib. p. 40. *Forms pt. of* 441.

443. [New] Experim^{ts}: & observations made upon y^{e} icy Noctiluca 8°. Lon: [16]81 130 $\frac{8}{170}$.
Oak Spring.

444. Sceptical Chymist 8°. Lon: [16]61 $\frac{8}{241}$.
Houghton Library, Harvard. 8-entry page list in ink.

445. Languid Motion 8°. Lon: 90 $\frac{7}{29}$.
An essay of the great effects of even languid and unheeded motion . . . 8°, London, 1690.
Oak Spring. Liber Johannis Locke ex Dono Authoris.

446. [An experimental discourse] Of some unheeded causes of y^{e} Insalubrity & Salubrity of y^{e} Air. $\frac{7}{29}$. *Forms pt. of* 445.

447. Experimentorum Phisico Mechanicorum continuatio secunda 8°. Lon: [16]80. 223 $\frac{7}{42}$.
Oak Spring. Liber J. Locke ex Dono Authoris.
4-entry page list in pencil.

448. Experimenta et observatt: Physicæ 8° Lon: [16]91 138 $\frac{7}{58}$.

449. Of strange reports ib 28 $\frac{7}{58}$. *Forms pt. of* 448.

450. X^{an}: Vertuosa [*sic*] 8°. Lon: [16]90. 120 $\frac{7}{60}$.

451. Reflections on y^{e} distinction of above reason & not ag^{t}: reason ib [16]90 35 $\frac{7}{60}$. *Forms pt. of* 450.

452. Greatness of mind promoted by X^{an}ity: $\frac{7}{60}$. *Forms pt. of* 450.