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THE EFFECT OF THE ADVANCE IN SCIENTIFIC KNOWLEDGE
UPON SEVENTEENTH CENTURY LITERATURE.

English.

Course iv.

1912.

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Crites - "It has been observed of arts and sciences that in one and the same century they have arrived to a great perfection; and no wonder, since every age has a kind of universal genius, which inclines those that live in it to some particular studies: the work then being pushed on by many hands, must of necessity go forward.

Is it not evident, in these last hundred years (when the study of philosophy has been the business of all the Virtuosi in Christendom), that almost a new Nature has been revealed to us? that more errors of the school have been detected, more useful experiments in philosophy have been made, more noble secrets in optics, medicine, anatomy, astronomy discovered, than in all those credulous and dotting ages from Aristotle to us? - so true it is, that nothing spreads more fast than science, when rightly and generally cultivated.

Dryden. An Essay of Dramatic Poesy.

(1668).

BIBLIOGRAPHY FOR THE SCIENTIFIC PORTION OF THE ESSAY.

i Modern Authorities.

Armitage. F. P.	History of Chemistry. 1906.
Ball. Sir. R. S.	Great Astronomers. 1895.
Ball. W. R. R.	History of Mathematics. 1888.
Bauer. H.	History of Chemistry. 1907.
Beazley. Prof. C. R.	Dawn of Modern Geography. 1897-1906.
Berdoe. E.	Origin and Growth of the Healing Art. 1899
Buckley. A. B.	Short History of Natural Science. 1883.
Huggins. Sir W.	The Royal Society. 1906.
Muir. M. M. P.	Story of Alchemy. 1902.
Sachs. J. Von.	History of Botany. 1906.
Traill. H. D. and Mann. G. S. (editors).	Social England. Vol. III - V. 1901-04.
Weld. C. R.	History of the Royal Society. 1848.
Withington. E. T.	Medical History from the Earliest Times 1894.

ii Seventeenth Century Writers.

Boyle R.	Works. ed T. Birch 1774. (espec. The Scep- tical Chymist).
Gilbert. W.	On the Loadstone and Magnetic Bodies. trans. Mottelay. 1893.
Glanvill. G.	Answer to Mr. Henry Stubbe. The Doctor of Warwick. 1671. Essay on Philosophy and Religion. 1676. Philosophia Pia or a Discourse of Experimental Philosophy. 1671.

i The date given is not necessarily that of the 1st. edition
this will be found in the text.

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THE EFFECT OF THE ADVANCE IN SCIENTIFIC KNOWLEDGE
UPON SEVENTEENTH CENTURY LITERATURE.

INTRODUCTION.

In a wide sense the term Literature may be held to comprehend all written or printed matter whatsoever - anything which avails itself of the medium of letters - but such a connotation destroys a distinction which most people make between a literary work and a scientific treatise. No doubt the North country farmers who were inveigled into purchasing copies of Ruskin's "Construction of Sheepfolds" owing to its equivocal title, explained to the bookseller, in stolid bucolic logic, the difference between the two, for the theological pamphlet would be described by them as literature, since it had no use in connection with their daily employments. Latent in their minds was the general belief that a purely literary work has a definite purpose which differs from that of a scientific one. The definition which Coleridge found inadequate to distinguish poetry and science will serve admirably to show the goal which literature and science have in view. "The proper and immediate object of science", he writes "is the acquirement, or communication of truth; the proper and immediate object of literature is the communication of immediate pleasure". The souveraineté du but demands the differences in matter and treatment which follow. Literature like poetry must be universal: it does not deal with technicalities nor does it ask the reader to

bring with him any definite technical equipment - his humanity is sufficient. Science, on the contrary, may legitimately require highly specialised knowledge in the reader, and then proceed from this ground to deal with matters which everyone cannot be expected to enjoy. The subject matter selected, the scientist endeavours to see it by the "siccum lumen" of the understanding, for science wages ceaseless warfare against the anthropomorphic tendencies of the human mind, always seeking to eradicate the universal confidence in the old Protagorean maxim "Man is the measure". Literature, on the other hand, views all things from the human standpoint and gives us human thoughts and feelings about the world around. The scientific treatise is objective, the literary work is subjective, so that we may compare them to a photographic print and a landscape respectively.

Nevertheless Literature and Science, like Philosophy and Religion are both the children of Wonder, though their methods have developed along such divergent lines that they are sometimes thought to be enemies, instead of the offspring of a common parent. Yet both attest their descent by their eager hopefulness - nothing is too wonderful to be true for either of them. Literature seeks for the order which reigns supreme through so much of human life even in the tangled web of pity and terror in which an Antigone or Lear is involved, while Science expects to find the same beautiful economy in the life of the lowliest and apparently most useless pond insect, as in that of the highest organism. Both attempt to resolve knots and difficulties in human experience but the

differences in the procedure adopted give rise to the perennial problem of the relationship of the two. The great writer has to decide how far results obtained by scientific methods may be incorporated into a work which is produced by a dissimilar mental process. It might be thought that an author could ignore the conclusions of science but in so far as he wishes to be a teacher, or to justify the ways of God to men, this course is impossible. He cannot speak as one having authority if the veriest dilettante in science may correct him. Moreover there is a general demand - and on the whole it is a reasonable one - that the great author should be able to understand the only world which the majority of people find at all intelligible, viz., the material one around. Still more imperious is the necessity which every writer feels within himself, urging him to hold fast to reality. There is a sense in which the world can be too little with us and the great imaginative artist has peculiar temptations to relax his grasp. Thus we find the sciences, indeed "terrible Muses", represented in literature, for the writer dare not avert his gaze from any important part of human life lest the facts which have been neglected should negative his whole position.

1. To illustrate this point we may refer to Plato's use of the myth. When he reaches a point in the argument beyond which it is impossible to proceed further by logical demonstration, he frequently lifts the whole discourse into a different plane by introducing a myth. This myth endeavours to arouse that transcendental feeling which it is the highest purpose of

1. Idea suggested by Prof. Stewart's Myths of Plato.

literature, and the other arts, to awaken, and which Nature herself excites without the grace of art. The myth is not intended to argue the auditors into belief nor does it profess to be exact in detail. "A man of sense ought not to say, nor will I be very confident that the description which I have given is exactly true. But I do say that he may venture to think not improperly or unworthily that something of the kind is true", says Socrates. Yet in this very myth, he is careful to bring the details into accordance with the teachings of "modern" science. He recognizes the rotundity of the earth, and while accepting the popular geocentric theory, explains incidentally the origin of hot and cold springs, volcanic action, and tidal movements. This shows in miniature the problem which confronts all literature. Of course Plato's geographical details do not form the most beautiful portion of the dialogue any more than the astronomical technicalities of Dante and Milton would serve to illustrate their poetical power. Yet the author works more freely and soars higher because he feels that there is a solid foundation of scientific fact at bottom. Possibly contemporaries felt just the same kind of pleasant surprise at these approximations to "modern" science, as we do at Tennyson's allusions to evolution and the nebular hypothesis. When the little systems have had their day students of Tennyson, like those of Dante and Milton, will be forced to resuscitate the theory in order to understand the poet, or in cases where the scientific fact is not disproved posterity will wonder at the interest displayed in it.

The question of the relationship of science and literature we have always with us, but it becomes more urgent when great and revolutionary changes are taking place in man's conception of the external world and of his place in the scheme of things. There are at least two such critical periods in literature - the 17th. and 19th. centuries. In the seventeenth century Galileo brought the Copernican hypothesis prominently before the world, and in the nineteenth Darwin explained his doctrine of Evolution. The seventeenth century heard with amazement that the sun, moon and stars are not merely the servants of man, passing in ceaseless procession around the passive earth, and that this earth of ours is not the "nodus et vinculum" of the cosmos, but just one world among myriads. The nineteenth century learned with dismay that no fixed line can be drawn between animal and human life, but that in the course of ages lower organisms have developed to produce "sovereign man". Both theories dealt a mighty blow at man's pride, though at the same time immense possibilities were opened to view. If the earth is only a wanderer in space, it is also a heavenly body, one with the stars above; while if man has developed from the lower animals there is the hope that he may some day become as high as the angels. Thus far the two periods are alike, but there is nothing in the nineteenth century to parallel the enthusiastic interest in scientific facts which dominated the seventeenth century. Men viewed the external world "with other eyes", (as did Teufelsdröckh after his baphometric fire baptism in the Rue de l'Enfer), when the diffusion of Bacon's

i teachings showed that it could be employed to extend human
 knowledge almost indefinitely. Lecky tells us that in this
 period "a passion for natural philosophy much resembling
 that which preceded the French Revolution had become general;
 and the whole force of English intellect was directed to
 the study of natural phenomena and to the discovery of natural
 laws. In the seventeenth century literature recognized "the
 ii impassioned expression which is in the countenance of all
 science," and so we find an extraordinary prevalence of
 scientific allusions throughout both prose and poetry. Not
 one or two favoured individuals but the whole nation was
 iii "nourishing a youth sublime
 With the fairy tales of science, and the long result of time."

i Rise and Influence of Rationalism in Europe. Vol.1. p.109.
 ii Wordsworth. Preface to Lyrical Ballads.
 iii Locksley Hall.

THE ORIGIN AND DEVELOPMENT OF THE SEVENTEENTH CENTURY
INTEREST IN SCIENCE.

Attempts have been made to trace the beginning of the scientific movement in the Renaissance of the 14th., 15th., and 16th. centuries, and it is probable that the seeds which developed later were sown in the wonderful expansion of that time, though it is to be remembered that the interest in, and admiration for, ancient authors were not confined to poets, philosophers, and orators, but were extended to the writings of astronomers, physicians, and anatomists like Ptolemy, Hippocrates and Galen, while the words of Aristotle were considered as irrefragable as the inspired utterances of Holy Writ. Of course the writings of Aristotle, properly considered, encourage enquiry into facts, but men were content to grasp at the shadow and lose the substance, by accepting his results but ignoring the method and spirit by which they were produced. For a time then, the Revival of Learning had an adverse effect upon scientific studies, and the Renaissance of Science was delayed till the seventeenth century, although before that time signs of returning life may be discerned. The name of Francis Bacon is always connected with this revival, though the justice of the association has been repeatedly challenged. There has been a tendency for the scientific world to split into two opposing camps, one party disposed to assign to him the

honour of all subsequent discoveries made by the inductive method, and the other determined to deny that he has had any influence upon science during his own or succeeding times. To decide between these opinions it is necessary to consider the history of the scientific movement in the seventeenth century.

Francis Bacon (1561 - 1626) stands at the threshold of the period looking backward to the eager pulsating time of the Renaissance and forward to the patient research spirit of the seventeenth century. Before his time, attacks had been made upon the scholastic philosophy, but the ancient authors, especially Aristotle, were still regarded as the sole masters of those who desired to know, to the complete neglect of the teachings of Nature. It was left for Bacon to deliver the mortal and despatching blows to this worship, freeing science from the shackles of authority. Dr. Rawley

- i. tells us on information "imparted from his lordship", that "whilst he was commorant in the University, about sixteen years of age, he first fell into the dislike of the philosophy of Aristotle", owing to the fact that it was "a philosophy only strong for disputations and contentions, but barren of the production of works for the benefit of the
- ii. life of man". Bacon was unjust to Aristotle but the universal misuse of the ancient philosopher's works misled
- iii. him. He rightly pointed out that just as water will not ascend higher than the level of the spring from which it takes

1. Works Vol.1 p.4 Spedding; Francis Bacon Vol.1 p.5-6. Also Nov. Org. Bk.1. Aph. 121.

ii. Especially in Nov. Org. Bk. 1. Aph. 63.

iii. Adv. Bk. 1. iv. 12.

its origin, so knowledge drawn from Aristotle, and subjected to no examination, will not rise higher than the source from which it is derived. Bacon often compares the labours of the schoolmen and their pupils, to the spinning of a

- i. spider's web. "For the wit and mind of man, if it work upon matter, which is the contemplation of the creatures of God, worketh according to the stuff, and is limited thereby; but if it work upon itself, as the spider worketh his web, then it is endless, and brings forth indeed cobwebs of learning, admirable for the fineness of thread and work, but of no
- i. substance or profit". Having their minds "shut up in the cells of a few authors", and "no great quantity of matter" with which to work, the schoolmen were forced to tie and untie the same knots continually, and Bacon tried to demonstrate to them the Penelope-like nature of their task.
- ii. He urged men to abandon the broad road of "high and vaporous imaginations" leading only to "hopes and beliefs of strange and impossible shapes", and enter the safe, though narrow way, of sober and laborious enquiry into facts. He found a science which might be described succinctly in Hamlet's phrase "Words, words, words", and he left men inspired with a resolute determination to understand the things which words inadequately represent. Cowley realised the first service which Bacon rendered to science, and in the Ode prefixed to the 1667 edition of Sprat's History of the Royal Society he writes:-

i. Adv. Bk.1 iv.5.
 ii. Adv. Bk.11 viii. 3.

1. "From words, which are but pictures of the thought
(Though we our thoughts from them perversely drew)
To things, the mind's right object, he it brought.
Like foolish birds to painted grapes we flew;
He sought and gathered for our use the true".

Bacon considered himself to be the founder of the method, whereby particular facts are studied in order to obtain

- ii. general laws, known as Induction. In the Advancement of Learning (1605) he tells us that "all true and fruitful natural philosophy hath a double scale or ladder ascendent and descendent" but in the Novum Organum (1620) we have
- iii. Deduction and Induction more elaborately differentiated. "There are, and can be, only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immovable, proceeds to judgement and to the discovery of middle idioms. And this way is now in fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all. This is the true way, but as
- iv. yet untried". While Bacon revealed to men the possibility of extending human knowledge by a study of natural phenomena he warns them against the danger of prejudices and delusions. It is not only necessary to see, but to see clearly. To show this Bacon invented what is perhaps the most beautiful of all

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1. Ode to the Royal Society (metaphor comparing words to pictures Adv. Bk.i. iv.3).
 - ii. Adv. Bk. ii. vii.1.
 - iii. Nov. Org. Bk. i. Aph. 19.
 - iv. Bacon slightly moderates the last clause in Nov. Org. Bk. i. Aph. 105.

his illustrations, bright winged and iridescent as many of them are, viz., the Idols, which must be removed before Truth can find an entrance into the City of Mansoul. These Idols

- i. are the false appearances which are imposed upon the understanding and Bacon classifies them thus: first, the Idols of the Tribe; second, the Idols of the Cave; third, the Idols of the Market-place; and lastly, the Idols of the Theatre.
- ii. In dealing with Idols of the Tribe, which have their foundation laid deeply in human nature itself, he points out the weakness of induction by simple enumeration, and the importance of considering negative instances. This protest against the tendency of many a Mistress Quickly to elaborate the fact that a dying man has "parted even just between twelve and one, even at the turning o' the tide", into a universal law in defiance of statistics, is of vital importance when considering Bacon's position in the history of philosophic and scientific thought. All things are
- iii. possible if only men will cast away the Idols "with a fixed and solemn determination, and the understanding thoroughly freed and cleansed; the entrance into the kingdom of man, founded on the sciences, being not much other than the entrance into the Kingdom of Heaven whereinto none may enter except as a little child".
- iv. Bacon also pointed out the important part which

i. Adv. Bk.ii. xiv. 9,10,11: much more clearly Nov. Org. Bk. i. Aph. 38 et seq.
 ii. Adv. Bk.ii. xiv.9: Nov. Org. Bk.i. Aph. 46.
 iii. Nov. Org. Bk.i. Aph. 68.
 iv. Nov. Org. Bk.i. 82, 83. Adv. Bk.ii. xiii. 9.

experiment plays in the attainment of knowledge and suggested that its usefulness might be further extended. He was fond of comparing the questions which science puts to nature with

- i. the cross-examination of a witness under torture. "For like as a man's disposition is never well known till he be crossed, nor Proteus ever changed shapes till he was straitened and held fast; so the passages and variations of nature cannot appear so fully in the liberty of nature as in the trials and vexations of art". Coleridge, who considered Bacon wrote "in
- ii. the language of the gods", said, "Bacon when like himself - for
- iii. no man was ever more inconsistent - says 'Prudens questio dimidium scientiae est'." Often we find the whole scientific movement of the 17th. century described as the Experimental Philosophy, from the importance which Bacon attached to this form of enquiry.

- Even without the Comus-like spells of Macaulay's "dear wit and gay rhetoric" it is quite apparent that Bacon is not the originator of the inductive method, nor even of the
- iv. philosophy of experiment. Common sense tells us that "The inductive method has been practised ever since the beginning of the world by every human being. It is practised by the most ignorant clown, the most thoughtless schoolboy, by the very child at the breast." Wherein then lies Bacon's claim to pre-eminence, for it cannot be doubted that the inductive method is the very corner stone of the

i. Adv. Bk.ii. 1.6. Nov. Org. Bk.i. Aph. 98.
 ii. Literary Remains (The Drama Generally, and Public Taste)
 iii. Table Talk. Oct. 8. 1830.
 iv. Macaulay Essay on Bacon.

Baconian temple of philosophy ? To assert that Bacon only re-discovered an old truth is to make an objection which applies with almost equal force to every system of knowledge. People recognized that things only exist for us as far as they are perceived, before Berkeley; that what we call "laws of nature" may be conceived of as our way of systematizing experience, before Kant; that all religions are true in so far as they serve to explain the world, before James; that intellect is only a part of the whole self, and life more than knowledge, before Bergson. Like Monsieur Jourdain, we are more accomplished than we thought - we have been philosophers all our lives without knowing it. The great thinkers here mentioned re-discovered the truths for which their systems are famous at crucial times. The age which most needed to grasp the truth firmly had allowed it to pass into oblivion, or groped blindly for it in vain. Bacon came at just such a critical period, for men had forgotten that the books of the ancients are not the only vehicles of truth. With convincing eloquence he persuaded them that

- i. they must not "disdain to spell, and so by degrees to read in the volume of God's works". We find this metaphor constantly recurring in seventeenth century literature.
- ii. Sir Thomas Browne tells us in his inimitable way that "there are two books from whence I collect my Divinity; besides that written one of God, another of His servant Nature, that universal and public Manuscript, that lies expanded unto the

i. Adv. Bk.i. V.6.
 ii. Religio Medici Part 1.

eyes of all". Drummond wrote the sonnet "Of this fair volume which we world do name" on the same theme, and Milton

- i. twice employs the comparison in *Paradise Lost*.

- Bacon was one of the divinely inspired beings whom
- ii. Carlyle describes as "children of the idea". Like Ram Dass he believed that he was furnished with fire to consume the miseries of men, and this Promethean energy flames through all his writings from first to last. He took all
 - iii. knowledge for his province and hoped that the "discovery of all causes and sciences would be but the work of a few years", if only the world would hear his message. The promises which he made on behalf of the new philosophy were calculated to attract the attention of men. He considered that
 - iv. knowledge should be "a rich storehouse for the glory of the Creator, and the relief of man's estate". A science which
 - v. had no effect upon the life of man he held as barren as religion without works. Macaulay not inadequately describes his system as the Philosophy of Fruit, and the splendid visions which Bacon saw, inspired the whole century with a desire to press on towards the promised Kingdom of Man. Bacon did not think that the mere registration of facts would revolutionize the life of man but this was the first step to be taken. When a complete Natural History had been made he thought that it would be possible to discover the

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- i. Bk. iii. l.47 - 50. Bk. viii. l.66-69.
 - ii. Life of Sir Walter Scott.
 - iii. Letter to Lord Burghley quoted in Spedding's Francis Bacon Vol.1. p.56.
 - iv. Adv. Bk.1. 5. 11.
 - v. Nov. Org. Bk.1. Aph. 73.

very essences of all things, in virtue of which they exist, to which entities he gave the name of "forms". Bacon imagined that quite apart from the totality of conditions which go to produce a thing or an effect, there is one definite "form" which causes a thing to exist, or an effect

- i. to be produced. "The form of a nature is such, that given
- ii. the form the nature infallibly follows" and "whosoever knoweth any form knoweth the utmost possibility of superinducing that nature upon any variety of matter".

Thus Bacon promised to give the world a Novum Organum far more powerful than the old philosopher's stone. Science, however, can only describe his hopes as chimerical. The seventeenth century scientists rarely mention the doctrine of formal causes but they realised the necessity of collecting facts. The plethora of illustration which Bacon employed to show the infallibility of his system, convinced men that some great thing would ultimately proceed from the

- iii. experimental philosophy. He compared the method which he was advocating to the compasses which enable the schoolboy to draw a circle as perfect as that which is made by a skilled
- iv. draughtsman. He undertook to point out the true course so that the lame man who should follow his direction would outstrip the runner whose very skill is his undoing, leading him yet farther astray. His method would go far to level men's wits, leaving but little to individual excellence

i. Nov. Org. Bk.ii. Aph. iv.
 ii. Adv. Bk.ii. vii. 6.
 iii. Adv. Bk.ii. xiii. 4. Nov. Org. Bk.i. Aph. 123.
 iv. Nov. Org. Bk.i. Aph. 61.

- i. "because it performs everything by the surest rules and demonstrations". Other inventions were due to chance, men
- ii. were beholden "to a nightingale for music, or to the pot lid that flew off for artillery", but the *Novum Organum* would mechanically reveal further devices, irrespective of the skill of the man who employed it. Such hopes were baseless, but the enthusiasm they kindled helped to bring about the Renaissance of Science which took place in the seventeenth century. Bacon not only pointed out the true grapes but,
- iii. "... when on heaps the chosen bunches lay,
He prest them wisely the mechanic way,
Till all their juice did in one vessel join,
Ferment into a nourishment divine,
The thirsty soul's refreshing wine".

Although Bacon had these Faustus-like visions he realized that he could hardly expect to see their materialization in his own life time. He compares himself to a bell-ringer summoning others to church, a pioneer in the mine of truth, the leader who sounds the clarion, but enters not into the battle, "an image in a crossway, that may point at the way, but cannot go it". Cowley compares him to Moses on Pisgah:-

"The barren wilderness he past,
Did on the very border stand
Of the blest promised land,
And from the mountain's top of his exalted wit,
Saw it himself, and shewed us it.
But life did never to one man allow
Time to discover worlds, and conquer too;
Nor can so short a line sufficient be
To fathom the vast depths of nature's sea".

- i. *Nov. Org. Bk.i. Aph. 122.*
- ii. *Adv. Bk.ii. xiii. 2.*
- iii. *Cowley. Ode to Royal Society. (metaphor suggested by Nov. Org. Bk.i. Aph.123).*
- iv. *Adv. Bk.ii. 12, 15.*

Copernicus in the sixteenth century, and Gilbert, Napier, and Harvey, in the early part of the seventeenth century, were working in the spirit of the new philosophy quite independently of Bacon, so that it is not possible to give him the credit of being the herald of the Renaissance of Science, but he was, as his writings incontestably prove in golden notes, the "vates sacer" of the scientific spirit. Harvey alone of all his contemporaries, speaks in depreciatory terms of Bacon's work, saying that he dealt with science "like a Lord Chancellor". Ben Jonson's estimate of his character and work is to be found at great
 i. length in Discoveries and it is surprisingly favourable. His seventeenth century successors rarely mention his name without an encomiastic adjective. Bishop Wilkins styles
 ii. him "the judicious Verulam", while Glanvil describes him
 iii. as "the immortal Lord Bacon", or "the deep and judicious Verulam". Boyle's works in five large volumes, contain allusions to "the noble Viscount St. Albans", and "Bacon, the great restorer of physics", passim. Sprat's tribute is
 iv. not more generous than just. He describes Bacon as "a man of strong, clear, and powerful imaginations: his genius was searching and inimitable, and of this I need give no other proof, than his style itself; which, as for the most part, it describes men's minds, as well as pictures do their bodies, so it did his above all men living. The

i. Discoveries 51, 73, 123.

ii. Discovery of a New World.

iii. Plus Ultra.

iv. History of the Royal Society. Part 1. Section 16.

course of it vigorous and majestic, the wit bold and familiar, the comparisons fetched out of the way, and yet the most easy: in all expressing a soul, equally skilled in men and nature. All this and much more is true of him, but yet his Philosophical Works do show that a single, and busy hand can never grasp all this whole design of which we treat. His rules were admirable: yet history, not so faithful as might have been wished in many places; he seems rather to take all that comes, than to choose; and to heap, rather than to register. But I hope this accusation of mine can be no great injury to his memory, seeing that at the same time, that I say he had not the strength of a thousand men, I do also allow him to have had as much as twenty". Whether

- i. Bacon's methods were "fructifera" or not, it cannot be denied that his words were "lucifera", and he gives the best "Apologia pro vita sua", when he says that he is content to
- ii. sow "for future ages the seeds of a purer truth" and perform his part towards the commencement of the great undertaking.

Bacon died in 1626 and the interest in the study of the external world did not pass away with him, as we see from the publication of Browne's *Pseudodoxia Epidemica* in 1646; but since this work is hardly concerned with the development of science viewed apart from literature, we may pass on to consider the rise of the Royal Society which did more than anything else to extend the seventeenth century interest in science. Exactly how the society originated is somewhat

i. Nov. Org. Bk.i. Aph.70 and 99.
 ii. *ibid.* Bk.i. Aph.116.

1. of a mystery, but the account of Dr. Wallis is generally accepted as correct. He tells us that about 1645, while resident at London, he became acquainted with "divers worthy persons, inquisitive into natural philosophy" who met by agreement weekly to discuss such matters. His account of their occupations may be quoted since it gives compendiously the subjects which exercised the Royal Society after its incorporation. "Our business was (precluding matters of theology and state affairs) to discourse and consider of philosophical enquiries and such as related thereunto: as Physics, Anatomy, Geometry, Astronomy, Navigation, Statics, Magneticks, Chymistry, Mechanics, and Natural experiments; with the state of these studies as then cultivated at home and abroad. We then discoursed of the circulation of the blood, the valves in the veins, the *venae lacteae*, and the lymphatic vessels, the Copernican hypothesis, the nature of comets and new stars, the satellities of Jupiter, the oval shape as it then appeared of Saturn, the spots in the sun, and its turning on its own axis, the inequalities and selenography of the moon, the several phases of Venus and Mercury, the improvement of telescopes, and grinding of glasses for that purpose, the weight of the air, the possibility or impossibility of vacuities, and Nature's abhorrence thereof, the Torricellian experiment in quicksilver, the descent of heavy bodies and the degrees of acceleration therein; with divers other things of like nature.

1. Most easily accessible in Weld's History of the Royal Society. (1846) Vol.i. p.30 et seq.

Some of them were then but new discoveries, and others not so generally known and embraced as they now are, with other things appertaining to what hath been called the New Philosophy, which from the time of Galileo at Florence and Sir Francis Bacon (Lord Verulam) in England, hath been much cultivated in Italy, France, Germany, and other parts abroad as well as with us in England". The discussion of these subjects, as the following pages show, was not confined to scientific gatherings, but was extended into literature, both poets and prose writers alluding to them. It will be noticed that Wallis mentions Bacon as one of the originators of the new spirit, and the whole idea of such learned societies arose from Bacon's eloquent description of the College of Solomon's House, "the very eye of this kingdom", in the New Atlantis. Boyle alludes to the same little band

i. of which Dr. Wallis gives an account in a series of letters under the enigmatical title of the "Invisible College".

This name has caused much conjecture but it is quite possible that Boyle, who was profoundly influenced by Bacon, had the methods of Solomon's House in mind. Those who sailed from Peru and were accidentally borne to the New Atlantis marvelled at the invisibility of travellers from the island "for it seemed to us a condition and propriety of Divine Powers and Beings, to be hidden and unseen to others, and yet to have others open, and as in a light to them".

Before the Royal Society was incorporated we find

i. Letters quoted in Weld's History of the Royal Society Vol.i. p.38-39.

several attempts made to found a College after Bacon's model and curiously enough the projects are all connected with names familiar in literature. In 1648 we have Sir William Petty's "Advice to Mr. Samuel Hartlib for the advancement of some particular parts of learning" which is an interesting side light on the multifarious interests of Milton's correspondent. Much more important than this, however, is the

- i. plan mentioned by Evelyn in his Diary, "I communicated to Mr. Robert Boyle, son to the Earl of Cork, my proposal for
- ii. erecting a philosophic and mathematic college". This letter well deserves perusal as it gives a most pleasing view of Evelyn's generous disposition, as well as making a significant contrast to Bacon's idealistic scheme. Evelyn realises that it is hopeless to look for a "mathematical college, much less a Solomon's House" in these dull Northern latitudes, so he works out a plan in great detail which is not to cost more than £ 1600 "at utmost." He even arranges for the restricted menu, which will be a necessary accompaniment of high thinking carried on with such small funds. The seekers after knowledge are to have "one meal a day of two dishes only" (unless some little extraordinary upon particular days or occasions, then never exceeding three) of plain and wholesome meat".

- iii. Cowley's "Proposition for the Advancement of Experimental Philosophy" was published in 1661, immediately before the incorporation of the Royal Society, and though

i. Sept. 1st. 1659.

ii. Quoted in full by Weld. Vol. i. p. 43-49.

iii. Cowley's Prose Works.

more elaborate than Evelyn's scheme, it is equally interesting, and is written in his characteristic, graceful style. Cowley expressly states that "we do not design this after the model of Solomon's House (which is a project of experiments which can never be experimented) but propose it within such bounds of expense as have often been exceeded by the buildings of private citizens". Despite this protest the whole spirit of the proposal is Baconian. He adapts Bacon's suggestion that there should be itinerant as well as resident professors, that there should be museums, laboratories, aquariums, etc., and that inventors should be honoured by statues. The professorial staff are to be busy about many matters but "briefly all things contained in the catalogue of natural histories annexed to my Lord Bacon's Organon". Really all the differences between the two spring from the fact that the revenue of the college is not to exceed £ 4000 and "Three thousand two hundred and eighty five pounds" of this will have to be paid in salaries. Neither of these proposals received "a local habitation and a name"; but they helped to hasten the incorporation of the Royal Society.

The company of scientific enthusiasts to whom Wallis and Boyle allude, became divided into two parts about 1648 or 1649 owing to the removal of some of the original members to Oxford. The London and Oxford members thus formed two societies which were independent of, but preserved a friendly relation with, one another. In 1662 the London branch became

incorporated and was henceforth known as the Royal Society. Its history is the history of science in England, for its rolls number as Fellows all the great English scientists from then to the present day. The Oxford society continued in close connection with the newly founded Royal Society till its dissolution in 1690. The Royal Society was mainly occupied with matters similar to those referred to by Wallis, but in those early days it by no means confined its attention to pure science. Of this we shall have occasion to speak later.

The Royal Society acknowledged Bacon as its inspirer and Spratt informs us that if his wishes had prevailed

- i. there would "have been no other Preface to the History of the Royal Society than some of his writings" for "that great man had the true imagination of the whole extent of this enterprise as it is now set on foot". Joseph Glanvil
- ii. apostrophizes the members thus "You really are what former ages could contrive but within romances; and Solomon's House in the New Atlantis, was a prophetic scheme of the Royal Society", and in his Plus Ultra, published in 1668, (which gives a most valuable contemporary account of the whole
- iii. scientific movement), he tells us that Bacon "formed a society for experiments in a romantic model, but ~~he~~ could do no more; his time was not ripe for such performances". Oldenburg who compiled the first volume of "Philosophical Transactions of the Royal Society" agrees that "The

i. History of the Royal Society. Part 1. Sect. 16.
 ii. Scep̄sis Scientifica - Dedication.
 iii. Plus Ultra. Chapter xiii.

i. enrichment of the storehouse of philosophy was a work begun by the single care and conduct of the excellent Lord Verulam, and is now prosecuted by the joint undertaking of the Royal Society". Boyle also acknowledged as founder "that profound naturalist our great Verulam".

The Royal Society adopted the methods advocated by Bacon and they were pursued with increasing vigour by its members throughout the century. Before long, however, the new movement met with determined opposition and the "virtuoso" became the favourite butt of satire. Much of the opposition was due to the dead weight of superstition which threatened to impede all progress. The most extraordinary beliefs lingered in the various sciences, as the following pages will show, but one superstition, viz., the belief in witchcraft, may be mentioned here. Reginald Scot's sane demonological work entitled *The Discovery of Witchcraft* appeared in 1584, but in the 17th. century the superstition was as prevalent as ever. The strange part of the matter is that even the most enlightened part of the community clung to this relic of the Dark Ages. Bacon was to a certain extent a believer in witchcraft, though he doubted not that

ii. many of the relations thereof were "fabulous and fantastical". Most of the supporters of witchcraft alleged scriptural warrant for their belief. Sir Thomas Browne declares "For

iii. my part, I have ever believed and do now know, that there are Witches: they that doubt of these, do not only deny them

i. Philosophical Transactions. No. xx. p.391.
 ii.. Adv. Bk.ii. vi.2.
 iii. Religio Medici. Part 1.

but Spirits; and are obliquely and upon consequence a sort not of Infidels, but Atheists" while in the Pseudodoxia

- i. Epidemica he tells us that Satan" endeavours to propagate the unbelief of witches, whose concession infers his own co-existency". Browne's part in the trial of the two luckless women at Bury St. Edmunds on March 10th. 1664 is notorious. Dr. Henry More who supported the Copernican theory when few would give it serious consideration, frequently declares his belief in the existence of witches, in his philosophical
- ii. poems. In a letter prefixed to Glanvil's Sadducismus Triumphatus (1666) he scorns the opposition to witchcraft offered by such "coarse grained philosophers as those Hobbians and Spinozians" and kindred "philosophick Sir Foplings", considering it "a special piece of Providence that there are ever and anon such fresh examples of apparitions and witchcraft as may rub up and awaken their benumbed and lethargic minds into a suspicion at least, if not assurance, that there are other intelligent beings besides those that are clad in heavy earth and clay". Glanvil to whom this letter was addressed was a member of the Royal Society and wrote a whole series of works in justification of the new movement. Yet by some strange irony the author of the Vanity of Dogmatizing (1661), and of Scepsis Scientifica (1666) also wrote the Sadducismus Triumphatus containing "full and plain evidence concerning witches and apparitions". Every argument brought against witchcraft is weighed and

i. Pseud. Epid. Bk.i. Chap.x.

ii. Pre-existency of the Soul Stanzas 57 and 58.

found wanting. Glanvil appears to hold firmly by the old maxim "Credo quia impossibile est", for when opponents allege the absurdity of hags journeying on brooms and similar exploits he calmly replies, "The more absurd or unaccountable these actions are, the greater confirmations are they to the truth of those relations, and the reality the objectors would destroy". Samuel Pepys hearing a noise during the night and coupling this with the fact that "our young cat did leap down our stairs from top to bottom, at two leaps, and frightened us, that we could not tell whether it was the cat or a spirit" notes in his diary "we do sometimes think this morning that the house might be haunted". Allusions to witchcraft are commonplaces in seventeenth century literature and plays having considerable portions of them devoted to the rites and misdeeds of witches are common. We have the Weird Sisters of Shakespeare's Macbeth, the Dame, and Mother Maudlin, of Ben Jonson's Masque of Queens, and The Sad Shepherd respectively. In addition to these we have Middleton's "tragicoomodie" of The Witch, Heywood and Brome's The Late Lancashire Witches, and The Witch of Edmonton, the joint work of Ford, Dekker, and Rowley. As late as 1681 Shadwell wrote The Lancashire Witches, in the Preface of which he naively remarks "For the magical part I had no hopes of equalling Shakespeare in fancy, who created his witchcraft for the most part out of his imagination (in which no man ever excelled him) and therefore I resolved to

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- i. Sadducismus Triumphatus.
 - ii. Diary Nov. 29. 1666-7.

take mine from authority". Shadwell gives the authorities for his statements in notes at the foot of the page, but is careful to add that he feels somewhat dubious about the authenticity of many witch stories. We cannot say that these dramatists believed in witchcraft, but the audiences evidently enjoyed references to such subjects, and the author himself doubtless maintained much the same attitude towards the matter as the general public of today, towards the necromantic proceedings of the spiritualists. They felt that possibly there was truth at bottom in spite of the tissue of fabrications. The terrible part of the matter is that thousands of hapless creatures were doomed to death, and anything which tended to curb the bloodthirsty folly of the practice deserves high commendation. Webster whose *Displaying of Supposed Witchcraft* appeared in 1677 appealed to the scientific spirit, arguing that one of the great causes of

- i. the belief was "men's supine negligence in not searching into, and experimenting the power of natural agents, but resting satisfied in the sleepy notions of general rules and
- ii. speculative philosophy." Subsequent historians of witchcraft have agreed that the Royal Society did ultimately render the belief untenable.

Obstinate as was the opposition offered to the experimental philosophy by ignorance and superstition it was not so damaging as the satire of the wits. Spratt indeed

i. *Displaying of Supposed Witchcraft*. Chap. xiii.
 ii. Lecky. *Rise and Influence of Rationalism in Europe*.
 Vol. i. p. 108 et seq. Sir W. Scott. *Letters on Demonology and Witchcraft*. Letter viii.

confesses that he considered it necessary to propitiate these terrible railleurs lest the infant society should be laughed out of existence. Many critics thought the laborious experiments and observations conducted by the members as ridiculous as the subtleties of the schoolmen.

- i. "A virtuoso", says Butler, "differs from a pedant as things do from words; for he uses the same affectation in his operations and experiments, as the other does in language".
- ii. Spratt tried to explain that "some must gather, some must bring, some separate, some examine and (to use a similitude which the present time of the year and the ripe fields that lie before my eyes suggest to me) it is in philosophy as in husbandry; wherein we see that a few hands will serve to measure out, and fill into sacks, that corn which requires very many more labourers to sow, and reap, and bind, and bring into the barn".

Bacon's Pisgah-sight of the promised Kingdom of Man had also aroused such high hopes that we continually find laments as to the futility of the experimental method. Evelyn in his Preface to Silva, argues against those opponents of the Royal Society who, "with an insolence suitable to their understanding, are still crying out and asking "What have the Royal Society done"? Glanvil devotes a chapter of his Plus Ultra to answering this persistent question and when he says

- iii. that "sufficient has been done to satisfy sober expectations",

i. Character of a Virtuoso.
 ii. History of the Royal Society. i. ix.
 iii. Plus Ultra. Chapter xiii.

though the philosophers have not yet discovered "the great elixir, the perpetual motion, the way to make glass malleable and man immortal," he discloses the source of much of the virulent opposition. Butler and Shadwell constantly ridicule the useless character of the new philosophy. Shadwell makes Stanford (whom man delights not) converse with Emilia (who is a lady "of the same humour with Stanford") in *The Sullen Lovers*. They bemoan the woes of human life and Emilia shows the wasted industry of those who "after twenty or thirty years' study of philosophy arrive no farther than at the weighing of carps, the invention of a travelling wheel, or the poisoning of a cat with the oil of tobacco: these are your arts and virtuosi." In fact the complaint of the seventeenth century satirists resembles that of the modern ratepayer who alleges that research students find most to do in places in which there is least to be got.

Another favourite objection was that the study of insects, stones, stars, and flowers, could teach a man nothing worth knowing, for "the proper study of mankind is Man." Shadwell insists on this point with wearisome iteration and the following is one of many similar colloquies which are to be found in *The Virtuoso*. Sir Nicholas Gimcrack, the hero is boasting of his knowledge of ant life, to Bruce a somewhat critical visitor:-

1. Sir Nich: Why I travelled all over Italy, and had no other affair in the world but to study the secrets of that harmonious insect.

Bruce: Did you not observe the wisdom, policies, and customs, of that ingenious people?

Sir Nich: O, by no means! 'tis below a virtuoso to trouble himself with men and manners. I study insects.

- ii. Addison uses this theme as the subject of an Essay in the Tatler and obviously borrowed the idea from Shadwell for he subjoins an amusing document purporting to be the last will and testament of a Virtuoso, one Nicholas Gimcrack. Many of the experiments were considered ridiculous and certainly we find strange items figuring in the agenda. We hear of
- iii. experiments "of a spider's not being enchanted by a circle of Unicorn's horn or Irish earth laid about it" and also of an attempt to make a dumb man speak. The questions which the Royal Society despatched to a Resident in Java
- iv. Major and the answers which were returned form an entertaining piece of reading. The members are anxious to know whether diamonds and other precious stones grow again in the places from which they have been removed but are assured, "Never, or at least not as the memory of man can attain to". They also desire confirmation of the existence of a vegetable which "Master James Lancaster relates to have seen". This plant Master Lancaster endowed with qualities which eclipse the mandrake completely, so that we are not surprised to hear the reply, "I cannot meet with anyone that ever heard of such a vegetable". Butler was not the only one to allege

i. The Virtuoso. Act iii.

ii. Tatler Aug. 26. 1710. No. 216.

iii. Sprat. History of the Royal Society ii. xxxiii.

iv. Sprat. History, appended to Part ii. p. 158-172 of 1667 edition. Questions 1 and 6.

that the members of the Royal Society

- i. "greedily pursue
Things wonderful, instead of true"

for Henry Stubbe, a most violent opponent of the Society, who frequently engaged in controversial amenities with Glanvil, published his *Legends: no Histories or a Specimen of some Animadversions upon the History of the Royal Society*, in 1670. The Virtuoso-in-Chief of the learned society which thought that it had discovered an elephant in the moon, bemoaned the fact that the discovery of the true cause of the dark object on the lunar surface would

- ii. "frustrate all we've done,
Only to make new work for Stubbs
And all the academic clubs".

The Royal Society was royal in more than in name and owed its incorporation to the help of Charles II. Nothing but the continuous support of the King and Court would have enabled it to survive the combined forces of superstition and ridicule which were arrayed against it. Bacon dedicated his *Advancement to Learning* to James I and was probably induced to choose the name which he gave to the College of the New Atlantis, by the fact that James was called by his admirers the British Solomon. The First Stuart though by no means an unlearned man, was a member of the old school and took little interest in Bacon's magnificent schemes. Under Charles I science and art received more definite encouragement. Rubens and Vandyke were both appreciated by Charles, while William Harvey was made

i. The Elephant in the Moon. 1.509-10.
ii. Elephant in the Moon. 1.430-432.

Physician to the King. Charles took a keen interest in Harvey's experiments and we find his book explaining the circulation of the blood dedicated to "the most illustrious and indomitable Prince Charles", with a conceit which is worthy of one of the "metaphysical" school. Since the heart of animals is the foundation of their life, and since the king is the heart of the republic; the fountain from whence

- i. all grace and power flow, Harvey is confident that "the knowledge of his heart will not be useless to a prince as embracing a kind of Divine Example of his functions". In his book *De Generatione* embodying the principle "omne vivum
- ii. ex ovo" and overthrowing the longstanding belief (constantly alluded to by seventeenth century writers) that living creatures are generated spontaneously from putrescent matter, we learn that Harvey had frequently pointed out to the king the *punctum saliens* in an embryo chicken or deer. Charles even supplied him with deer from the Royal Park in order to facilitate his experiments, and we hear of an anatomical examination made by the physician upon the body of a certain Thomas Parr, who had died at the age of one hundred and fifty two years, at the express desire of the king. Cromwell did practically nothing for science proving the truth of Dryden's statement:-

- iii. "For Colleges on bounteous kings depend,
And never rebel was to arts a friend".

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- i. The Works of William Harvey translated by Wallis 1848.
 - ii. *Donne Divine Poems*. To the Earl of Doncaster; Browne *Pseud. Epid.* Bk.ii. Chap.xii; Butler *Hudibras* P.iii. C.ii. l.1-11; Walton *Compleat Angler* Chap.xiii;
 - iii. *Absalom and Achitophel* Part 1. ll.873-874.

The Royal Society was not incorporated till after the Restoration and Sprat dedicated his History to Charles. The 1667 edition contains a most curious frontispiece, representing the bust of Charles about to receive a laurel wreath, as the central feature, and on the pedestal is written "Carolus II Societatis regalis author et patronus". The text of the History gives additional confirmation of the important part the king played in its foundation. After dealing with the support which the society had received

- i. from all classes Sprat writes "But I make haste to that which should be esteemed the very life and soul of this undertaking, the protection and favour of the King and Royal Family". He gives a detailed account of the help received from the king, adding a little note which gives an air of unmistakable verisimilitude to the whole, "I will not conceal that he has reproved them for the slowness of their proceedings", which reproof Sprat interprets as a mark of affection. The letters patent quoted by Spratt show that the society is
- ii. to be honoured with royal favour "to the intent these kinds of study which are nowhere yet sufficiently cultivated may flourish in our dominion, and that the learned world may acknowledge us to be not only the defender of the faith but the patron and encourager of all arts and useful knowledge".
- iii. Both before and after its incorporation the journals of the

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- i. Sprat History of Royal Society Part ii. Sect.xxv.
 - ii. History of the Royal Society Part ii. Sect.xxv.
 - iii. The items are taken from the numerous entries quoted in Weld's History of the Royal Society. Vol.i. p.95-122.

society prove the interest of the king and royal family.

On May 8th. 1660 we hear that Mr. Wren is commanded to make a globe of the moon, with mountains, valleys, etc., shown, for the king. On June 5th. 1660 the Duke of Buckingham "promised to cause charcoal to be distilled by his chymist" and His Grace further undertook "to bring into the society a piece of the unicorn's horn". On July 17th. of the same year we learn that the "King having desired to know" why the humble and sensitive plant stirs, or draws back at the touching of it, a committee appointed to report

- i. upon the fact". Evelyn records that the king "sent us a mace of silver gilt, of the same fashion and bigness as those carried before His Majesty to be borne before our president on meeting days". Evelyn dedicated his *Silva* to the king and speaks of the "many accurate treatises and volumes of the most curious and useful subjects, medicinal, mathematical, and mechanical dedicated to His Majesty as
- ii. Founder" and with an unusual fervour prophesies "You will find Charles II placed among the heroes and demigods for his patrociny and protection". Edmund Halley the discoverer of the comet named after him, did his best to fulfil Evelyn's
- iii. prediction. He undertook a voyage to the Southern hemisphere for the purpose of studying the stars in those parts and on his return in 1677 drew up a map showing the

i. Diary Aug. 21. 1662.

ii. *Silva*. To the Reader.

iii. Sir R. Ball's *Great Astronomers*. (Edmund Halley.)

results of his labours. By dint of a little compression he contrived to place a new constellation amid the groups which stud the Southern pole to which he gave the name of The Royal Oak, declaring that the incidents which it symbolized were sufficiently important to be inscribed on the floor of heaven. It is noteworthy that the interest in science, though not by any means confined to the higher classes, is generally associated with them. Sprat was very anxious to prove that the experimental philosophy was "a proper study for the gentlemen of the nation", while the Honourable Robert Boyle seems to have been regarded as the beau idéal of virtuosité. Shadwell's Virtuoso was a knight, as well as the first faint pencil sketch of him, Sir Positive-at-All in The Sullen Lovers. Henry Stubbe, "the doctor of Warwick" as Glanvil calls him with acrid politeness, also used a

i. similar name - Sir Nicholas Nemo-to typify one of the scientific enthusiasts.

It is quite evident from the foregoing pages that many enthusiasts were eager to continue the apocalypse of nature of which Bacon had written the inspiring preliminary chapter, and it may be desirable to point out how the seventeenth century differed in temper from the Elizabethan morning time, in view of the effect which the difference

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- i. Referred to in the Postscript of Glanvil's Answer to Mr. Henry Stubbe 1671. An interesting suggestion has been made that Shadwell's Sir Nicholas Gimcrack is intended to represent Boyle. (Spingarn. Critical Essays of the Seventeenth Century. Vol.i. Introduction xc. Vol. ii. p.340).

made upon literature. A new spirit had come over England in the last decades of the sixteenth century as we see from the boundless life, and throbbing spirit which surge through the works of Marlowe, Spenser, and Shakespeare. The interest in voyages had much to do with the Elizabethan spirit of hopeful buoyancy - the pillars of Hercules were seen to form the proscenium of an ampler stage. Death did not quench the light of hope and the very quintessence of Elizabethan energy is to be found in the words which Mortimer proudly utters as he is haled to execution,

- i. "weep not for Mortimer
 That scorns the world, and, as a traveller
 Goes to discover countries yet unknown"

The sixteenth century saw the world with the wonder waiting eyes of a child, it aimed at the universe generally and never condescended to consider the question of ways and means. It had no conception of the gulf which separates possibilities from impossibilities, and its genius was distinguished by an immense incapacity for taking pains. Bacon belonged in part to the sixteenth century but he understood that if his visions were to be given actuality a rigorous method of procedure was necessary. As the years of the seventeenth century passed the glow of hope faded but there was an almost ferocious determination to master the newly discovered volume of the world - to leave no page unexplored. Like Browning's grammarian the typical representative of the century would cry to the base crowd of critics,

"Let me know all! Prate not of most or least,
Painful or easy:
Even to the crumbs I'd fain eat up the feast
Ay, nor feel queasy".

The boundless vision of the grammarian is not of the seventeenth century, it belongs to the time "shortly after the revival of learning in Europe", but his resolve to know
i. all by patient endeavour is typical of our period. Employing Swinburne's well known metaphor we may compare the men of the sixteenth century to the Olympians and those of the seventeenth century to the Titans; only the modern representatives of the latter race had no mountains to assist their progress, but were forced to make use of accumulated small facts in their progress towards the heights.

It may be noticed that the chief poets and prose writers have this desire for encyclopedic knowledge, and a firm belief in Bacon's convincing "*Nam ipsa scientia potestas est*". John Donne confessed in one of his letters that he had embraced "the worst voluptuousness, an hydroptic, immoderate desire of human learning and languages". John Whitefoot, the friend of Sir Thomas Browne declared that the horizon of the
ii. doctor's understanding was "much larger than the hemisphere of the world; all that was visible in the heavens he comprehended so well that few that are under them knew so much. He could tell the number of the visible stars in his horizon, and call them all by their names that had any, and of the earth he had such a minute and exact geographical

i. In A Study of Ben Jonson.

ii. The quotation and comment both to be found in Dr. Johnson's Life of Sir Thomas Browne.

knowledge, as if he had been by Divine Providence ordained surveyor general of the whole terrestrial orb, and its products, minerals, plants, and animals". Of which eulogy Dr. Johnson says "But it is not on the praises of others, but on his own writings, that he is to depend for the esteem of posterity, of which he will not easily be deprived, while learning shall have any reverence among men; for there is no science in which he does not discover some skill; and scarce any kind of knowledge profane or sacred, abstruse or elegant, which he does not appear to have cultivated with success. His exuberance of knowledge and plenitude of ideas, sometimes obstruct the tendency of his reasoning and the clearness of his decisions; on whatever subject he employed his mind there started up immediately so many images before him that he lost one by grasping another." Cowley's interest in science has already been sufficiently demonstrated, while Milton's tractate On Education, indeed "not a bow for every man to shoot in, that counts himself a teacher", with its protest against the "asinine feast of sow thistles and brambles" usually masquerading under the name of education, and its insistence that "though a linguist should pride himself to have all the tongues that Babel cleft the world into "his knowledge is useless if he has neglected the things which the words represent", is one more proof that the greatest poet of the seventeenth century did not dwell apart from the movements of his own time. Waller was a member

of the Royal Society though he hardly strikes one, from his
 i. Sacharissa poems, to be "skilled in mathematics and anatomy"
 as well as "an excellent botanist". Dryden was also a
 Fellow of the Royal Society and a most ardent supporter of
 ii. the scientific spirit. His poem "To my honoured friend
 Dr. Charleton" proves that he had the characteristic
 seventeenth century interest in all matters pertaining to
 science. A detailed account of the advances made in the
 various sciences, and of the allusions to the discoveries
 in literature will serve to show still more clearly the
 "myriad-minded" character of the age.

i. Evelyn. Diary. April 24. 1694.
 ii. Annus Mirabilis Stanzas 165 and 166, also Crites speech
 in "An Essay of Dramatic Poesy" quoted at the beginning.

THE MOVEMENTS IN EXPLORATION AND COLONIZATION AND THE INTEREST IN GEOGRAPHY.

The national interest in exploration was not fairly kindled in England till the "spacious times of great Elizabeth," although the overland and oversea expansion had been infusing a new *spirit* into Europe all through the thirteenth, fourteenth and fifteenth centuries. When people really awoke to the significance of the movement, nothing had a greater effect on the subsequent history of England, and if one thing can account for the unlimited hopes aroused by the experimental philosophy, it must be the interest in exploration. Bacon expresses the truth of his life and doctrine in one pregnant sentence "Multum incola fuit anima mea," and he uses the unexpected results which followed the labours of the early explorers to justify his own sanguine hopes. The world "had never through-lights made in it, till the age of us and our fathers," and they had revealed things in such an unexpected manner that all things seemed possible. Truly the times might bear the words "Plus Ultra" for their motto. Bacon was not slow to perceive "that this proficience in navigation and discoveries may plant also an expectation of the further proficience and augmentation of all sciences." He points out that it would be a disgraceful thing, if at the time the material globe was being opened and revealed more widely to

i Adv. Bk. II. II. 13.

ii Adv. Bk. II. II. 14.

iii Nov. Org. Bk. I. Aph. 82.

men, no corresponding development took place in the intellectual globe. He considered that the prophecy of Daniel "Many shall go to and fro, and knowledge shall be increased," was about to be fulfilled. Similarly Browne when about to show the folly of Pseudodoxia Epidemica pleads for the indulgence of the reader on the ground "that we find no open tract or constant manuduction in this labyrinth but are oft times fain to wander in the America and untravelled parts of truth." Dryden clearly understood the importance of the exploration movement in relation to the new science. He described Columbus as the first who shook the throne of the tyrant Aristotle for,

ii "Had we still paid that homage to a name
Which only God and Nature justly claim,
The western seas had been our utmost bound,
Where poets still might dream the sun was drowned,
And all the stars, that shine in southern skies
Had been admired by none but savage eyes."

Bacon tells us that the sages of the New Atlantis sent out two ships for discovery every twelve years not to seek "for gold, silver, or jewels, nor for silks, nor for spices, nor any other commodity of matter; but only for God's first creature, which was light." When Democritus Junior draws his ideal state he adds "I will have certain ships sent out for new discoveries every year."

It is not difficult to realise the importance of the magnet in navigation and we find constant allusions to it throughout the seventeenth century, which are partly explained by the

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- i Nov. Org. Bk. I. Aph. 93
 - ii To my honoured friend, Dr. Charleton.
 - iii Burton. Anatomy of Melancholy. Preface of Democritus Junior to the Reader.

keen interest taken in navigation. The attractive power of the magnet was known to the ancients and it is conjectured that the Chinese knew of its use in navigation, as early as the second century A.D. but for some inexplicable reason the secret was lost till the twelfth century, when we hear it spoken of as being used by sailors for direction. References to the magnet are of course to be found in earlier literature than that of the seventeenth century, for, as Gilbert complained, theologians and philosophers when in want of an illustration immediately turn to magnetism, but nevertheless the seventeenth century allusions are so numerous that we are forced to seek for further explanation. The phenomenal interest in magnetism was partly excited by the publication of Gilbert's treatise *De Magnete* in 1600. This work is as epoch making in its particular department as Napier's *Constructio in Mathematicis*, or Harvey's *De Motu Sanguinis* in Physiology. His book created immediate attention and Galileo pronounced the author to be "great to a degree that is enviable." William Gilbert of Colchester (1540 - 1603) is interesting as an exponent of the scientific spirit as well as for his actual achievements. He was a supporter of the Copernican theory and when discussing the matter at length

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- i Article in *Encyclopaedia Britannica*.
 - ii Authorities for statements contained in this account: Whewell, *Philosophy of the Inductive Sciences*, Vol. 11, p. 216-*Philosophy of Discovery*, Ch. 14, Sec. 7; *Social England*, Vol. 111, p. 697; P. Fleury, Mottelay's translation of, and introduction to, Gilbert's *De Magnete* (London 1893).

i in De Magnete, honours the founder as "a man most worthy of the praise of scholarship." Gilbert's general remarks as to the correct way of learning by observation and experiment resemble those of Bacon, though written many years before the Novum Organum was published. Bacon did not, as one might have expected, welcome this co-worker in the same field as himself, but almost always adversely criticises him. When speaking of the tendency of scientific men to exaggerate the

ii importance of their own discoveries he cites the evil example of "Gilbertus our countryman [who] hath made a philosophy out of the observations of a loadstone." Science has not upheld Bacon's verdict, for Gilbert's treatise is held classical to this day, modern writers considering that he deals with all the fundamental phenomena of the science. Gilbert carefully classified the information which he obtained from navigators, as well as that derived from the works of the ancients. He also endeavoured to show the fallacies under-

iii lying the popular superstitions about the magnet. Among others he dealt with the belief that a needle immersed in the juice of garlic will not respond to the attraction of the

iv magnet. Sir Thomas Browne attempted to refute this, along with other Vulgar Errors, and the reply of a worthy Scotchman, Alexander Ross, is interesting as showing the difficulties which confronted the few who struggled to free science from

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- i Mottelay's translation p. 318.
 - ii Adv. Bk. I. V. 7, also Nov. Org. Bk. I. Aph. 54, 64, 88.
 - iii Mottelay's translation, p. 2.
 - iv Pseud. Epid. Bk. II. Ch. 3.

the dictatorship of the ancients. He was the author of *Arcana Microcosmi* (1652) in which, having girded himself with triple brass, he proceeds to refute "Doctor Browne's Vulgar Errors, the Lord Bacon's Natural History, and Doctor Harvey's Book De Generatione." He was a valiant supporter of the ancients and could not believe that Ptolemy, Pliny and other
 1 writers could have erred so grievously. "I cannot think the ancient sages would write so confidently of that which they had no experience of, being a thing so obvious and easy to try, therefore I suppose they had a stronger garlic than is with us."

By far the most important point in Gilbert's treatise was his realization that the earth is a great magnet, and from that fact he explained the various magnetic phenomena. He showed also that the magnet repels as well as attracts, and that the polarity of the magnet is caused by a constant conjunction of attraction and repulsion. Gilbert's systematic study of magnetism, undertaken from both the theoretical and experimental points of view, constituted a new science, in which the doctrine that the earth is a great magnet is still fundamental.

Doubtless the seventeenth century writers were impressed by magnetic phenomena in the same way that children become almost breathless with delight when a magnet is plunged into iron filings, or when the needle of a mariner's compass, after a few momentary waverings, rests with the needle pointing to the North. Many of the references seem to show this practical

1 Quoted Bohn Edition of Sir T. Browne's works. Vol. I p. 136

acquaintance with the magnet, and often Gilbert's name is mentioned in connection with the matter. Burton constantly alludes to Gilbert and is inclined to extend the sphere of magnetic influence to lengths of which Bacon might justifiably complain. "Attraction is a ministering faculty, which, as a loadstone, doth iron, draws meat into the stomach." Dryden prophesies that,

ii "Gilbert shall live, till loadstones cease to draw
Or British fleets the boundless ocean awe."

Apart from direct allusions to Gilbert we may be sure that Ben Jonson had consulted De Magnete from the numerous recondite references to the science. Not only have we The Magnetic Lady.—

iii "Your ladyship is still the Lady Loadstone,
That draws, and draws unto you, guests of all sorts;
The courtiers, and the soldiers, and the scholars,
The travellers, physicians, and divines."

- but also the additional characters Compass, Captain Ironside, Mistress Placentia Steel her niece, and Needle her steward. The alternative title Humours Reconciled is a side glance at the polarity of the magnet; as we see from the remark of Compass

iv "the prime magnetic guests
Our Lady Loadstone so respects: the Arctic
And the Antarctic."

Other illustrations drawn from the magnet, to be met with constantly in poetry, prose and the drama, may be divided into

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- i Anatomy of Melancholy 1. 1. 2. 5.
 - ii To Dr. Charleton.
 - iii Magnetic Lady, Act 1. Sc. 1.
 - iv Ibid.

two classes, accordingly as they are employed in matters of love or religion. The comparison of a lady to a magnet is sufficiently obvious to strike even the least ingenious of lovers, but Heywood makes a sea-captain very appropriately say of Bess Bridges ,

i 1st. Capt. "Well she's a most attractive adamant
Her very beauty hath upheld that house,
And gained her master much.

Carrol That adamant
Shall for this time draw me too, we'll dine there.

2nd. Capt. No better motion: come to the Castle then.

The wavering of the needle before it finally settles northwards has possibilities in love poetry. Cowley having resolved to find one that should love him explains his former aberrations thus

ii "The needle trembles so and turns about
Till it the northern point finds out
But constant then and fixt does prove
Fixt, that his dearest Poleas soon may move."

The constant employment of illustrations drawn from magnetic phenomena in religious poetry is very characteristic of the period. Donne's question to a newly ordained priest may be quoted

iii "Dost thou find
New thoughts and stirrings in thee? and, as steel
Touch'd with a loadstone, dost new motions feel?"

Francis Quarles was very fond of such metaphors, and in his

iv Emblems we have a winged being, holding a mariner's compass,

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- i Fair Maid of the West. Act 1.
 - ii The Mistress. Resolved to be beloved.
 - iii To Mr. Tilman after he had taken Orders.
 - iv Emblems Bk. V Emblem IV.

of which the needle points to the Cross. The accompanying verses compare the soul, which leads men to God, to the magnetic needle, which guides men to port after stormy seas. The quivering of the needle which

"frantics up and down from side to side
And restless beats his crystal ivory case"

i is again mentioned. In *The School of the Heart*, a little book with even quainter engravings than *The Emblems*, the illustration is also employed. Benlowes was fond of magnetic allusion

ii "Remove the needle from the pole-star, and
'Tis still with trembling motion fanned,
Till it returns. No fixture but in God does stand."

iii Traherne had evidently heard of Gilbert's theory that the earth is a great magnet, for in one of those dark sayings which seem to contain a soul of truth within them, struggling to get out, so eminently characteristic of him, he tells us "I have found that things unknown have a secret influence in the soul, like the centre of the earth unseen violently attract it. We love we know not what and everything allures us. As iron at a distance is drawn by a loadstone, there being some invisible communication between them, so is there in us a world of love to somewhat though we know not what in the world that should be."

Most Europeans were familiar with the magnet in the thirteenth and fourteenth centuries but it was only with the Elizabethan age that its properties became interesting to the English.

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- i *School of the Heart* - *The Binding of the Heart* Ode XLII St. 6.
 - ii *Theophila's Love Sacrifice*. Canto VIII Stanza 50.
 - iii *Centuries of Meditations* 1. 2.

The height of the exploration energy had been reached before the closing years of the sixteenth century and we then have the calmer interest in colonization under the régime of the first Stuart. It is typical of the seventeenth century that it should take an interest in the details of the exploits of the early voyagers and the publication of books of voyages enabled men to gratify their curiosity. Hakluyt's Voyages, "the prose epic of the English nation," was published in its final form in 1600 and Purchas continued his work in a collection of voyages known as Purchas His Pilgrimes, published in 1625. His earlier work, Purchas His Pilgrimage, is famous for all time as inspiring Coleridge's Kubla Khan. Thomas Coryat, another traveller, appears to have been a touchstone for the wits. "If I travel any more," says Waspe in Bartholomew Fair, "call me Coriat with all my heart" alluding to the book of travels entitled Coryats Crudities Hastily Gobbled Up.

In view of the importance of the expansion movement in both science and literature it will be necessary to give some account of the history of exploration and colonization, however brief. When the seventeenth century turned to examine the records of the men by which the world had been extended, the first name which attracted its attention was of course that of Columbus. Cowley was so impressed with his achievement of 1492, that whenever he wishes to speak of a pioneer the name recurs to him.

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- i Warner's Albion's England (1586) gives a full account of the voyages in Bk. II. 53.
 - ii Ben Jonson's satirical verses "To the Right Noble Tom Tell Troth of His Travailes, The Coryate of Odcombe; Taylor (Waterman Poet) Penniless Pilgrimage (1613)" I have a smack of Coryatizing.

He addresses Hobbes:-

- i "Thou great Columbus of the golden lands of new philosophy."
- ii He speaks of St. Paul as the "World's Columbus" and of himself he says,
- iii "'Tis I who Love's Columbus am; 'tis I"
- The voyage of Sebastian Cabot in 1497, although the first attempt made under the English flag, was practically ignored by the seventeenth century. That of Vasco da Gama who set out in July of the same year, and first made the direct crossin to India is occasionally mentioned but Ferdinand Magellan, whos ship circumnavigated the globe reaching Cadiz in 1521, seems to have created attention second only to Columbus. Milton,
- iv curiously enough, speaks of a country in the south as Magellan. With the other European explorers we cannot stay but must turn to the English navigators of the sixteenth century. Among the earliest was,
- v "That brave adventurous knight, our Sir Hugh Willoughby", who set sail in May 1553 in his flagship the Bona Esperanza, with two other ships "for the search and discoverie of the Northern part of the world, to open a way and passage to our men for travel to new and unknown kingdoms," as Hakluyt informs us. This attempt failed and Drayton realised the gallantry of Willoughby who
- vi "In all her fearfullest shapes saw horror"

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|-----------------------------|-----------------------------------|
| i To Mr. Hobbes. | ii The Extasia. |
| iii The Prophet. | iv Paradise Lost Bk. X. l. 686-7. |
| v Drayton Polyolbion Song. | Song XIX. |
| vi Drayton Polyolbion Song. | XIX. |

and the pity of his fate. Space prevents any reference to the majority of the heroes of whom Browne of Tavistock sings:-

- i "Time never can produce men to o'ertake
The fames of Grenville, Davies, Gilbert, Drake,
Or worthy Hawkins, or of thousands more
That by their power made the Devonian shore
Mock the proud Tagus"

although most of them are mentioned in passing by seventeenth century authors. Robert Burton's quaint interest in these

- ii "modern argonauts" is especially pleasing. "Globe-engirdling
iii Drake" who in his ship the Pelican or Golden Hind sailed
"into the South Sea and thence about the whole of the globe"
between 1577 - 1580 cannot be thus summarily dismissed. The
idea of a girdle being placed about the world seemed to have
iv a special fascination, for we find allusions to it in Shakes-
peare, Massinger, Chapman and Webster. The fact that East
and West eventually meet could not fail to attract the ingenious
poets of the seventeenth century. Donne in his Hymn to God,
My God, in my Sickness, meditates:-

- v "I joy, that in these straits I see my West,
For though those currents yield return to none,
What shall my West hurt me? As West and East
In all flat maps - and I am one - are one,
So death doth touch the resurrection!"

vi Denham in his play The Sophy pointed out that,

- "The East and West
Upon the globe a mathematic point
Only divides"

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- i Britannia's Pastorals Bk. II. Song 1 l. 609-613.
ii Anat. of Melancholy II. II. III. A digression of the air.
iii Polyolbion Song XIX
iv M.N.D. II.I; Maid of Honour I.I; Bussy D'Ambois I.I.
Duchess of Malfi III.I.
v Also in Divine Poems The Annunciation and Passion l. 19-24
vi Sophy IV.I.

while Butler satirised the popular conceit thus:-

- i "Th' extremes of glory and of shame,
Like East and West, became the same."

Drake's ship, like Nelson's Victory, years afterwards, was preserved as a sacred and historic vessel for the wondering gaze of visitors. Ben Jonson refers to this in Every Man in His Humour "Drake's old ship at Deptford may sooner circle the world again." Cowley wrote an excellent Bacchanalian Ode "Sitting and Drinking in the Chair made out of the Reliques of Sir Francis Drake's Ship."

The seventeenth century did not pursue the work of navigation much farther although spasmodic attempts were made to find the North-east and North-west passages. Among the learned speculations and constant occupations of the Royal Society Butler mentions,

- iii "To find the North West passage out
Although the farthest way about."

Apart from these references it may be considered how far the rich splendours of certain passages in Milton, and the almost heedless way in which "barbaric gold and pearl" are sown broadcast, are due to his interest in voyages and travels. Moreover his magic use of proper names, sometimes considered to be caught from Marlowe, may have been inspired by books of travel. He compares the primitive dress of Adam and Eve after the Fall to

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- i Hudibras P. II. C.I. l. 271-272.
ii Act I. Sc. 2.
iii A Satire on the Royal Society l. 91-92.
iv Par. Lost Bk. XI. L. 399-411. Names familiarized by voyagers.

the state of the aborigines,

- i "Such of late
Columbus found th' American, so girt
With feather'd tincture."

The picture of Satan going,

- ii "with lonely steps to tread
Th' unfounded deep, and through the void immense
To search with wand'ring quest a place foretold
Should be"

expresses the poetry of tentative exploration as completely as Keats' Sonnet (On First Looking into Chapman's Homer) does that of successful discovery.

- iii More important than the efforts to continue the work of the early travellers and navigators were the colonizing expeditions sent out during the first half of the 17th century. Abortive attempts were made in Elizabeth's reign but nothing of much importance was done till 1606 when James sent out an expedition to colonize what the charter describes as, "the dear strand of Virginia, earth's only paradise." But for the attempts made to colonize we probably should never have heard of Gonzalo's commonwealth, the New Atlantis, or Democritus Junior's ideal state. Constant allusions to Virginia are to be found. Donne for instance writes, "I asked

- iv "Of the Virginia plot and whether Ward
The traffic of the island seas had marred"

- i Paradise Lost Bk. IX l. 1115-1117.
ii Paradise Lost Bk. II l. 827-831.
iii For particulars of voyages and attempts to colonize, the writer is indebted to Prof. Beazley's articles in Social England. Vols 3 & 4.
iv Elegy XV. A Tale of a Citizen and His Wife.

the gentleman named being a pirate. In another place he boasts,

i "We've added to the New World, Virginia."

Drayton addressed a poem To the Virginian Voyage, while Moll Cutpurse gives advice to Sebastian Wengrave which suggests that Coleridge's Pantisocratic scheme had been anticipated, at least in one important particular, "Take deliberation, sir; never choose a wife as if you were going to Virginia."

ii In May 1609 a fleet of nine ships under Sir George Somers, despatched for Virginia, was wrecked and one of the ships being driven on to the Bermudas, they were then known as the Somers or Summer Islands. This misadventure doubtless suggested Waller's lengthy poem known as The Battle of the Summer Islands and Marvell's delightful little piece "Where the remote Bermudas ride," as well as a crop of minor allusions. In the English Traveller we have the stormy character of the "still vexed Bermoothes" hinted:-

iii First Gallant. Whence is your ship, - from the Bermoothes?
Reignald. Worse, I think from Hell.
We are all lost, split, shipwrack't, and
undone.

The character-writers are fond of allusions to the Bermudas which go to prove that great contemporary interest was taken in the matter. In a character of an Executioner we hear of the delight of a hangman because a criminal considered his

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- i Verse Letter to the Countess of Bedford.
ii Middleton. The Roaring Girl. Act II. Sc. 2.
iii Heywood. English Traveller. Act II. Sc. 3.
iv Essayes and Characters. Ironical and Instructive (1613)
John Stephens. Bk. II. No. XXVIII.

chances of escape to be greater from Tyburn than the Bermudas, upon which the author suggests, that had the Muse inspired him, the executioner would have composed an epitaph for his victim, beginning somewhat after this fashion,

"Here lies a wretch so loving to the rope
He chose it rather than Bermuda's hope."

With the interest in exploration is closely connected the Adventure Drama of which *A Fair Maid of the West* is an attractive example. The whole is reminiscent of the exciting adventure stories in which a boy, hardly emancipated from the school room, takes charge of a ship and escapes with glory from the most dangerous positions. The leader is not a youth in this case but "a girl worth gold," fair Bess Bridges not fully seventeen. A fresh salt sea breeze seems to drive through the play.

The introduction of tobacco as a result of these voyages is often referred to, more especially in the drama. Shakespeare
i does not appear to allude to it, but Ben Jonson constantly mentions it - the characters even taking tobacco upon the stage. Tobacco-sellers and Tobacco-takers are favourite sub-
ii jects for the character-writer but opinions as to the usefulness of the weed are not all favourable. Dekker particularly seems to have been impressed by the manner in which tobacco vanishes into smoke. Fortunatus soliloquises "If that lean
iii tawny face Tobacconist Death, that turns all into smoke, must turn me so quickly into ashes, yet I will not mourn in ashes,

i Every Man out of His Humour. Act III. Sc. 3.

ii The Man in the Moon (1609) The Wandering Jew telling Fortunes to Englishmen (1649).

iii Old Fortunatus. Act I. Sc. 1. Similar idea in Act II.

but in music, hey, old lad, be merry." Burton sees that there are two sides to the question and shows the uses and abuses of tobacco as clearly as any one. "Tobacco, divine, rare, super-excellent tobacco, which goes far beyond all the panaceas, potable gold, and philosopher's stone, a sovereign remedy to all diseases" though as it is commonly "abused by most men, who take it as tinkers do all, 'tis a plague, a mischief, a violent thief of goods, land, health, hellish, devilish, and damned tobacco, the ruin and overthrow of body and soul."

The colonization movement had an important effect upon science the Royal Society sending lists of questions to residents in foreign parts, the answers to which were carefully tabulated. Shadwell who seems to have had an invincible belief in the old maxim, that fact is stranger than fiction, mentions this practice in the Virtuoso as the following little scene will show:-

Enter Servant

ii Servant Sir, the gentleman that's going to Lapland, Russia, and those parts, is come for your letters and queries which you are to send thither.

Sir Nicholas I'll wait on him. I keep a constant correspondence with all the virtuosi in the North and North East parts. There are rare phenomena in those countries. I am beholden to Finland, Lapland and Russia for a great part of my philosophy. I send my questions thither. Come, Sir Formal, will you help me despatch him

When we reflect that this is intended to be a caricature of the virtuosi of the time we can understand why Dryden adjudged the mantle of Flecknoe to have fallen upon Shadwell, for as fact it

i Anatomy of Melancholy 2. 4. 2. 1.
ii The Virtuoso Act. II.

is useful, but as satire, it can only be described by the adjective which Milton found so irritating, "toothlesse."

- i. The collections of curiosities which travellers brought home
- ii always interested the members of the Royal Society and D'Avenant in his House of Astragon arranges for A Cabinet of Death to receive the rarities supplied by voyagers from distant lands.

- iii Not only have we an interest in foreign countries but also a desire to know the configuration of England itself. Dr. Johnson gives to Denham the honour of inventing "a species of composition that may be denominated local poetry, of which the fundamental subject is some particular landscape to be poetical described "but Cooper's Hill (1641) was preceded by Drayton's Polyolbion (1612-1622) which is nothing less than a gazetteer of England & Wales and the smaller islands adjoining. Certainly the sixteenth century would have been reluctant to
- iv undertake "the strange Herculean toil" of Drayton and subsequent centuries hardly regard such a subject as susceptible to poetic treatment. Drayton left no corner of England unsung
- v. and owing to his "natural inclination to love antiquity" we find that the history, legendary or otherwise of a district is invariably given. He cannot leave Southampton without telling us of the exploits of Bevis, or Nottingham without introducing us to that most fascinating of all circles, Robin

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- i cf. Account of Evelyn's visit to see Dr. Sloane's collection of curiosities from Jamaica. 16th April 1691.
 - ii Gondibert Bk. II. C. 5.
 - iii Dr. Johnson's Life of Denham.
 - iv Polyolbion Song XXX ad fin.
 - v Op. cit. Preface To my friends the Cambro-Britains.

Hood, Scarlock, John-a-Green, Friar Tuck and Maid Marian. Drayton is often very successful in capturing the spirit of the county with which he deals. He tells us of,

x. "fruitful Somerset
And her attending brooks,"

i and the alliterative epithet which he employs to describe the seacoast of Lincolnshire, "levelled and lank" might have been used by Tennyson himself. One expects Drayton to ignore the mountainous districts, ^{but} he does nothing of the kind. Seven songs are devoted to the beauties of Wales and "Proud mountain Plynillimon," whom all the neighbouring hills obey, delights him especially. Smaller ranges of hills are noticed and Malvern, King of Hills, makes a spirited defence against those,

ii "That term us barren, rude, and void of all delight
We mountains, to the land, like warts or wens to be
By which fair'st living things disfigured oft they see"
declaring that,

" mountains be like men of brave heroic mind,
With eyes erect to heaven, of whence themselves they find."

iii He celebrates the Peak District, and the "stern Westmerian wild," while when Copland (Cumberland) is reached he asks,

iv "I would know
What place can there be found in Britain that doth show
A surface more austere, more stern, from every way."

Neither the echoes of the hills nor the beauties of "Great Fourness', mighty fells" escape his notice. This interest is,

- i Op. cit. Song XXIII
ii Song VII.
iii Song XXX
iv Ibid.

x. Op. cit. Song III.

of course, a quite exceptional thing, for Herrick took as little pleasure in the Torrs of Dartmoor as did Jeremy Taylor in the hills of Wales. Vaughan evidently did not appreciate such scenery for he complained of,

- i "My walk, a monstrous mountain'd thing"
- ii. while Marvell, praising the gentle slope of Billborow, wishes that all other mountains which,

"The earth deform, and heaven affright",
were equally smooth and pleasing to the eye.

- iii. Geography evidently had charms for the seventeenth century mind, and Izaak Walton gave his pupil a lesson in this subject as they journeyed on towards Tottenham Cross. Rivers, of course, occupy Piscator's attention, for the most part, and he distinguishes several of the "Three hundred and twenty five" which he says are mentioned in Dr. Heylin's Geography, with especial care. The Thamisis "compounded of two rivers Thame and Isis," the Sabrina or Severn, and the Trent "so called from thirty kind of fishes that are found in it, or that it receiveth thirty lesser rivers," are among those so treated.

The seventeenth century scientific movement was one expression of the enormous energy which the oversea and overland expansion infused into England. The colonization which always follows closely on exploration helped to keep alive the interest in science by providing fresh storehouses of information,

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- i Silex Scintillans. Regeneration.
 - ii Upon the Hill and Grove at Billborow.
 - iii Compleat Angler. Chap. XIX.

while the resolution to understand the external world which was inspired by the new philosophy, accounts for the keen interest taken in the details of geography. The sixteenth century within whose ken a new world had recently swam, had no inclination to concern itself with minute particulars, for it thought to grasp the universe with one swift bound. It left to the seventeenth century the laborious work of slowly and patiently sifting the information which the new discoveries had brought to light.

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i. In Mathematics and Astronomy as great and unparalleled advances were made, as in the other branches of science. Yet we still find mathematics associated with the black art, and astronomy entangled with the delusions of astrology. Hobbes did not open a Euclid till he was forty years of age, as we learn from Aubrey's circumstantial account, and the controversies in which he became involved, owing to an insufficient acquaintance with what proved his favourite subject, were endless. At Oxford geometry was not an essential part of a student's training, and Sir Henry Savile instituted his professorships of astronomy and geometry in 1619, lest these studies should sink into oblivion; for which, declares Anthony a Wood, his name will survive among the learned and righteous "for ever, till the general conflagration shall consume all books and learning". According to Wood not a few of the gentry kept back their sons from the university, fearing to have them "smuttred with the black art", for mathematical calculations were described as "spells", and the unfortunate professors were designated "limbs of the devil". Hobbes complained even as late as the middle of the century, that the universities had but just ceased to regard geometry as an "art diabolical". Sidrophel having read,

ii. "The Devil and Euclid o'er and o'er"

- i. For the history of Mathematics obligations are due to (a) Articles on Natural Science in Social England Vol.iii. (b) Ball's Short History of Mathematics. (c) Articles in the Encyc. Brit.
- ii. Hud. P.ii. C.iii. l.236.

is well equipped for his role of conjuror and general mountebank. Perhaps the association of the two names is due to such proceedings of astrologers as those mentioned by Butler,

- i. "With that he circles draws and squares
With ciphers, astral characters".

From the Renaissance to the time of Newton and Leibnitz historians of mathematics reckon the beginning of the modern

- ii. era. "During this period logarithms were invented, trigonometry and algebra were developed, analytical geometry was invented, dynamics put upon a sound basis, and the period closed with the magnificent invention of (or at least the perfecting of) the differential calculus by Newton and Leibnitz". The importance of the period from the mathematical point of view may be gauged from the words of its historian
- iii. "The discovery of America in 1492 and the discussion that preceded the Reformation, flooded Europe with new ideas, which by the invention of printing were widely disseminated, but the advance in mathematics was perhaps even more marked than that in literature and politics".

Bacon leaves few fields of knowledge unexplored in his "general and faithful perambulation of learning," and it will be desirable to consider his opinion of the mathematics of his day. Bacon, unlike Descartes, was not a mathematician and he regarded involved astronomical calculations with an impatience mingled with contempt. His praise of the science

i. Hud. P.ii. C.iii. l.987.
ii. Encyc. Brit.
iii. Ball's History. p.179.

is condemnatory by its faintness. He considers that the study of mathematics has been pursued more diligently than

- i. other sciences, owing to the fact that it is the "nature of the mind of man (to the extreme prejudice of knowledge) to delight in the spacious liberty of generalities, as in a champaign region, and not in the inclosures of particularity". In the *De Augmentis* Bacon notices several deficiencies, complaining that geometry had made no advances since the time of Euclid. The Royal Society encouraged the pursuit of mathematical studies, as being included in its design to promote Physico-mathematical-experimental learning. We may now proceed to mention a few of the names which are especially important in the history of seventeenth century mathematics, though it must be remembered that the need for exact astronomical calculations forced all astronomers to take part in mathematical studies, and the interest in mathematics evinced by the writers of the period is closely connected with the interest in astronomy. For the sake of clearness the work in pure mathematics will be dealt with first.

- ii. Incomparably the most important name is that of John Napier of Merchiston (1550-1617) who is described by Hume as "the celebrated inventor of logarithms, the person to whom the title of Great Man is more justly due than to any other whom his country ever produced" and of whose invention Kepler said "*Nihil autem supra Neperianam rationem esse puto*".

i. *iii Adv. Bk.ii. viii. 1.*

ii. In addition to the authorities already mentioned "The Construction of the Wonderful Canon of Logarithms" trans. by Wm. Rae Macdonald (1889), and the Memoir prefixed to *De Arte Logistica* (Bannatyne Club 1839).

There can be no doubt that Napier's uncle was well advised when he wrote to the Laird of Merchiston (1560) "I pray you, schir, to send your sone Jhone to the schuyllis; oyer to France or Flandaris; for he can leyr na guid at hame, nor geit na proffeit in this maist perullous worlde - that he may be savet in it - that he may do frendis efter honour and proffeit - as I dout not but he will". The letter which was prefixed to *Rabdologia* . (1617) explains the genesis and nature of logarithms sufficiently for our purpose. "The difficulty and prolixity of calculation, a toil which is apt to deter most people from the study of mathematics, I have all my life, with what powers and little genius I possess, laboured to eradicate. And, with that end in view, I published of late years the Canon of Logarithms (for a long period elaborated by me) which, rejecting the natural numbers and the more difficult operations performed by them, substitutes in their place others affording the same results by means of easy additions, subtractions and extractions of roots". In 1614 Napier published his first work on logarithms known as the *Descriptio* but the important *Constructio* was only published posthumously by his son in 1619. Napier discovered an improved system of logarithms but, worn out by the arduous calculations already undertaken, he left his materials to "that most learned man Henry Briggs, my most beloved friend". The form of logarithms now in general use is that revised by Briggs.

Mathematic calculations are frequently referred to, and Cowley, for instance finding his assumed passion too strong to allow him to study his books writes,

"As well might men who in a fever fry
Mathematic doubts debate" (The Incurable).

The attempts made to square the circle - Hobbes it will be
i. remembered was one of the circle-squarers - were satirized by Butler, while Marvell content with the modest dimensions of Appleton House resolves to,

"Let others vainly strive to immure
The circle in the quadrature".

Mathematical tables compiled by Napier and other mathematicians made a great impression upon seventeenth century writers. Face, when extolling Subtle's power to instruct a gallant how to bear himself in a quarrel declares

ii. "He has made a table
With mathematical demonstrations,
Touching the art of quarrels"

Napier's work was evidently known to Jonson, though Bacon never mentions it, for he makes Compass, "a scholar mathematic" say to Practice, a lawyer,

iii. "There's within
Six Interest, as able a philosopher
In buying and selling! has reduced his thrift
To certain principles, and in that method
As he will tell you instantly, by logarithms,
The utmost profit of a stock employed
Be the commodity what it will."

Jeremy Taylor, when showing the necessity of a man's putting
iv. his spiritual accounts in order, assures his reader, "we shall find the computations of a man's life are *busy as*

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- i. Satire on the R.S. l.88.
 - ii. Alchemist Act ii.
 - iii. Magnetic Lady Act i.
 - iv. Holy Dying. II.ii.1.

the tables of sines and tangents". Butler would have us know that Hudibras,

- i. "by geometric scale
 Could take the size of pots of ale;
 Resolve by sines and tangents straight,
 If bread or butter wanted weight;
 And wisely tell what hour o'th' day
 The clock does strike by algebra.

Napier's name is constantly found in the diaries, characters, and satires of the time, but this is not on account of his invention of logarithms. In the letter already quoted he tells us that, "for the benefit of those who preferred to work with the natural numbers as they stand, I have excogitated other compendious methods of calculation", the most famous of which were undoubtedly the numerating rods known as "Napier's bones". This famous invention, explained in the *Rabdologia* (1617), was a mechanical device for multiplication and division. Pepys, who records his valiant struggles with the multiplication table, jots down in his diary for September 26th. 1666-7, "To my chamber, whither Jonas Moore comes, and tells me the mighty use of Napier's bones, so that I will have a pair presently". Butler alludes to them several times and when Sidrophel's pockets are investigated they prove to contain

ii. a set of Napier's bones.

Another mathematical instrument often alluded to, was the Jacob's staff which was employed chiefly for taking altitudes though also used to measure distances. Jonson

i. P.i. C.i. l.121.
 ii. Hudibras P.ii.C.iii p.1095.

describes his Puntarvolo in Everyman Out of His Humour as "the very Jacob's staff of compliment", while Webster in the

- i. White Devil satirically says "It seems you would be a fine capricious mathematically jealous coxcomb; take the height of your own hands with a Jacob's staff afore they are up". Astrologers were supposed to be equipped with this instrument, so that Lady Frugal bitterly congratulates
- ii. Stargaze on "the cunning of his Jacob's staff". Aymer trying to flatter Novalis assures him that his clothes fit as well
- iii. "as if your tailor were deep read in astrology and had taken measure of your honourable body with a Jacob's staff, an ephemerides".

The Royal Society interested itself in all manner of mechanical devices, Spratt assuring us in his History, that

- iv. the "noise of mechanic experiments is heard in Whitehall itself". Evelyn gives an account of a visit he made on August 4th. 1665 when he found "Dr. Wilkins, Sir William Petty, and Mr. Hooke, contriving chariots, new rigging for ships, a wheel for one to run races in, and other mechanical inventions; perhaps three such persons together were not to be found elsewhere for parts and ingenuity". Dr. Wilkins' book, Mathematical Magic (1648), telling of the wonders that may be performed by mechanical geometry, "one of the most easy, pleasant, useful, (and yet most neglected) part of mathematics" gives a good idea of the

1. Act 1. Sc.ii.
- ii. City Madam Act iiii. Sc. ii.
- iii. Fatal Dowry. Act iv. Sc.i.
- iv. B.ii.Sect.xxvii. For mechanical experiments see also P.iii.Sect XXIV. and P.ii. S.XXXVI

interest taken in such matters.

Ben Jonson was interested in mechanical contrivances for Face when describing Subtle's capacity for discovering whether the Retort Courteous or the Lie Direct would be the more suitable form of reply, undertakes that his master shall show,

- i. "An instrument he has of his own making,
Wherewith no sooner shall you make report
Of any quarrel, but he will take the height on't
Most instantly, and tell in what degree
Of safety it lies in, or mortality.
And how it may be borne; whether in a right
Or a half circle; or may else be cast
Into an angle blunt, if not acute:
All this he will demonstrate."

- Butler in his character of a Virtuoso describes him as "a
- ii. well willer to the mathematics" while Sir Formal declares that "All the ingenious world are proud of Sir Nicholas for his Physico-mechanical excellencies".

The interest in mathematics cannot, however, be severed from that taken in astronomy, and the revolution which took place in the latter science is of vital importance in a consideration of contemporary literature. Men had looked upon the earth as the centre of the universe, for whose delight sun, moon, and stars had passed in ceaseless procession across the sky since the creation of the world. With the announcement of the new theory the floor of heaven "thick inlaid with patines of bright gold", sank back into an immense abyss of space in which countless worlds were floating. Rossetti declared that he could not accept the

- i. Alchemist. Act iii. Sc. ii.
- ii. Virtuoso. Act ii.

Copernican hypothesis and asserted that after all it did not matter which theory was true. Most people feel a similar unconcern today, but the 17th. century was not familiar with the idea of the earth's movement, from childhood. The psalmist had said that the earth stood firmly on foundations that should not be moved for ever, and the disproof of the geocentric theory was a matter of some matter, to a generation which believed in the literal accuracy of the Bible. When this fact is remembered the fierce denunciations of the Copernican hypothesis and the constant allusions to astronomical details which occur in the most unexpected places become explicable. None but the seventeenth century would have made Adam ask his omniscient angel guest to explain the stellar universe, when,

"The world was all before them, where to choose".

Although this period saw the dawn of modern astronomy the old belief in astrology still lingered. Even the pioneers of the new movement gave their support to astrology and the duties of an astronomical professor were indeed multifarious - he was expected to foretell the destinies of individuals and nations, as well as the date of eclipses. We cannot wonder that Herbert, speaking of The Holy Scriptures should say,

"Stars are poor books, and oftentimes do miss
This book of stars lights to eternal bliss".

On April 29th. 1652 Evelyn wonders at the superstition which

prevented all work being done, because an eclipse of the sun had been predicted, but on December 12th. 1680, we find him putting his affairs in order for, "we have had of late several comets, which though I believe appear from natural causes and of themselves operate not, yet I cannot despise them". During the Civil War as we know from Lilly's History of his Life and Times, recourse was frequently had to astrologers. The star which appeared on the day of Charles II's birth, May 29th. 1630, was generally regarded as an omen.

- i. It is referred to by Dryden in his *Astraea Redux*, and *Annus Mirabilis*; by Cowley in his *Ode on the Restoration*; by Waller in his *Poem on St. James' Park*; by Herrick in his *Pastoral upon the Birth of Prince Charles*; while Butler of course cannot resist the temptation to satirize the "royal stars". Characters throughout the drama bewail the evil power of the stars which govern their destiny. Wendoll in an agony of remorse for his treachery, cries,

- iii. "O my stars!
What have my parents in their lives deserved
That you should lay this penance on their son".

It was not without reason that Browne exhorted in tones which recall, in spite of their quaintness, the voice of some

- iv. Hebrew prophet, "Burden not the back of Aries, Leo, or Taurus, with thy faults, nor make Saturn, Mars, or Venus, guilty of thy follies. Think not to fasten thy imperfections on the stars, and so despairingly conceive thyself under a

i. l.288; St.18.

ii. Hud. i.ii. C.iii. l.197.

iii. A Woman Killed with Kindness. Act v. Sc. iii.

iv. Chri. Morals P.iii. S.vii.

fatality of being evil, Calculate thyself within, seek not thyself in the Moon, but in thine own Orb or Microcosmical Circumference. Let celestial aspects admonish and advertise not conclude and determine thy ways". Astrologers, mock and "genuine", constantly appear in the plays of the time. The 17th. century would condemn with Burton the man who "will

- i. attribute no virtue at all to the heavens, or to sun, or moon, more than he doth to their signs at an inn keeper's post or tradesman's shop".

The connection of astrology with medicine will be referred to later, but it may be noted here that the operations of agriculture were ruled by the phases of the moon. Evelyn in his *Kalendarium Hortense* assures his

- ii. reader "We are yet far from imposing those nice and hyper-critical punctilios, which some astrologers and such as pursue their rules seem to oblige our gardeners to, as if forsooth, all were lost and our pains to no purpose, unless the sowing and the planting, the cutting and the pruning, were performed in such and such an exact minute of the
- iii. moon" and in his *Sylva*, he says that he would not "altogether govern a felling at the pleasure of this mutable lady".

Thomas Fuller, a kind of prose Chaucer whose study was "on the Bible", has the following among his *Good Thoughts in*

- iv. *Bad Times*, "Lord, I read that Thou didst make grass, herbs, and trees, the third day. As for the sun, moon, and stars, Thou madest them on the fourth day of the Creation.

i. Anat. of Mel. P.i. S.ii.M.i.S.iv.
 ii. Introduction.
 iii. Ch. xxx.
 iv. Scrip. Observ: xviii.

Thus at first Thou didst confute the folly of such who maintain, that all vegetables, in their growth are enslaved to a necessary and unavoidable dependence on the influence of the stars. Whereas plants were even when planets were notHereafter I will admire Thee more, and fear astrologers less; not affrighted with their doleful predictions of dearth and drought, collected from the complexions of the planets".

Sidrophel numbered among his accomplishments the power to tell,

- i. "Whether the wane be, or increase
Best to set garlic, or sow pease".

Among the miscellaneous purposes for which astrology was employed, may be mentioned the discovery of lost property. Antonio in the Duchess of Malfi informs Bosola,

- ii. "I have been setting a figure
For the duchess jewels",

while Butler satirises the pretensions of astrologers to find out by their art,

- iii. "Which way a serving man that's run
With clothes or money away, is gone".

The Astrologer or Almanac maker was always a favourite subject for the character writers. Sir Thomas Overbury describes him thus "Ptolemy and Tycho Brahe are his patrons, whose volumes he understands not but admires; and the rather because they are strangers and so easier to be credited than controlled. His life is upright, for he is always looking

upward; yet dares believe nothing about *primum mobile*, for 'tis out of reach of his Jacob's staff. He would be thought the devil's intelligencer for stolen goods".

- i. Yet out of the darkness of these superstitions astronomy was born, - Sir Isaac Newton owned that the pursuit of astrology led him to the love of astronomy. To understand the struggle between the rival systems of
- ii. Ptolemy and Copernicus some account of the history of astronomy is necessary. The doctrines which Ptolemy promulgated in his great work *The Almagest*, dating from the second century A.D., held undisputed sway for fourteen centuries. His theory certainly appeared to explain the facts as observed by ordinary men, and the advance in scientific knowledge does not prevent us from speaking of the journeyings of the sun even today. An attractive anthology could be compiled, consisting of passages of English poetry based on the Ptolemaic system with its concomitant music of the spheres. Copernicus, born at Thorn on the Vistula in 1473, and dying in 1543, a few hours after receiving a copy of the book embodying his life work, was the first to challenge the geocentric theory with a reasoned train of argument. Doubtless the publication was delayed owing to the astronomer's fear of consequences - a fear only too well founded as the fate of Bruno, burnt at the stake in 1600, for denying that the earth is the centre of the universe, proved. The Copernican hypothesis did

i. cf. Coleridge *Table Talk*. March 18th. 1832.

ii. For this part of the work obligations are due to Sir R. Ball's *Great Astronomers*, and to the articles in the *Encyc. Brit.*

not arouse universal attention till the time of Galileo, who published his Dialogue in 1632, but occasional allusions to the new theory are to be found before that date. Bacon considered the Ptolemaic and Copernican systems were

- i. "indifferently agreeable" to the observed phenomena, and hence did not support the new theory. Donne employs the following illustration in his Verse Letter to the Countess of Bedford (1609-10),

"As new philosophy arrests the sun
And bids the passive earth about it run,
So have we dull'd our mind, it hath no ends
Only the body's busy and pretends".

while in The First Anniversary (1611) he complains,

- ii. "new philosophy calls all in doubt,
The element of fire is quite put out
The sun is lost, and th'earth, and no man's wit
Can well direct him where to look for it".

Browne of Tavistock alludes to the theory in the 3rd. book of Britannia's Pastorals (date unknown, circa 1618 ?), telling of a pleasant wood where

- iii. "Poppy and henbane thereby grew so thick
That had the earth been thrice as lunatic
As learn'd Copernicus in sport would frame her
We there had sleepy simples found to tame her".

Alexander Browne (1620-1666) named his Bacchanalian ode Copernicus. The *raison d'être* will be apparent from the following lines,

"As Copernicus found
That the earth did turn round
We will prove so does everything in it".

i. Adv. Bk.ii. viii. 5.
ii. 1.205 et seq.
iii. Bk. iii. Song 1.1.291 - 4.

Tycho Brahé is the next important figure, whose character shows much the same combination of inspiration and charlatanism as that of Paracelsus. It is to be regretted that we have not a companion picture of Tycho Brahé to go with that of Paracelsus for the life of the old Dutch astronomer would lead one to think

"Robert Browning, you writer of plays
Here's a subject made to your hand!"

Tycho Brahé (1546-1601) did not accept the Copernican hypothesis, but elaborated a theory of his own, known as the Tychonic system, which has now passed into oblivion. His importance, however, does not lie in his theory but in his realization that the only method of investigating the movements of the heavenly bodies was to carry out a protracted series of accurate measurements. He invented all the apparatus he used and even when a youth carefully allowed for errors in the instrument. "This principle, employed by the boy with his cross staff in 1564", says Sir Robert Ball, "is employed at the present time by the Astronomer Royal at Greenwich, with the most superb instruments that the skill of modern opticians, has been able to construct". For 25 years Tycho lived in the little island of Huen in the Baltic, which had been given to him by Frederick II. Here he built an observatory Uraniborg - the City of Heaven - equipped with all necessary apparatus and adorned with pictures. During his residence there,

he drew up the valuable tables of astronomical facts which Kepler found of such immense service later. Tycho combined the roles of astrologer and astronomer and his striking personality attracted popular attention, as we see from the constant allusions in the characters. In the Middle Isle of St. Paul's, we learn that certain adventurers, if they meet

1. "with a yonker that hath his pockets well lined with silver" volunteer "to relate to him the meaning of Tycho Brahe and the North Star". Momus referring to the stars which have been extinguished at the entry of every anti-masque in Carew's *Coelum Britannicum*, observes "Here is a total eclipse of the eighth sphere which neither Booker, Allestre, nor any of your prognosticators, no, nor their great master Tycho, were aware of". Habington when telling of the power of Castara's smile or frown to alter fore-ordained events apostrophizes the

"Learned shade of Tycho Brahe, who to us
The stars prophetic language dost impart
And even in life their mysteries discuss
Castara hath o'erthrown thy strongest art".

- ii. Butler assures us that Hudibras was more proficient in mathematics than Tycho while Dryden in his poem *Upon the Death of Lord Hastings*, describing the constellated appearance of the illustrious smallpox patient, declares

"Lived Tycho now, struck with the ray which shone
More bright in the morn than others beam at noon,
He'd take his astrolabe, and seek out here
What new star 'twas did gild our atmosphere".

- i. London and the Country Carbonadoed and Quartered into Several Characters by D. Lupton (1632).
- ii. P.i. C.i. 1.120.

It was the discovery of a brilliant new star in Cassiopeia on November 11th. 1572, which stimulated Tycho Brahe's astronomical interests, and inspired him to undertake his life's work.

Galileo del Galilei, born at Pisa in 1564, was intended for the medical profession, as was Copernicus, and he studied in the University of his native town under the famous botanist Caesalpinus.. Galileo had a most inventive brain even in youth, and a workman was kept in the house to execute the ideas which occurred to him. Among his inventions were the thermometer and pendulum clock, but the one by which he seized hold of men's imaginations was that of the telescope. Writing to his brother-in-law Landucci, he explains the origin of the invention thus: "You must know, that two months ago there was a report spread here that in Flanders some one had presented to Count Maurice of Nassau a glass manufactured in such a way as to make distant objects appear very near, so that a man at the distance of two miles could be clearly seen. This seemed to me so marvellous that I began to think about it. As it appeared to me to have a foundation in the Theory of Perspective, I set about contriving how to make it, and at length I found out, and have succeeded so well that the one I have made is far superior to the Dutch telescope". Galileo went on to show that ships at sea could be seen two hours before they were visible to the naked eye, and that objects fifty miles

away appeared to be only five miles distant. The telescope was invented in 1609 and Galileo presented many telescopes to his distinguished friends, but no one appeared to realise their importance for the study of astronomy. Possibly some did apply the glass to the heavens, but like Wordsworth's London star gazers saw nothing particularly interesting. At any rate Galileo was the first to prove its usefulness for astronomical purposes. He discovered that the stars were ten times more numerous than the naked eye could count, while the broad band of silvery light, known as the Milky Way, proved to be composed of myriads of tiny stars. In 1610 came the most momentous of all the discoveries which have been made by the help of the telescope viz., that of the system of four satellites revolving round Jupiter. Its importance lies in the fact that Jupiter circled by its four moons, is a picture in miniature of the solar system. If such a thing could be true in the case of one planet there was nothing to prevent the Copernican hypothesis from being the correct explanation of the universe. Just in the same way the relatively smaller planets revolve round the sun while the earth has its own satellite the moon. In 1611 Galileo discovered the spots in the sun while another of his important revelations was the phenomenon known as the libration of the moon. In literature his discovery of the irregularities on the moon's surface is most to be remembered but the use to which he put

this observation is of importance in astronomy. By careful measurements of the lunar spots and markings he found that

- i. there is "a slight periodic variation which permits us to see now a little to the east or to the west, now a little to the north or to the south, of the average lunar disc."

His epoch making work *The Dialogue of the Two Systems* was published in 1632 and the tragedy of "the famous Galileo, grown old, a prisoner to the inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought", interested men more than ever in his discoveries. He died in 1643 blind and among enemies, in circumstances resembling the end of his English visitor.

The interest which centred round the figure of Galileo was partly due to his invention of the telescope and the new world which was thus brought within human ken, and partly to the confirmation which he gave to the Copernican hypothesis. Throughout the century we hear of the trunk, perspective glass, perspicil, tube, etc., all of which refer to,

- ii. "that fantastic glass
Invented by Galileo the Florentine"

Even Bunyan who seems to have taken no interest in science, as a general rule, so that his own description of his process of writing is exactly true,

- iii. "It came from my own heart, so to my head
And thence into my fingers trickled",

alludes to the telescope. The *Shepherds take Christian* and

-
- i. *Great Astronomers* p.63.
 - ii. *Duchess of Malfi* Act ii. Sc.iv.
 - iii. *Holy War*.

Hopeful to the summit of the Hill Clear and lend them a
perspective glass to see the Celestial City from afar.
In Quarles' Emblems we find Spirit holding a telescope to
the eye, while Flesh standing at her side asks,

- i. "What means my sister's eye so oft to pass
Through the long entry of that optic glass?"

to which Spirit replies,

"It helps the sight, makes things remote appear
In perfect view, it draws the object near".

The diaries of Evelyn and Pepys show the interest in
telescopes. Pepys, it will be remembered examined Jupiter
with his much prized glass but later extended the field of

- ii. his operations by proceeding to the parish church, "There
did entertain myself with my perspective glass up and down
the church, by which I had the great pleasure of seeing
and gazing at a great many very fine women".

Quaint old Robert Burton alludes to the discovery of
the star sown path of the Milky Way, telling us that

- iii. "Galileo by his glasses" found "that via lactea, a confused
light of small stars, like so many nails in a door".

Cowley also refers to it

- iv. "Men doubt, because they stand so thick i'th' sky,
If those be stars which paint the galaxy".

Raphael in describing the return of the Creator after "his
six days' work a world", explains to Adam

- v. "he through Heav'n
That open'd wide her blazing portals, led
To God's eternal house direct the way,

i. Bk.ii. Emb.14.
ii. May 26th. 1666-7.
iii. P.ii. S.2. M.3.
iv. Ode of Wit.
v. Bk.viii. l.574 et seq.

A broad and ample road, whose dust is gold
 And pavement stars, as stars to thee appear
 Seen in the galaxy, that milky way
 Which nightly as a circling zone thou seest
 Powder'd with stars".

The supreme discovery of Galileo, viz., that of the four moons of Jupiter, is not generally noticed but Henry More appreciated it at its true value. When supporting the Copernican theory in his Platonic Song of the Soul he describes the "opaque moon";

- i. "That turns about the earth (so turn those four
 'Bout Jupiter, tend him as he doth run his annual course"

In the Infinity of Worlds the satellites of Jupiter are constantly mentioned:-

- ii. "Besides each greater th'attendance find
 Of lesser; our earth's handmaid is the moon.
 Which to her dark'ned side right duly shines,
 And Jove hath four, as hath been said aboven
 And Saturn more than four if the plain truth were known"

The fact that irregularities were to be seen on the moon's

- iii. surface created much interest. Evelyn records that he felt confirmed in his belief that the moon was an earth, on seeing that the sun shining upon a landscape makes it appear luminous like the moon. Milton honours Galileo by choosing him as the only contemporary to be mentioned in Paradise Lost and his name is particularly associated with this discovery. Satan's shield

- iv. "Hung on his shoulders like the moon, whose orb
 Through optic glass the Tuscan artist views
 At ev'ning from the top of Fesole,
 Or in Valdarno, to descry new lands,
 Rivers or mountains in her spotty globe.

i. Bk.ii. St.63. again in St. 64.
 ii. St. 30.
 iii. Diary. Oct. 14th. 1641.
 iv. Bk.i. l.287 et seq.

From which lines it will be apparent that the inventions of man may have place in even the greatest poetry without causing a feeling of somewhat painful surprise - the illustration rises even to the height of its great argument.

The general attitude towards the discovery of mountains and valleys in the moon may be inferred from Butler's question,-

- i. "Have we not lately in the Moon
Found a new world, to th'old unknown?
Discover'd sea and land, Columbus
And Magellan could never compass?"

The excitement which the suggestion that the moon was inhabited caused was largely due to Kepler, so that we may postpone consideration of this point.

The spots which Galileo discovered in the sun are

- ii. alluded to by Browne in his *Urn Burial*. "While we look for incorruption in the heavens", he complains, "we find they are but like the earth; durable in their main bodies, alterable in their parts: whereof beside comets and new stars, perspectives begin to tell tales. And the spots that wander about the sun, with Phaeton's favour, would make clear conviction". When Satan reaches the sun Milton describes him thus
- iii. "There lands the Fiend, a spot like which perhaps
Astronomer in the sun's lucent orb
Through his glaz'd optic tube yet never saw"

Marvell in his satire *To the King* employs a similar metaphor

"So his bold tube, man to the sun applied
And spots unknown in the bright star descried".

i. Hud. P.ii. C.iii. l.727.
ii. Chap.v.
iii. Bk.iii. l.586.

Waller was much interested in the new astronomical discoveries and in his Divine Poems among the changes of modern times he notes that

- i. "Spots are observ'd in that which bounds the year".

The confirmation which Galileo gave to the Copernican hypothesis was at first viewed with unfriendly eyes. Robert Burton gives both sides of the question though his real opinion may be inferred from the warning of Democritus Junior, that the reader should not expect "some ridiculous treatise" or "paradox of the earth's motion". He assures us that, if the earth is a planet and moves and shines to others as the moon does to us, in the way astronomers would have us believe "then are we also giddy, vertiginous and lunatic within this sublunary maze". In his Digression of the Air - which gives Burton in quintessence - he describes the disputes of astronomers thus: "In the meantime, the world is tossed in a blanket amongst them, they hoist the earth up and down like a ball, make it stand and go at their pleasure; one saith the sun stands, another he moves".

- ii. Sir Thomas Browne believed, mainly on religious grounds, in the Ptolemaic system but with his determination "to adhere unto things doubtful in a dubious and opinionative way" he is content to allow "if any affirm the earth doth move and will not believe with us it standeth still I will not quarrel with his assertion". The reason for this freedom in "bivious theorems and Janus faced doctrines" Browne shows

i. C.iv.

ii. Pseud. Epid. Bk.i. Ch. v.

i. in his Christian Morals. "Speculative misapprehensions may be innocuous, but immorality pernicious; theoretical mistakes and physical deviations may condemn our judgements, not lead us into Judgement".

ii. In Henry More's A Platonic Song of the Soul we have by far the most elaborate exposition of the Copernican hypothesis in seventeenth century poetry, and it is the more remarkable from the early date of its publication (1647). He tries to render the position of the "stiff-standers for aged Ptolemy", untenable by scientific arguments (diluted with "proofs theosophical" however) which would not discredit a modern astronomical primer. The discovery of the moons which revolve about Jupiter, he recognized as an important argument from analogy, as we have already seen. The whole canto is so full of astronomical technicalities that we cannot consider the apprehension expressed towards the close of the following lines as altogether unfounded.

iii. "Many other reasons from those heavenly motions
Might well be drawn, but with exility
Of subtle mathematics obscure notions
A poet's pen so fitly no'te agree.
And curious men will judge't a vagrancy
To start thus from my scope".

In the next canto he prudently resolves,

iv. "It me behoves to hold forward on my way
Leaving this uncouth strange philosophy
In which my lightsome pen too long did play
As rigid men in sad severity
May deem"

It is possible that Milton was acquainted with More's work

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- i. P.i. S.xvii.
 - ii. Bk.iii. C.iii.
 - iii. Stanza 73.
 - iv. Bk.iii. C.iv. Stanza 8.

and quite apart from the astronomical digression, a poem embracing the whole cosmology, could not fail to interest the author of *Paradise Lost*.

The philosophical doubt with which Milton received the Copernican hypothesis is eminently characteristic of the general mid-century attitude towards the new astronomy. In his earlier poems, the *Ode on the Nativity*, *Arcades*, and *Comus*, the Ptolemaic system is accepted unreservedly, but later Milton had the exceptional inducement to adopt the new theory, given by a personal acquaintance with its great
i. exponent. Yet even after his visit to Galileo he continued to teach his pupils the old astronomy from the *De Sphaera* of Joannes a Sacrobosco. Nevertheless it is probable, as Professor Masson suggested, that Milton in later life recognized the superiority of the Copernican hypothesis for purposes of scientific explanation, though he preferred the Ptolemaic system - with a difference - for the *mise en scène* of his epic poem. Raphael replies very doubtfully indeed to Adam's enquiries concerning celestial motions, and is careful to make the alternative suggestion,

- ii. "What if the sun
Be centre to the world, and other stars
By his attractive virtue and their own
Incited, dance about him various rounds".

Waller was particularly interested in the new theory, though according to Dr. Johnson, he was "too much of a Copernican"

- iii. in the little lyric beginning "Stay, Phoebus, Stay!" In his

i. Masson Vol.vi. p.534-5.
ii. Bk.viii. l.122.
iii. Life of Waller.

Divine Poems, when praising the Bible he writes,

"As late philosophy, our globe has graced
And rolling earth among the planets placed
So has this book entitled us to heaven
And rules to guide us to that mansion given".

Dryden frequently avails himself of both systems for illustrations, though he accepted the Copernican hypothesis.

Panegyriizing Clarendon he says,

1. "Such is the mighty swiftness of your mind
That, like the earth's, it leaves our sense behind,
While you so smoothly turn and roll our sphere
That rapid motion does but rest appear".

While Galileo was busy discovering new worlds with his optic glass and bringing irrefragable arguments to the support of the Copernican theory, Kepler (1571-1630) was working out his great laws concerning the movements of the planets.

Kepler formulated the immense number of facts collected by Tycho Brahe into the Rudolphine tables, and from these facts he deduced the three planetary laws bearing his name. The most important of these embodied the discovery that planets move in ellipses not in circles. "All the theories must be wrong if they do not agree with what Tycho saw" was the point from which he started, and he soon discovered that the facts did not confirm the general belief that the planets have circular orbits. Kepler did not confine himself to this brilliant theorizing but proceeded to deduce the logical conclusion from the discovery that the moon was an earth. He conceived that there were two races of lunar inhabitants, the Privolvani who never see the earth, and Subvolani, who

continually have our planets in view. Science has forgotten Kepler's fruitless speculations ("chips" Sir Robert Ball calls them), and has gratefully accepted his supreme discoveries, but literature, in the 17th. century, was more interested in his fantastic theories. He is occasionally mentioned with other astronomers, in Burton, Sir Thomas Browne, and the character writers, but elsewhere he is only thought of in connection with the theory which proposed that the moon was inhabited.

In 1621 Jonson produced his masque, *News from the New World Discovered in the Moon*, in the course of which a herald brings "sure and certain news" of the lunar world and its brave new inhabitants. The populace of the moon is not to be thought of in the manner of Bottom and his confreres. "The lanthorn, dog, and bush of thorn, "are but" stale ensigns o' the stage's man i' the moon, delivered down to you by musty antiquity and are of as doubtful credit as the makers".

- i. The "universally curious Dr. Wilkins" was the author of a most amusing little book, *The Discovery of a New World or A Discourse tending to prove that ('tis probable) there may be another Habitable World in the Moon; with a Discourse concerning the Possibility of a Passage thither*. Kepler's
- ii. Privolvani and Subvolvani are mentioned, and in the curious frontispiece to the first edition (1638), Copernicus, Galileo, and Kepler are portrayed. The last named astronomer is represented as saying "Ulinam et alae".

i. Evelyn. Diary. July 13th. 1654.
 ii. Proposition vi.

i. Robert Burton puts the case for the habitability of the planets into the form of a hypothetical syllogism "If the earth moves, it is a planet, and shines to them in the moon as they do to us upon the earth; but shine she doth as Galileo, Kepler and others prove, and per consequens the rest of the planets are inhabited as well as the moon".

ii. Sir Thomas Browne informs us that "according to better discovery the poor inhabitants of the moon have but a polary life, and must pass half their days in the shadow of that luminary".

The writers influenced by Plato were generally favourable to the suggestion Drummond of Hawthornden tells us in his Cypresse Grove that, "Some affirm there is another world of men and sensitive creatures, with cities and palaces in the moon". More in his Essay upon the Infinity of Worlds out of Platonic Principles still admits:-

iii. "But that experiment of the optic glass
The greatest argument of all I deem
Ne can I well encounter nor let pass
So strong a reason, if I may esteem
The feat withouten fallacy to been".

The idea of the planets being inhabited was generally viewed with derision. Butler's satire, *The Elephant in the Moon*, is perhaps the best known attack on the new astronomy.

When Galileo asked a sceptical contemporary to look at Jupiter's moon through the telescope he was met with the objection that the satellites might be visible in the lens,

iv. but they were certainly not in the sky. Glanvil also

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- i. Anat. of Melancholy.
 - ii. Garden of Cyrus. Chap. iv.
 - iii. Stanza 91.
 - iv. Chapter ix.

devoted a chapter of his Plus Ultra to an attempt to persuade people who would not believe the telescope gave true sight. He urged the doubting ones to try the telescope on well known objects a short distance off, in order to prove that its sole effect was to magnify objects enormously. This spirit animated Butler's satire. The members of a learned society imagine that they see the more cultivated "Subvolvans" engaged in battle with those

1. "Call'd Privolvans, with whom they are
Perpetually in open war".

and close observation reveals what is thought to be an elephant. The elated virtuosi resolve to have the discovery printed in the next Transaction but while they are engaged in drafting the report a mischievous footboy discovers that the supposed elephant is a mouse imprisoned in the tube. The disappointed members console themselves with the discovery of the lunar population which is after all no mean achievement. The telescope is then lowered but unfortunately,

11. "ere the tube was half let down,
It clear'd the first phenomenon;
For, at the end, prodigious swarms
Of flies, and gnats, like men in arms,
Had all pass'd muster, by mischance
Both for the Sub, and Privolvans".

In Hudibras we are told that Sidrophel knew

111. "How many dukes, and earls, and peers
Are in the planetary spheres".

Shadwell's Virtuoso on being asked if he believes the moon

1. L.53-4.
11. L.485-490.
111. P.11. C.111. L.253-4.

1. to be an earth replies "Believe it! I know it; I shall shortly publish a book of geography for it. Why 'tis as big as our earth; I can see all the mountainous parts, and valleys, and seas, and lakes in it; nay the larger sort of animals, as elephants and camels; but public buildings and ships very easily. I have seen several battles fought there. They have great guns and have the use of gunpowder. At land they fight with elephants and castles, I have seen 'em". After which outburst we are assured that Sir Nicholas Cimcrack is "but a faint copy to some originals among the tribe".

Bunyan viewed the proposition with contempt. He is anxious not to be regarded as a fable maker, and in his prefatory verses to *The Holy War*, he begs the reader,

"Count me not, then, with them that to amaze
The people, set them on the stars to gaze
Insinuating with much confidence
That each of them is now the residence
Of some brave creatures; yea, a world they will
Have in each star, though it be past their skill
To make it manifest to any man
That reason hath, or tell his fingers can".

Though Kepler perceived that the planetary orbits must be elliptical if the observed facts were to be explained, he did not know why no planet can have a circular orbit. Sir Isaac Newton (1642-1727) showed the necessity by establishing his theory of gravitation. At Woolsthorpe in 1666, he became occupied with the problem, though he did not publish his great discovery till 1687 in the work known as the *Principia*. The probably apocryphal story of the

apple is useful as showing the principle underlying the whole theory. The fruit always falls to the ground, irrespective of the height of the tree, and the rule would still hold though the summit reached to the moon. In just the same way the moon is attracted by the earth, while the earth in its turn, is attracted by the sun. Schoolboys from time immemorial have had an innate confidence in the attractive force of the earth, as they have shaken the apple tree boughs, but it required the scientific imagination of a Newton to connect the falling apple with a falling world. It is not therefore surprising to find the attractive force of the earth frequently mentioned in seventeenth century literature, and such references cannot be regarded as literary prophecies of the law of gravitation. Shakespeare makes the faithless Cressida protest

1. "Time, force, and death
Do to this body what extremes you can,
But the strong base and building of my love
Is as the very centre of the earth,
Drawing all things to't".

Cowley's Mistress from which the following two lines are taken was published in 1647 when Newton was only five years old. Maidenhead is addressed as a power which

"like the centre of the earth
Dost heaviest things attract to thee".

- ii. Traherne describes the Cross of Christ as the Centre of Eternity, and, "As on every side of the earth all heavy things tend to the centre, so all nations ought on every side to flow into it".

- i. Tr. & Cr. Act iv. Sc.ii.
- ii. Centuries of Meditations I. 56.

Many of such allusions are connected with the interest in magnetism, and the remainder evidently do not prove an acquaintance with the law of gravitation. Henry More deserves slightly more attention, for he is apparently the only seventeenth century writer who alludes to the attractive force of the earth in a definitely astronomical context. In the canto devoted to explaining the rationale of the Copernican hypothesis, he replies to possible opponents,

- i. "The earth's swift motion
Because 'tis natural not violent
Will never shatter buildings. With straight line
It binds down strongly each particular element
Of every edifice; all stones incline
Unto that centre; this doth stoutly all combine".

He assures the reader,

- ii. "single centrality
You'll find shall do whaters's advent by phantasy".

and concludes by asking,

- iii. "Who then so blind but plainly sees
How far our safety Nature well contrives
Binding all close with down propensities".

This appeared in 1647 and it might conceivably be regarded as a poetic prophecy of the law by which the most ancient heavens are fresh and strong.

If the science of astronomy should cease to be, men would always yearn "towards the journeying moon, and the stars that still sojourn, yet still move onward", and feel the same "silent joy at their arrival". Nevertheless it is probable that the heavens were scanned more anxiously than

i. Immortality of the Soul. Bk.iii. C.iii. St.30.
ii. Ibid. St.29.
iii. Stanza 31.

usual, in the seventeenth century when the announcement of the Copernican hypothesis caused a revolution in astronomy. Drummond of Hawthornden, Vaughan, and Milton, to mention only three poets, are remarkable for their spacious stellar similitudes, while Sir Thomas Browne is exalted by the stars as he is by only one other thing - the contemplation of Death.

It is curious that great writers frequently do attempt to assimilate astronomy and literature. Plato, Dante, and Milton are three great instances, while Tennyson nearer our own day is constantly alluding to the sidereal system. Milton called Galileo the Tuscan artist, and the term is very suggestive for astronomy is more often dealt with in literary art than any other science.

CHEMISTRY.

1. From the fourth century A.D. to the middle of the sixteenth century the history of alchemy is also the history of chemistry, and chroniclers of the latter science describe this portion of its history as the Period of Alchemy. The practice of alchemy was continued well on into the seventeenth century, but it fell more and more into disrepute, while the accredited "chymists" began to devote their attention to the preparation of drugs. Thus, the alchemy which had been contemptuously dismissed as a cloak for fraud and superstition, regained the esteem it had lost, by becoming a science ancillary to medicine. The stage of subservience to medicine is known as the period of Iatrochemistry, and it continued through the sixteenth to the middle of the seventeenth century. Towards the close of the latter century chemistry began to take its stand as an independent science, the ground having been cleared by the work of Boyle and Mayow. Thus within our period we find the lingering of alchemy, the zenith of iatrochemistry, and the dawn of the modern science. It will be the business of these pages to show how far the three stages in the growth of chemistry are reflected in contemporary literature.

Chaucer's Canterbury Pilgrims were interested in the Chaucuns Yemannes account of the wiles of his gold transmuting master, while Shakespeare speaks of the sun gilding pale streams "with heavenly alchemy", so that it is quite

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1. Authorities (a) A History of Chemistry. Dr. Hugo Bauer (Translation 1907). (b) History of Chemistry F.P.Armitage

apparent that passing allusions to the science are not an innovation of the seventeenth century. The alchemistic historian Schmieder considered that the high water mark of the science was not reached till the seventeenth century, and although this view is not generally accepted, it is certainly only in the literature of that period that we find a perfect acquaintance with the alchemist's apparatus, his method of procedure, and above all of the theory which is the justification for the whole process. To go from the sixteenth century references to alchemy to those of the seventeenth century, is like turning from Tennyson's Palace of Art to Browning's poems about pictures, in which we seem to have a peep behind the scenes, into some real studio with its paint and turpentine. The allusions are so vivid that it would appear that the poet had paid a visit to the laboratory of an alchemist, and while narrowly observing the proceedings, had obtained a reasoned account of the alchemical method.

Ben Jonson's *Alchemist* (1612), is of course the locus classicus on the subject, and is a perfect mine of information the alchemistic historians frequently employing the play to elucidate the cloudy writings of the alchemists themselves. Jonson is not the only writer to understand the fundamental principles of alchemy but nowhere else do we find such encyclopedic completeness.

1. The alchemistic philosophy rested on a belief in the

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1. The *Story of Alchemy* by M.M.Pattison Muir is the source of information for the theory of alchemy.

uniformity and simplicity of nature, it regarded the supposition that there is one law for animals and plants, and another one for inorganic substances as unreasonable. Such enigmatical propositions as "What is above, is as what is below" are constantly recurring in the alchemistic writings, and they are interpreted to mean that metals and other minerals live, just as do plants and animals and like them pass from imperfection to perfection. Nature if left to herself, would ultimately transmute all the inferior metals into gold, which is the most lasting and perfect of all metals, only the alchemists thought to hasten the process by artificial means. Subtle's remark will show the belief on which alchemy was based,

- i. " 'twere absurd
To think that nature in the earth bred gold
Perfect in the instant: something went before.
There must be remote matter".

Sir Epicure Mammon is assured,

- ii. "Nature doth first beget the imperfect, then
Proceed she to the perfect"

The old alchemists delighted in the comparison of baser metals to a seed or an egg. Thus when Surly scoffingly suggests that Subtle would hatch gold in a furnace as eggs are hatched in Egypt, the following colloquy takes place,

- iii. Subtle: "No egg but differs from a chicken more
Than metals in themselves"
Surly: "That cannot be,
The egg's ordain'd by nature to that end
And is a chicken in potentia"
Subtle: "The same we say of lead and other metals
Which would be gold, if they had time".

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- i. Alchemist Act ii. Sc.1.
ii. Ibid.
iii. Ibid.

Bacon considered that the "ends or pretensions" of alchemy

- i. are noble for it "professes to extract and eliminate the heterogeneous elements which are latent in substances, as they exist in nature, and to purify bodies which are impure, to set free those which are enchained, and to perfect those which are incomplete." Milton anxious to prove that Raphael partook of the fruits not seemingly, nor in mist, explains that the grosser particles are transmitted through "spirits celestial" with ease,

- ii. "Nor wonder, if by fire
Of sooty coal the empiric alchemist
Can turn or holds it possible to turn
Metals of drossiest ore to perfect gold
As from the mine".

Dryden also alludes to the idea in his *Annus Mirabilis*;
for just

- iii. "As those who unripe veins in mines explore
On the rich bed again the warm turf lay
Till time digests the yet imperfect ore
And know it will be gold another day"

so the king saw in the early fight

"The essay and rudiments of great success".

Even today we have terms proper to ethics employed in science.- there are perfect and imperfect gases, and good and bad conductors of heat and electricity, but the alchemists were not satisfied with this simple classification. A metal, like a man, was supposed to consist of body, soul, and spirit. By the body of a metal was meant the specific characteristics in virtue of which a substance is described

i. De Aug.
ii. P.L.Bk.v. L.439-443.
iii. Stanza 139. Also King Arthur Act v.

as metallic, by the soul the properties which distinguish one class of metals from another, and by the spirit the one inner immaterial potency which is common to all things. The alchemists were fond of saying that in the same way that the body must be mortified if the soul is to be freed from its prison of flesh, so the outward character of metals must be destroyed in order to set free the soul. Hence the endless calcinations, distillations, etc. After the body was cast aside it still remained to remove the soul, and set free the spirit or quintessence, and to effect this second operation was obviously the most difficult part of the matter. Since ordinary measures would not suffice the philosopher's stone was introduced, which was supposed to set free the spirit of the metal. The unclogged spirit would inevitably take the most perfect of all forms - gold. In the first place the function of the philosopher's stone was differentiated from that of the "red tincture" or great elixir, which was capable of renewing life, but ultimately the properties became confused and either term was employed indiscriminately. Thus even in the period of alchemy we find a tentative alliance with medicine. From the literary point of view an acquaintance with the alchemical theory is necessary to the understanding of much of the seventeenth century religious poetry, which simply teems with illustrations drawn from that source.

Subtle is no doubt adapting his language to the

theological pretensions of Ananias "the sanctified elder", though his metaphors are nevertheless true to the conception which the alchemists themselves held, when he adjures Face his bold compeer,

i. Subtle: "Sirrah, my varlet, stand you forth and speak to him,
Like a philosopher: answer in the language.
Name the vexations, and the martyrizations
Of metals in the work".

Face: "Sir, putrefaction,
Solution, ablution, sublimation,
Cohobation, calcination, ceration, and
Fixation".

We also find the terms "mortification", "proper passion of metals", "ultimum supplicium auri", employed in this same passage.

Jonson did not belong to the religious school so that we do not find the application of the doctrine to the Christian life in his work. Donne at once perceived its possibilities and his references to alchemy equal, if they do not exceed the number of his medical allusions. Speaking of himself within the tomb he says,

ii. "till us death lay
To ripe and mellow here we've stubborn clay
Parents make us earth, and soul's dignify
Us to be glass; here to grow gold we lie".

Remembering that the red tincture has a double function, to transmute baser metals into gold and to renew life, the meaning of Donne's reference to the Resurrection becomes clear. Christ became a mineral for three days,

iii. "He was all gold when He lay down, but rose
All tincture, and doth not alone dispose
Leaden and iron wills to good, but is
Of power to make e'en sinful flesh like His".

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- i. Alchemist Act II.
 - ii. On Himself.
 - iii. Divine Poems. Resurrection.

Herbert's poem The Elixir is based on this idea,

"All may of Thee partake,
Nothing can be so mean
Which with his tincture "for Thy sake"
Will not grow bright and clean.

A servant with this clause
Makes drudgery divine;
Who sweeps a room as for Thy laws
Makes that and th'action fine.

This is the famous stone
That turneth all to gold
For that which God doth touch and own
Cannot for less be told".

- i. Sir Thomas Browne shows the same reverential feeling towards "that mystical metal of Gold, whose solary and celestial nature I admire", and assures us that "The smattering I have of the Philosopher's Stone (which is something more than the perfect exaltation of gold) hath taught me a great deal of Divinity, and instructed my belief, how that immortal Spirit and incorruptible substance of my Soul may lye obscure, and sleep awhile within this house of flesh". Many other writers appear to have received similar instruction from the Will o' the wisp search for gold.

Even Robert Herrick who normally betrays as little interest in science as faithful Prudence Baldwin, or Tracy, employs an alchemical metaphor in His Noble Numbers,

- ii. "There is no evil that we do commit,
But hath th'extraction of some good from it:
As when we sin; God, the great Chymist thence
Draws out th'Elixir of true penitence".

When a religious age speaks of God as the Great Chemist it can only be concluded that chemistry must then have had a far closer connection with poetry than the science of our own day.

Quarles delighted in illustrations drawn from alchemy.

When the soul has become purified he sings,

- i. "So now the soul's sublimed: her sour desires
Are re-calcined in Heaven's well tempered fires:
The heart restored and purged from drossy nature
Now finds the freedom of a free born creature".

Benlowes of course did not neglect the popular science, though it is to be feared that the three following lines show a diminuendo accelerando of poetical power, with the introduction of theology and alchemy,

- ii. "The opal colour'd dawns raise fancy high;
Hymns ravish those who pulpits fly;
Convert dull lead to active gold by love-chemy".

The Matchless Orinda is thinking of the frequent disappointments which beset the path of the alchemist, when she employs the following illustration to describe how the soul of her baby escaped from its bodily prison soon after birth,

- iii. "So the subtle alchemist
Can't with Hermes' seal resist
The powerful spirits' subtler flight,
But 'twill bid him long good night".

One other aspect of the influence of alchemy upon literature deserves notice. The vasty dreams which the hope of transmuting base materials into gold excited, had some influence upon the creation of such characters as Barabas, Old Fortunatus, Volpone, and the immortal Sir Epicure Mammon,

i. Bk.ii. Emblem xv.

ii. Theophila's Love Sacrifice. Canto i. Lxvi.

iii. Epitaph on Her Son. H.P.

Sir Epicure's magnificent ravings climb almost to the height of the apostrophe of Faustus to Helen. He indeed talks gold, as he resolves that his mistress

- i. "shall feel gold, taste gold, hear gold, sleep gold".

In the sixteenth and seventeenth centuries we have the poetry of the desire for gold expressed more splendidly than in any other period of our literature.

Although the seventeenth century understood the theory on which alchemy was based, it was by no means disposed to take the veracity of its exponents for granted. Neither Ben Jonson nor Donne had any faith in the pretensions of the alchemist, while Burton cannot help wondering what would happen if Democritus, the laughing philosopher, should be equipped with some "rare perspective glass" whereby to view

- ii. all the "forgeries of alchemists, the philosopher's stone, projectors, and all those works of darkness". The terms which the alchemists employed were as "clergial" and "queynte" as in Chaucerian times and we find Bacon protesting against
- iii. their "enigmatical writings", and Sprat discovering a
- iv. marked resemblance in their style "to the smoke in which
- iii. they deal". Bacon also complained of "auricular traditions" by which the master alchemist, when about to die, was supposed to convey the supreme secret of his art to a favourite disciple. The mysteries of the alchemistic writings were therefore really insoluble for the key was only entrusted to one person, lest some unworthy individual

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- i. Alchemist Act iv. Sc.i.
 - ii. Anatomy of Melancholy. Preface.
 - iii. Adv. Bk.i. iv. ii.
 - iv. History of the Royal Society. Part ii. Sect. viii.

should discover the means of manufacturing gold ad volentem.

It is eminently characteristic of the man who declared, "You never enjoy the world aright till the sea itself floweth in your veins, till you are clothed with the heavens, and crowned with the stars", that he should unequivocally condemn the unctuous alchemists who protested that though they possessed the power of transmuting metals into gold, they

i. always refrained from employing it. "No folly in the world is more vile, than that pretended by alchemists, of having the philosopher's stone and being contented without using it."

ii. Sir William Petty told Pepys "in good earnest", that though he intended to reward scientific discoveries by bequests he would give "nothing for the philosopher's stone; for, says he, they that find out that, will be able to pay themselves".

Bacon has given the most eloquent justification of alchemy, when, with one of his favourite illustrations, he

iii. pleads, "Yet surely to alchemy this night is due, that it may be compared to the husband man where of Aesop makes the fable; that, when he died, told his sons that he had left unto them gold buried underground in his vineyard; and they digged over all the ground and gold they found none; but by reason of their stirring and digging the mould about the roots of their vines, they had a great vintage the year following; so assuredly the search and stir to make gold hath brought to light a great number of good and fruitful

i. Centuries of Meditations. iv. ii.
 ii. Diary. March 22nd. 1665.
 iii. Adv. Bk.i. iv. ii.

inventions and experiments, as well for the disclosing of nature as for the use of man's life".

- Coleridge pointed out that from alchemy came forth chemistry, and he declared that to the alchemistic ideal
1. the science would ultimately return for, "there must be a common law upon which all can become each, and each all".
- With the establishment of the Atomic theory science seemed to disprove the hopes of alchemy, by showing that there were a number of elements, of which any given one was composed of atoms differing essentially from those which went to the composition of a disparate element. Under the attack of modern science the atoms are beginning to fly apart and suggestions are not wanting that all are modifications of one primordial substance, so that Coleridge's prophecy may yet see fulfilment.

While alchemy was enjoying an unprecedented vogue and hastening to its dissolution, the period of iatro-chemistry which had set in during the sixteenth century had reached its zenith. Basil Valentine who lived in the latter half of the fifteenth century took his stand upon the ground of alchemy and made some attempt to introduce chemical preparations into medicine. Posterity, however, has acknowledged Paracelsus (1493-1541) as the real founder of the iatro-chemical school. Some historians consider this honour to be undeserved, and allege that Paracelsus owes his fame to the impression which his character made upon the literary imagination of his own and subsequent centuries.

1. The luminosity which plays about his shadowy figure has survived in spite of the egotistical bombast which disfigures his writings. In some dim way the best part of Paracelsus must have felt as does the hero of Browning's poem. In one point at any rate, they agree

"Rejecting past example, practice, precept
Aidless"

to stand alone.

- Galen had forbidden the use of mineral as poisons, and in consequence all mineral preparations were banished from the pharmacopoeia. Paracelsus placed alchemy, which apparently means chemistry, among the Four Pillars of Medicine
- ii. for "without a knowledge of alchemy the physician will use all the resources of his art in vain". In addition to the usual herbal remedies Paracelsus employed mercury, (in its metallic state and in solution), lead, and iron preparations, and above all antimony, in medicine. The controversy to which this innovation gave rise, belongs to the history of medicine.

The writers of the time took an interest in iatro chemistry, though it is not so general as the interest in alchemy. Bacon in his *New Atlantis* tells us that the Brethren of Solomon's House had laboratories for the compounding of metallic medicines, while Davenant describes certain messengers of the House of Astragon whose business it was to journey from the "mine to the hot furnace", in

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1. Hermetic and Alchemical Writings of Paracelsus.
2 vols. London 1894.
 - ii. Medical History from the Earliest Times, Withington p.256

order that they might,

- i. "to hopeful chymics matter bring
Where medicine they extract for instant cure".
- ii. Volpone, when disguised as a mountebank, refers in no complimentary terms to the doctors who, "with one poor groat's worth of unprepared antimony, finely wrapt up in several scartoccios, are able, very well, to kill their twenty a week!"

Drayton, in his description of the Peak, declares that the drug antimony was known to the mountain, before doctors were aware of its usefulness,

- iii. "For she a chymist was and nature's secrets knew.
And from amongst the lead, she antimony drew
And crystal there congeal'd, (by her enstiled flowers)
And in all medicines knew their most effectual powers".

In the dramas of the century we continually hear of metallic compounds but they are usually regarded as poisons.

- iv. Cymbeline's queen had "a mortal mineral" which she intended to administer to her husband. Especially in the ensanguined darkness of such plays as those of Webster and Tourneur do we find allusions to metallic poisons. In the terrific scene in The White Devil where Lodovico and Gasparo stand like Furies beside Brachiano's dying bed, the poisons which have been employed, are jerked out like the sharp grim notes of the prison bell which announces a murderer's death.

- v. "Gasparo: Now there's mercury -
Lodovico: And copperas -
Gasparo: And quicksilver -
Lodovico: With other devilish 'pothecary stuff
A melting in your politic brains, dost hear"?

- i. Gondibert. Bk.ii. C.v.
- ii. The Fox. Act ii. Sc.i.
- iii. Polyolbion Song. xxvi.
- iv. Cymbeline Act v. Sc.v. L.50.
- v. The White Devil. Act v.

The most important figure in the third period of chemistry is Robert Boyle (1627-1691) who is noteworthy, quite apart from his discoveries, for his persistent devotion to the experimental philosophy. He took an important part in the foundation of the Royal Society and in 1680 was elected President. The law of the relation between the volume and pressure of gases is known in England as Boyle's Law, but on the continent it is known by the name of Mariotte who discovered it rather later than the Englishman.

Mayow, (1645-1679) was a promising chemist who conducted a most fascinating series of experiments on respiration and combustion, in the course of which he proved that something which he called "fire-air" (our oxygen), is the chief agent in combustion and respiration. On his early death his discovery was forgotten and the fallacious Phlogiston Theory held the favour of the scientific world till the time of Lavoisier, in the eighteenth century. The work of chemists was thus chiefly concerned with experiments on air and gases. Torricelli invented the barometer in 1644 and the instrument created much interest in the learned societies. The satirists alone seemed to take an interest in the attempts made towards the foundation of a real science of chemistry. Butler tells us that one of the chief employments of the Royal Society was,

- i. "To measure wind and weigh the air",
- ii. while Sir Nicholas Gimcrack boasts "I can tell to a grain what a gallon of any air in England weighs". He also

- i. Satire on the Royal Society. L37.
- ii. The Virtuoso. Act ii.

volunteers to show Bruce and Longvil, who are impatiently waiting for an opportunity to interview the ladies, Clarinda and Miranda, his "Microscopes, Telescopes, Thermometers, Barometers, Pneumatic Engines, Stentoro-phonical tubes and the like".

Butler in his Satire Upon Critics, "who judge of modern plays precisely by the rules of the ancients", likens their procedure to a

- i. "measuring of air upon Parnassus
With cylinders of Torricellian glasses"

Dryden numbers Boyle among the "asserters of free reason's claim", though he is praised in quite general terms,

- ii. "And noble Boyle, not less in nature see
Than his great brother, read in states and men".

- the brother mentioned being the Earl of Orrery to whom Dryden dedicated his play, The Rival Ladies.

Pepys alludes to a very popular experiment when he iii. notes in his diary "Mr. Peter did show us the experiment, which I had heard talk of, of the chymical glasses, which break all to dust by breaking off a little small end; which is a great mystery to me". "The chymical glasses", also known as Prince Rupert's drops, were formed by allowing melted glass to fall into water. Butler mentions the invention in Hudibras,

- iv. "Honour is like that glassy bubble
That finds philosophers such trouble,
Whose least part cracked, the whole does fly
And wits are cracked to find out why".

i. Upon Critics. L.15-16.
ii. To Dr. Charleton.
iii. 13th. Jan. 1661-2.
iv. Hudibras P.ii. C.ii. L.385.

It will be apparent that the interest in chemistry waned with the progress of the century. This is partly due to the fact that alchemy has greater poetic possibilities than iatrochemistry, which in its turn is more susceptible of literary treatment than the early stages of pure chemistry. Something no doubt is also due to the passing of the ingenious school, and still more to the gradual decline of interest in things in general, which was stealing into the minds of men.

NATURAL HISTORY.

In giving this somewhat old fashioned but comprehensive title to the advances which were made in the study of Plants, Animals, Insects, Birds and Fishes, we are employing a term which would have been acceptable to the seventeenth century, for one man frequently studied the whole group of natural sciences, and though attempts at specialization were made, the more aristocratic sciences of Botany, Zoology, Entomology, Ornithology, and Ichthyology, were yet in a very rudimentary state. Nevertheless steady advances were made in the study of natural objects though we have no name of surpassing greatness to chronicle.

- i Conrad Gesner (1516-1565) is generally considered to be the first man to write anything original about plants and animals since the time of Aristotle. He travelled extensively to equip himself for his work as a naturalist, and established a botanical garden in his native city of Zurich. He was particularly interested in the medicinal properties of plants and once partook of a dose of Leopard's bane with serious, though fortunately not fatal, effects. His life work was a monumental History of Animals, comprising five parts, two being devoted to quadrupeds, and one each to birds, fishes and serpents. A sketch showing the animal's structure accompanies the life history of each creature. He also left materials for a similar treatise on plants and his drawings of 1500 specimens were

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- i Authorities (a) A Short History of Natural Science by
A. B. Buckley.
(b) Articles in Encyclopaedia Britannica.

published posthumously. He pointed out that superficial resemblances between plants are misleading and that a true classification must be based on differences of structure in the flowers and seedvessels. Donne refers to Gesner once while Robert Burton, Sir Thomas Browne, John Evelyn and Izaak Walton quote him as an authority constantly. Caesalpinus (1519-1602), who attempted to classify plants according to sex and Aldrovandus (1522-1605), who compiled an important natural history, are two other naturalists frequently cited by the same group of authors.

Marcello Malpighi (1628-1694) brought a world which had hitherto been concealed by its minuteness within view, by his invention of the compound microscope in 1661. With its aid he discovered, on examining the circulatory system in the stomach of a frog, that the blood passes from the veins to the arteries by the fine tubes known as the capillaries, Harvey knew that the veins and arteries must communicate, but his microscope was not sufficiently powerful to show the actual means by which this was done. Malpighi also solved a problem which much exercised Sir Thomas Browne, by showing the reason for the "atramentous condition" of negroes. The physician considered the various theories but he was at length forced to admit "how and when this tincture first began is yet a riddle, and positively to determine it surpasseth my

i Upon Mr. Thomas Coryat's Crudities 1. 22.
 ii Pseud. Epid. Bk. XI. Chap. X - XII.
 iii Chap. X.

presumption." In 1665 Malpighi with his microscope discovered that the epidermis of a negro is as white as the skin of any Englishman and that the colouring matter which gives him a dark tint is due to a soft layer between the dermis and the epidermis. This is still known as the Malpighian layer. Nehemiah Grew (1628-1711) is important in the history of vegetable anatomy and he is mentioned by Sir Thomas Browne and Evelyn. The work of the two friends, John Ray (1628-1705) and Francis Willoughby (1635-1672), is the most important English contribution towards the science of natural history. They undertook to compile a complete natural history, Ray devoting himself more especially to the study of plants, while Willoughby concerned himself with the birds, beasts and fishes. Willoughby's early death prevented the plan from being carried out, and Ray edited his friend's materials for the life history of birds and fishes. The study of animals he had to undertake entirely by himself and he did his work so well that he has been described as the father of modern zoology. His *Catalogus Plantarum Angliae* (1670) has been the basis of all subsequent English floras and Linnaeus adopted many of Ray's botanical classifications.

In the history of seventeenth century natural science the establishment of the Ashmolean Museum at Oxford in 1677 is

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- i For the English naturalists: *Social England*. Vol. IV p. 770, has been consulted.
 - ii Obligations due to account in *Social England*. Vol. IV p. 555.

i important. The gift was made by Elias Ashmole (Art's Maecenas, noble Esquire Ashmole) and it consisted of the collection which he had inherited from his friend John Tradescant, keeper of the botanic garden at Chelsea, the son of John Tradescant, a Dutchman, who had an interest in natural history. The father had begun to make the collection after his arrival in England, about 1600, and his son continued the work. Ashmole himself also made additions, chiefly of an

ii archaeological character. Piscator tells his pupil "There be so many strange creatures to be now seen, many collected by John Tradescant, and others added by my friend Elias Ashmole, Esq., who now keeps them carefully and methodically at his house near to Lambeth, near London, as may get some belief of the other wonders I mentioned." The good fisherman then gives an account of some of the rarities which will go far to prove that "the waters are Nature's storehouse, in

iii which she locks up her wonders." On the 23rd July, 1678, Evelyn paid a visit to Ashmole's house and he notes in his diary "The famous John Tradescant bequeathed his Repository to this gentleman who has given them to the University of Oxford, and erected a lecture on them over the laboratory, in imitation of the Royal Society." A suitable building having been erected by Sir Christopher Wren, the collection occupying twelve waggons, was moved to Oxford in 1682. When

i Lilly. History of his Life and Times.
 ii Compleat Angler. Chap. 1.
 iii Diary.

the Ashmolean Museum was established it was the first public institution of its kind in England and it gave a very valuable stimulus to the nascent study of natural history. It is now exclusively an archaeological museum.

Two other forces, Bacon and the Royal Society, also did much to encourage popular interest in the natural sciences. i Bacon considered that histories of "nature in course" were extant and, "that in good perfection," but that histories of "nature erring or varying; and of nature altered or wrought" ii were deficient. He also advocated the formation of "a kalendar of popular errors: I mean chiefly in natural history, such as pass in speech and conceit, and are nevertheless' apparently detected and convicted of untruth; that man's knowledge be not weakened nor imbased by such dross and vanity Sir Thomas Browne's *Pseudodoxia Epidemica* might be described as such a "kalendar of popular errors" though he nowhere acknowledges Bacon as the father of the idea. In the New Atlantis aquariums, vivanums, and "great and spacious houses," to enquire into the generation of such creatures "as froggs, flies, and diverse others," were maintained. The sages of this ideal land, by an art that shared "with great creating nature," made "in the same orchards, and gardens, trees and flowers, to come earlier, or later than their proper seasons; and to come up and bear more speedily than by their natural course they do."

The Royal Society took a keen interest in the natural sciences

i Adv. Bk.II. I. 3.
ii Adv. Bk.II. Viii. 5.

Grew and Malpighi were asked to contribute papers at one of the meetings and Willoughby's *De Historia Piscium* was published at its cost. Evidently this latter venture did not meet with financial success for we find that when Halley had undertaken to measure a degree of the earth's surface at the request of the society, it was ordered that his expenses should be defrayed by the grant of £50 sterling or fifty "Books of Fishes."

Microscopic examinations of plants and animals frequently figure among the agenda of the society. Pepys paid a certain Mr. Reeve five pounds ten shillings for a microscope "a great price, but a most curious bauble it is, and he says, as good, nay, the best he knows in England!" Later on we hear that he invested in "Hook's book of microscopy, a most excellent piece, and of which I am very proud."

The questions which the Royal Society sent abroad, were despatched "in order to the making of a natural history in general."

Among the poets of the seventeenth century there is a keen interest in flowers and insects, birds, fishes, and animals but very rarely do we find anything which may be described as a scientific allusion. Shakespeare's attitude may be taken as typical of the early seventeenth century. He obviously delights in flowers but he never attempts to compile an exhaustive list. The favourites — and they are not really very numerous are individualized with the exquisite

i Great Astronomers. Sir R. Ball. p.176.
 ii Diary. August 13th. 1664.
 iii Diary. January 20th. 1665.
 iv History of the Royal Society. Part II. Sect.

and inevitable phrase. The seasons of the flowers are not confused and facts which would only strike an observant country boy are mentioned, but there is no scientific accuracy of detail.

Similarly Browne of Tavistock tells of the fishes which haunt the Tavy, of the flowered banks and daisied downs between which it flows, as well as the concert of birds whose "well tuned orchestra" is supplemented by the droning bass of the bee. Pleasant Willy is, however, true to his own confession,

"And play'd to please myself on rustic pipe
Nor sought for ^{pay} the learned shepherd's need."

Drayton, whose name, as Lamb said, carries a perfume in the mention, does not forget the flowers, fishes, birds and insects of England, while Giles Fletcher's world bursts into flower like the white rosed hedges of De Quincey's Easter Sunday dream. He tells of the

"wood's late wintry head.
With flaming primroses set all on fire."

on the completion of Christ's Triumph After Death.

Herrick describes,

"How roses first came red, and lilies white"

with a sublime disregard for scientific accuracy while Andrew Marvell declares,

"Thus I, easy philosopher
Among the birds and trees confer,"

annihilating science, along with other things, to the characteristic green thought in a green shade.

Apart from this enchanted band of singers, Donne, Cowley, and Milton were all interested in botanical studies.

Donne's poem *The Primrose* may be compared with Browne's simple statement of the same idea,

i "The primrose when with six leaves gotten grace
 Maids as a true love in their bosoms place."

Donne's attitude towards flowers is neither poetic nor scientific, but is something *sui generis*, which later ages have agreed to describe as metaphysical.

Cowley's poetry would hardly strike an impartial observer as showing a scientific knowledge of the natural world, but we shall hear more of his interest in matters horticultural when we come to deal with Evelyn.

Milton's enumeration of the flowers which are to be scattered on the "laureat hearse where Lycid lies," has long served as an illustration of the poet's lack of scientific exactitude, and his other poems do not reveal greater knowledge.

Two other writers are specially noteworthy for their attitude towards the natural world. Jeremy Taylor had an almost fairy fineness of sensibility, possibly this accounts in part for Coleridge's keen appreciation of his work, but though his metaphors are justly famed for their vital freshness and beauty, they do not show attention to scientific detail.

ii Thomas Traherne considered "natural philosophy" to be
"nobly subservient to the highest ends; for it openeth the

i Britannia's Pastorals. Bk.II. Song III.

ii Centuries of Meditations. iii 44.

riches of God's Kingdom, and the natures of His territories, works, and creatures, in a wonderful manner clearing and preparing the eyes of the enjoyer," while elsewhere he declared, i "You never enjoy the world aright, till you see how a sand exhibiteth the wisdom and power of God." Nevertheless Traherne was too anxiously endeavouring to recapture the golden time when, "The corn was orient and immortal wheat, which never should be reaped, nor was ever sown. I thought it had stood from everlasting to everlasting," to concern himself with the minutiae, so fascinating to a scientific mind.

In the sixteenth and seventeenth centuries contemporaneously with the iatro -- chemical period we have determined efforts made to increase the number, and improve the quality of, herbal remedies. Burton gives endless lists of drugs obtained from plants, which he considers possible cures for melancholy. Drayton praises the "sweet retired life" of the hermit and tells us of the wood where,

ii "He fumitory gets, and eyebright for the eye;
The yarrow wherewithal he stops the wound made gore;
The healing tutsan then, and platane for a sore;
And hard by them again, he holy vervain finds,
Which he about his head that hath the megrim binds.
The wonder-working dill he gets not far from these,
Which curious women use in many a nice disease.
For them that are with newts, or snakes, or adders stung
He seeketh out an herb that's called adder's-tongue.

Of these most helpful herbs yet tell we but a few,
To those unnumber'd sorts of simples here that grew."

i Centuries of Meditations. i. 27
ii Polyolbion. Song XIII.

In his fragrant little book *A Priest to the Temple*, Herbert shows that the country parson must be "full of all knowledge," not omitting herb lore. "In the knowledge of simples wherein the manifold wisdom of God is wonderfully to be seen, one thing would carefully be observed, which is, to know what herbs may be used instead of drugs of the same nature, and to make the garden the shop. For home bred medicines are both more easy for the parson's purse, and more familiar for all men's bodies." If the priest decided to take unto himself a wife it would be a *sine qua non*, that she should be able to prepare drugs, and dress the wounds of poor parishioners.

"For salves his wife seeks not the city, but prefers her gardens and fields before all outlandish gums; and surely hyssop, valerian, mercury, adder's tongue, melilot, and St. John's wort made into a salve, and elder, camomile, comfrey, mallows, and smallage made into a poultice have done great and rare cures."

In the House of Astragon certain messengers hasten constantly from the "flowry fields to weeping stills," and from the loads they bring medicines, slow in action, but sure in effect, are compounded. The renewed interest in the search for herbal remedies, and the zeal with which experiments for the manufacture of new mineral drugs were undertaken only served to accentuate the great Paracelsian V Galenist quarrel.

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- i *A Priest to the Temple*. Chap. xxiii.
 - ii *ibid* Chap. xxiii.
 - iii *Gondibert*. Bk.II C. V.

Three writers are considerably influenced by the scientific study of natural objects viz. Sir Thomas Browne, Izaak Walton, and John Evelyn. The seven books of *Vulgar Errors* are obviously due to the questioning character of the new scientific spirit, while the *Garden of Cyrus* would have been considerably reduced in bulk had not Browne's observant eye
 i found "quincunxes in heaven above, quincunxes in earth below, quincunxes in the mind of man, quincunxes in tones, in optic nerves, in roots of trees, in leaves, in everything."

At first sight Browne's *Pseudodoxia Epidemica* appears to bear a family likeness to the strange farrago which Burton describes as a *Digression of the Air*, but this resemblance is merely superficial for the methods of the two writers are fundamentally different. Burton regards all opinions as equally valuable, irrespective of the character of the person who expresses them, or of the grounds on which they are based. Browne will respectfully consider all views, but he rejects everything which appears to him to be at variance with fact. Statements which are vouched for by Holy Writ alone escape his searching examination.

ii Almost all the errors with which Browne deals are mentioned in the literature of the time. The truth of his assertion, "That a brock, or badger, hath the legs on one side shorter then that of the other, though an opinion, perhaps, not very ancient, is yet very general; received not only by theorists

i Coleridge.
 ii *Pseud. Epid. Bk.III. Chap.V.*

and unexperienced believers but assented unto by most who have the opportunity to behold and hunt them daily," is demonstrated when a writer like Browne of Tavistock describes the badger as having legs,

i "One long, the other short, that when he runnes
Upon the plains he halts; but when he wonnes
On craggy rocks, or steepy hills, we see
None runnes more swift, nor easier, than he."

- ii The superstition that the bear brings forth its young informe
iii and afterwards shapes them by licking is mentioned, by Jonson,
Donne, Burton, Butler and Dryden. The belief that the elephant
iv hant had no joints and could therefore never lie down is described by Browne as a conceit "not the daughter of modern times but an old and grey headed error." We are nevertheless
v somewhat surprised to find that Evelyn on seeing an elephant at Rotterdam in 1641 should think it worthy of record, that the limbs of the animal were nimble and flexible "contrary to
vi the vulgar tradition." The legends which clustered around the phoenix Browne arraigned as repugnant to philosophy and Holy Scripture. In the beginning the command "Let fowl multiply on the earth" went forth, and in Noah's time we are assured "Every fowl after his kind, every bird of every sort, they went into the ark, two and two of all flesh, wherein there is the breath of life." Browne therefore concludes

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- i Britannias Pastorals. Bk.I. Song IV.
ii Ps. Ep. Bk.iii Ch. 6.
iii Discoveries CXXX; Bracelet l.31 et seq; Anat of Mel. Preface; Hud.Pl.C111.1.1305; Hind and Panther. Pl.135.
iv Ps. Ep. Bk.III. Ch.I.
v Diary. Aug.13. 1641.
vi Ps. Ep. Bk.III. Ch.12.

that there must be some mistake in the stories of the solitary Arabian bird. Even this hoary, or rather bald headed error, is accepted as veritable fact by the worthy Alexander Ross. He cannot produce a specimen of the genus it is true, but it is all part of the economy of Nature, that the phoenix
 i should live a secluded life, "for had Heliogabulus that Roman glutton met with him, he had devoured him though there were no more in the world." Evidently Browne was combating existing vulgar errors, not as is frequently suggested, explaining away shadows peculiar to his own imagination.

Many of the warnings to be found in the first book of the *Pseudodoxia Epidemica* might have proceeded from the Lord of Verulam himself, and the method by which every doubt is brought to the test of observation and experiment is essentially Baconian. When people, with a cheerful disregard for etymology, insisted that the earwig was an "impennous" insect, Browne urged them to watch carefully or put aside the sheathy
 ii cases on the back with a needle, when "his wings, of a proportionable length for flight, and larger than in many flies" would appear. He calmed the fears of the superstitious by explaining that the noise or shriek of the mandrake consequent
 iii upon eradication was nothing but, "a smaller stridulous noise, which being firmly rooted it maketh upon divulsion of parts." To the determination of science and the general opinion of

i Quoted in Vol 1. p.276 Browne's Works (Bohn) from *Arcana Microcosmi*.

ii *Pseud Epid. Bk. III. Ch.27.*

iii *Bk. II. Ch.6.*

the learned world, that worms are exsanguinous animals, Browne
i hardly knew what to reply. He could only refer to "the discernment of others what to determine of that red and sanguinous humour "to be found in worms and which certainly had the property of "affording in linen or paper an indiscernible
ii tincture from blood." When Browne asserted "that moles have eyes in their heads is manifested unto any that wants them not in his own," Alexander Ross was in no wise disturbed. With a Platonic touch, becoming in an author destined to be
iii studied by Butler's "ancient sage philosopher," he shows that they are but "forms of eyes," given by nature, "rather for
iv ornament than use; as wings are given to the ostrich, which never flies, and a long tail to the rat, which serves for no other use but to be sometimes caught by it." Browne often employed magnifying glasses for his observations. At the time of the first publication of the *Pseudodoxia Epidemica* (1646) only imperfect microscopes were available, but when the
v last edition was published in 1672, Malpighi's invention was evidently quite familiar to Browne for several alterations
vi are made. Thus in the earlier editions he was unable to determine on examining a snail, "whether those black and atramentous spots which seem to represent them are any ocular

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- i Ps. Ep. Bk.III. Ch.28.
 - ii Bk.III. Ch. 13.
 - iii Hud. P.I. C.I. l.I.
 - iv Browne's Works.Vol.I. p.312. (Bohn).
 - v Galileo is stated to have invented the first microscope on uncertain authority.
 - vi Another instance in Ps. Ep. Bk.II. Ch.VII. Sect. 3. Example quoted is in Bk.II. Ch.20.

realities "but in the sixth edition (1672) we find "this now seems sufficiently asserted by the help of exquisite glasses, which discover those black and atramentous spots or globules to be their eyes." Before this invention was known to him

i Browne had examined the "mathematics of the neatest retiary spider, which concluding in forty four circles, from five semi diameters beginneth that elegant texture," and pointed out

ii to his readers that he who "would exactly discern the shape of a bee's mouth, needs observing eyes, and good augmenting glasses; wherein is discernible one of the neatest pieces in nature."

Like Bacon, Browne employed the experimental method. To test the truth of the solemn stories which were told of the antipathy between a spider and a toad, he shut a toad in a

iii glass vessel with several spiders. "What we have observed herein we cannot in reason conceal; we beheld the spiders, without resistance to sit upon his head and pass over all his body; which at last upon advantage he swallowed down, and that in a few hours, unto the number of seven." When popular opinion declared "that the kingfisher, hanged by the bill, showeth in what quarter the wind is," he hung two up in a room of his Norwich home, only to discover that they would, "not

iv regularly conform their breasts, but ofttimes respect the

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- i Garden of Cyrus. Ch.III.
 - ii *ibid.*
 - iii Ps.Ep. Bk.III. Ch.27.
 - iv Bk.III. Ch.10.

opposite points of heaven." He partook of experimental meals
 i of spiders and bees, and administered glass "subtilely powdered in butter and paste, without any visible disturbance," to his dogs. Not that experiments would convince people like Alexander Ross. On Browne citing the fact that Aldrovandus had observed the ostrich to exclude iron undigested, as disproof of the popular belief "that the ostrich digesteth iron,"
 ii he is warned not to be too sure, for, "one swallow does not make a summer," and even in this case "the stomach suckt something out of it."

Browne took a humble but necessary step towards the Kingdom of Man founded on the sciences. Many of his observations show extraordinary acuteness, while the experiments he records are most ingeniously contrived. His conclusions are not
 iii always irrefutable but later research has justified some of his speculations. It is in his works that we find the expression par excellence of the seventeenth century scientific spirit. The indefinable quaintness and unconscious humour which characterize the writings of both supporters and opponents of the new movement — Glanvil, Sprat, and Wilkins on the one hand, Ross and Stubbes on the other — are seen in a concentrated and heightened form in the works of the medicus religiosus of Norwich.

Izaak Walton was indebted to the interest in natural

i Ps. Ep. Bk.II. Ch.5.
 ii Browne's Works. Vol.I. p.334.
 iii Browne's Works. Vol.I. p.366. Note 1. gives a striking instance.

history to a considerable extent and he constantly quotes Gesner, Aldrovandus, Bacon, and the Royal Society as authorities for the subjects with which he deals. The creatures of the air, earth, and water, are praised by the Falconer, Hunter, and Angler respectively but we naturally find most of the scientific detail in the conversations between Piscator and Venator, when the fisherman has volunteered to become a master for the nonce. Honest Izaak labours as earnestly to show his pupil that there are many varieties of trout, as Evelyn to convince his reader that there is more than one species of quercus. The life history of the fishes is given in great detail but Walton recounts the labours of "the curious searchers into nature's productions" with such quiet grace, that the liquefaction of his style operates even upon this somewhat unpromising material. Piscator does not forget "those very many flies, worms, and little living creatures, with which the sun and summer adorn and beautify the river banks and meadows." For "a taste of the rest" of his descriptions, we may consider this of the caterpillar, "His eyes black as jet; his forehead purple; his feet and hinder parts green; his tail two-forked and black; the whole body stained with a kind of red spots, which run along the neck and shoulder blade, not unlike the form of St. Andrew's Cross, or the letter X, made thus cross-wise, and a white line drawn down his back to his tail; all which add much beauty to his whole body!" This interest in "smallest lineaments exact" is typi-

cally seventeenth century. Had there been no detailed information on fishes readily accessible, Walton would probably have considered the matter too slight for a book and the world would have been infinitely the poorer by the loss of this healthy work and its "fresh sheets that smell of lavender."

John Evelyn was "mighty knowing" as Pepys said, but though he was interested in all aspects of the scientific movement, horticulture was his favourite pursuit. He never visited a house without taking particular notice of the gardens, "(paradises and sweet retirements)", and he was the author of a series of works on agriculture. By far the best from a literary point of view is the *Sylva*, or A Discourse of Forest Trees and the Propagation of Timber, first published in 1664. The prefatory address To the Reader forms an eloquent defence of the Royal Society. Cowley wrote his poem *The Garden* and also a prose epistle to be prefixed to *Sylva* in which he tells us, "I never had any other desire so strong and so like to covetousness as that one which I have had always, that I might be master at last of a small house and large garden, with very moderate conveniences joined to them, and there dedicate the remainder of my life only to the culture of them, and study of nature." When Cowley writes in prose one can understand why Coleridge declared that "the sweetest names," are "Kit Marlowe, Drayton, Drummond of Hawthornden, and Cowley."

Sir William Temple wrote an *Essay on Gardening*, but it does not display the same scientific knowledge as Evelyn's

treatise. The great naturalists, Gesner, Malpighi, Grew etc. are constantly quoted, while the use of the microscope, is advocated in the latter work. It is quite obvious that the book was not intended "for the sake of our ordinary rustics
i but for the more ingenious," when the author, speaking of the figurings in the wood of the maple, or walnut, assures the
ii reader, "Do but plane off a thin chip or sliver from one of these old trees and interposing it 'twixt your eye and the light, you shall observe it to be full of innumerable holes (much more perspicuous and ample by the application of a good microscope.)" Evelyn is unusually enthusiastic throughout the whole work, but when he speaks of the Holly tree, he can
iii scarcely restrain his emotion. "Is there under heaven," he asks, "a more glorious and refreshing object of the kind than an impregnable hedge of near three hundred feet in length, nine feet high, five feet in diameter; which I can show in my poor gardens at any time of the year, glittering with its armed and varnished leaves? the taller standards at orderly distances blushing with their natural coral." Pepys con-
iv sidered Evelyn's gardens "for variety of evergreens, and hedge of holly the finest things I ever saw in my life."

The more important forest trees are dealt with in great detail, the uses to which the timber, and the various parts of the living tree may be put, being mentioned in every case.

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- i Advertisement.
 - ii Chap.XI.
 - iii Chap.XXVI.
 - iv Diary.Oct.7. 1664-5

i In conclusion Evelyn regrets that the topics, in every field, in every hedge, sufficient to employ the meditations and hands of a contemplative man, though his years were many as the most aged oak, should be neglected merely "because they are common and obvious."

ii The Pomona is of little interest except to antiquarians but when speaking of the efforts of the Royal Society to obtain a new kind of apple Evelyn becomes angry with the critics of the movement. "Truly men receive no small discouragement from the ugly affronts of clowns and less cultivated persons who laugh and scorn at everything which is above their understanding."

The most interesting part of the Kalendarium Hortense, to those who are not initiated into the mysteries of a gardener's work, which is "never at an end; it begins with the year and continues to the next. He prepares the ground and then he sows it; after that he plants and then he gathers the fruits; but in all the intermedial spaces he is careful to dress it," will be the introduction.

iii Apart from these three writers it may be noticed that Davenant was evidently thinking of the advances which had been made in the study of natural history and the methods employed, when he describes Great Nature's Office, a building which formed part of the House of Astragon. There

"Old busy men, yet much for wisdom famed
Hasty to know though not by haste beguiled."

-
- i Chap.XXXV.
 - ii Pomona. Chap.IV.
 - iii In Gondibert. Bk.II. Ch.V.

known as Nature's Registers received the information brought by intelligencers, whose business it is to track down the creatures of water, air, and land.

"And there of ev'ry fish, and fowl, and beast.
The wiles these learned Registers record."

Adjoining Nature's Office is Nature's Nursery,

"Where seems to grow all that in Eden grew
And more (if Art her mingled species show)
Than th'Hebrew king, Nature's historian, knew."

In another room skeletons of all kinds of animals are arranged in pairs,

"These Astragon (to watch with curious eye
The diff'rent tenements of living breath)
Collects, with what far travellers supply;
And this was call'd, The Cabinet of Death."

Much of this episode is suggested by Bacon's New Atlantis.

The satirists did not fail to observe the care with which the virtuosi studied minute phenomena. One of the learned members of the society which discovered the elephant in the moon was a natural history expert. He is described as,

- i "one whose task was to determine,
And solve th'appearances of vermin;
Who'd made profound discoveries
In frogs and toads, and rats and mice"

Later Butler alleged that the society made—

- ii "nat'ral hist'ry a Gazette
Of tales stupendous and far fet."

Sir Nicholas Gimcrack was especially interested in natural

- iii history. He intended to dissect a lobster, one of "the most curious of all testaceous and crustaceous animals," for the edification of his guests, but unfortunately the fishmonger

i Elephant in the Moon. 1377 — 380.
ii Elephant in the Moon. 1512 — 13.
iii Virtuoso. Act ii.

i failed to provide the required specimen. He also dissected the eggs of ants upon the plate of a microscope and was well
 ii acquainted with "the six ^{and} thirty sorts of spiders." Izaak Walton speaks of a work published by the Royal Society which gave details of "thirty and three kinds of spiders" and doubtless Shadwell had some similar basis for other particulars which he gives of Gimcrack's attainments.

Clarinda and Miranda, the nieces of Sir Nicholas, held their uncle's scientific tastes in great contempt. They even go so far as to suggest that their father was not compos mentis, when he allowed a virtuoso to become their guardian:-

iii Clarinda: "A sot, that has spent £2000 in microscopes to find out the nature of eels in vinegar, mites in a cheese and the blue of plums, which he has subtilely found out to be living creatures.
 Miranda: One, who has broken his brains about the nature of maggots, who has studied these twenty years to find out the several sorts of spiders, and never cares for understanding mankind."

Shadwell's play is of invaluable help for a consideration of the scientific movement, and its intrinsic merits would be high, but for the hideous lapses of good taste which vitiate even the best scenes.

Despite the interest which seventeenth century writers took in the scientific movement we find nothing which will stand comparison with the minute observation of birds, plants, animals, and insects, so characteristic of modern literature—the natural sciences were then in their infancy.

i Virtuoso. Act III.
 ii Compleat Angler. Chap. IV.
 iii Act I.

MEDICINE.

The writers of the seventeenth century appear to have taken an extraordinary interest in the construction of the human body - an interest which is not shared by the modern world despite Walt Whitman's declaration

"Of physiology from top to toe I sing".

It requires a mind resembling that of Tytyl or Mytyl, or the boy who never grew up, to rejoice in such a common thing as one's own body. Yet Phineas Fletcher could compose a pastoral poem in which Thirsil the shepherd swain sings, with as much joy as of flowers and delights more suited to the rural pipe, of

- i. "A foreign home, a strange, tho' native coast;
Most obvious to all, yet most unknown to most".

- a region no more exciting than "the little Isle of Man or Purple Island", with all its veins, arteries, and cartilages.

The geographical metaphor is employed by other writers and its use suggests the eager curiosity of the explorer. Donne is specially fond of such illustrations and with his contempt for "keeping of accent" says,

- ii. "Let sea-discoverers to new worlds have gone;
Let maps to other, worlds on worlds have shown;
Let us possess one world; each hath one and is one".

Browne was not contented with the general pieces of wonder
iii. but believed, "We carry with us the wonders we seek without us: there is all Africa and her prodigies in us; we are that

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- i. Purple Island. C.i.
 - ii. The Good Morrow. L.12. also a Hymn to Christ (L.9);
Hymn to God in Sickness;
 - iii. Rel. Med. Part i.

- bold and adventurous piece of nature, which he that studies wisely learns in a compendium what others labour at in a divided piece and endless volume". Similarly Browne rejoices
1. at the revelation of the scalpel whereby "according to common anatomy the right and transverse fibres are decussated, by the oblique fibres; and so must frame a reticulate and quincuncial figure by their obliquations, emphatically extending that elegant expression of Scripture 'Thou hast curiously embroidered me', thou hast wrought me up after the finest way of texture, and as it were with a needle".

It is the same naïve spirit of wonderment which induced Traherne to say that he would not use metaphors to describe God's gifts,

11. "For metaphors conceal
And only vapours prove.
They best are blazoned when we see
The anatomy,
Survey the skin, cut up the flesh, the veins
Unfold: the glory there remains
The muscles, fibres, arteries, and bones
Are better far than crowns and precious stones".

It is realism carried so far, that to a mind which can attain the same point of view it becomes idealism.

This abnormal interest in physiology was largely due to the immense advances which were made in the study of anatomy but much of the literature carries with it a heavily medicated atmosphere. The prevalence of the plague, which had never been in abeyance since the time of the Black Death,

1. Garden of Cyrus. Chap.iii.
11. The Person.

but which was more disastrous than ever, in the decades immediately preceding its extinction in 1666, had probably much to do with this. Dekker's arraignment of the Seven Deadly Sins of London, which unless checked will cause another visitation of the plague, draws an arresting picture of its effects. When Cruelty appears in this terrible "old interlude of iniquity", Dekker reminds London "Against thy dead children were thou cruel in that dreadful, horrid, and tragical time, when 30,000 of them (struck with plagues from heaven) dropt down in winding sheets at thy feet.

Thou didst then take away all ceremonies due to them, and haledst them rudely to their last beds (like drunkards) without the dead man's music (his bell). Alack, that was nothing: but thou tumbledst them into their everlasting lodgings (ten in one heap, and twenty in another), as if all the rooms upon earth had been full: the gallant and the beggar lay together, the scholar and the carter in one bed; the husband saw his wife and his dead enemy whom he hated within a pair of sheets". Scenes similar to these were the accompaniment of each of the three great outbreaks of plague in 1603, 1625 and 1665, while the intervening years were not free from its devastating breath. It is therefore not

1. and 11.

surprising to find constant allusions to the "saffron colour'd hag" of pestilence, to the dreaded "mustard tokens" which announced its onset, and to the pomander bracelets and other

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1. Drummond. Shadow of the Judgment. L.251-266.
 11. Shoe maker's Holiday. Act 1. Sc.1.

amulets which were used as preventatives. The dramatists, especially, abound in passing references to the plague.

- i. Morose, we are told, was forced to devise "a room with double walls and treble ceilings" owing to the ceaseless ringing of
- ii. bells due to the sickness, while Subtle's master immediately jumped to the conclusion that if his house had been visited during his absence, the plague must have been the visitant. Sinister suggestions like the accusation implied in the words of Lodovico, after he has strangled the poisoned Brachiano are not infrequent.

- iii. "The snuff is out. No woman keeper i'th'world, Though she had practised seven year at the pest house Could have done it quaintlier".

Small-pox was especially virulent during this period and the diaries of Pepys and Evelyn record numerous deaths among persons of even the highest rank, from this cause. Mrs. Hutchinson's wedding had to be postponed, for she was attacked with the disease the day before the date originally fixed.

Surgical operations increased in number owing to the injuries wrought by gun-shot, and anaesthetics were practically

- iv. unknown. The description of an amputation which Evelyn witnessed will enable a modern reader to understand why Pepys celebrated his "feast of the cutting of the stone" every 26th. day of March as regularly as his birthday. Bleeding seems to have been regarded as a panacea for all ills. Burton, like the physicians, does not appear to be very clear
- v. upon the matter. "Phlebotomy is promiscuously used before

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- i. Silent Woman. Act i. Sc.i.
 - ii. Alchemist. Act v. Sc.i.
 - iii. White Devil. Act v.
 - iv. Diary. March 24. 1672.
 - v. Anat. of Mel. P.2. S.5. M.1. S.2.

and after physic, commonly before, and upon occasion is often reiterated, if there be any need at least of it". Thus many of the medical illustrations which occur in the minor dramatists have other than a scientific origin.

Since, however, many writers were affected in a real way by the advances in the study of medicine, a brief account of that science will be useful. Bacon took a complete survey of medicine and offered important suggestions for improvement.

- i. He deplored the unfortunate competition existing between witches and physicians, though he pointed out that the poets long ago imagined Aesculapius and Circe to be brother and sister, both children of the sun. That witches and sorcerers
- ii. had such power was taken as a foregone conclusion. "Hoc posito", says Burton, they can affect such airs the main question is, whether it be lawful in a desperate case to crave their help or ask a wizard's advice". Astrology and medicine had a close connection, phlebotomy being practised at the bidding of the stars. Sir Thomas Browne's protest
- iii. is enlightening, "I feel not in me those sordid and unchristian desires of my profession; I do not secretly implore and wish for plagues, rejoice at famines, revolve ephemerides and almanacs in expectation of malignant aspects, fatal conjunctions and eclipses".

Bacon also protested against empiric doctors, explaining that the skill of an Apollo was needed to tune the curious

- iv. harp of man's body and to reduce it to harmony. For owing

i. Adv. Bk.ii. x. 2.

ii. Anat. of Mel. P.ii. S.i. M.i. S.i.

iii. Rel. Med. Part ii; also Hud. P.ii. C.iii. Sm. 15.

iv. Adv. Bk.ii. x. 2.

- i. to the delicacy of its construction, the "subtilty of the subject doth cause large possibility and easy failing; and therefore the inquiry ought to be the more exact". Burton
- ii. gives endless lists of the pretenders to the art of healing
- iii. while Ford declares that "Mountebanks, empirics, quack salvers, mineralists, wizards, alchemists, cast apothecaries, old wives and barbers, are all suppositors to the right worshipful
- iv. doctor". The empirics were constantly accused of putting their medicines upon trial only to find them guilty of manslaughter.

For the improvement of the science Bacon suggested that

- v. greater attention should be paid to anatomical examinations, and that vivisection of the lower animals would be of considerable help. This was being undertaken by professional men even while he wrote, but his realisation of the importance
- vi. of pathological anatomy as showing "much of the footsteps and impressions of diseases", is original and remarkable.
- Still more noteworthy is his insistence upon the need for "receipts of propriety". Medicines hitherto compounded, had been given with the intention of affecting the whole body but were not directed to the cure of any particular disease. Modern pharmacy describes Bacon's "receipts of propriety" under the name of "specific medicines".

Bacon countenanced many idle superstitions as we see from the strange cures recommended in the History of Life and Death

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- i. Adv. Bk.ii.x.1.
 - ii. Anat. of Mel. P.i. S.ii. M.iii. Subs.15.
 - iii. Lover's Melancholy. Act i. Sc.ii. (suggested by Burton ?)
 - iv. Butler's Character of an Empiric.
 - v. Adv. Bk.ii. x. 4.
 - vi. Adv. Bk.ii. x. 8.

but his works served to draw popular attention to the renaissance which was taking place in the science of medicine

The Royal Society numbered among its members many doctors

- i. and by its charter received permission to "anatomize to all intents and purposes". We therefore find Pepys noting that a friend "offers to bring me into the college of virtuosoos and my Lord Brouncker's acquaintance, and show me some anatomy, which makes me very glad", on April 28th. 1662.
- ii. Evelyn when at Padua procured certain Tables of Veins and Arteries which he afterwards presented to the Royal Society "being the first of that kind that had been seen there, and for aught I know, in the world, though afterwards there were others". The members were particularly interested in the transfusion of blood, while the world at first imagined that a substitute for the great elixir had been discovered. On November 21st. 1667 Pepys heard that a man, a little frantic, who had been a kind of minister, had been hired by the College "for 20 shillings to have some of the blood of a sheep let into his body", while on November 30th. we learn that the patient was so pleased with the beneficial results of the operation, that he agreed to have it performed again on payment of a similar sum. Shadwell accordingly makes Sir
- iii. Nicholas boast "I have performed admirable effects by transfusion of blood; to wit by putting the blood of one animal into another", while Longvil in mock admiration observes "That was a rare experiment of transfusing the blood of a

i. Sprat. History of the Royal Society. P.342. (1st. edition)
 ii. Diary. January 1646.
 iii. Virtuoso. Act ii.

sheep into a madman. Later Sir Nicholas is visited by a crowd of sick and lame folk who assemble in the court yard.

- i. After Sir Formal has arranged them "in their classes, forms, or orders of diseases", the virtuoso proceeds to prescribe for his patients.

The Royal Society also took an interest in the sympathetic powder introduced by Sir Kenelm Digby, "a person very eminent and notorious throughout the whole course of his life from his cradle to his grave", to take Clarendon's estimate, "an arrant mountebank", in Evelyn's curt phrase, in the year 1658. On June 5th. 1660 the minutes record that those members who had "any powder of sympathy were desired to bring some of it at the next meeting". It was supposed to possess the property of healing wounds irrespective of the distance

- ii. of the sufferer. Browne had no faith in "sympathetic receipts while Butler tells us that Orsin wore a pouch

- iii. "Replete with strange hermetic powder,
That wounds nine miles point blank would solder".
- iv. and laughs at the vagaries of "sympathetic gunpowder".

The 16th. and 17th. centuries have been described as the golden age of the medical sciences, and the great and signal advances which marked that period are largely due to the increased number of anatomical examinations. The sanctity with which the human body was regarded prevented Galen from examining the bodies of men so that he was forced to anatomize animals. In consequence, whenever the structure of a human

i. Virtuoso. Act iv.
 ii. Pseud. Epid. Bk.i. Ch.iv.
 iii. Hud. P.i. C.ii. L.223.
 iv. Hud. P.ii. C.iii. L.294.

being differs from that of the lower animals, Galen went wrong, and his successors followed his errors till the sixteenth century. In the rare cases where an autopsy did take place, the body was cut open and the fact noted that the position of the viscera corresponded with Galen's account. Vesalius whose *De Humani Corporis Fabrica* was published in 1543, illustrated with fine engravings showing the structure of the body, was the first to call attention to the mistakes in Galen's account. He is regarded as the founder of modern anatomy, and his work was continued by Fallopius, and Eustachius, two other sixteenth century anatomists,

The general interest in the new science may be inferred from the popularity of the title "Anatomy". In the 17th. century we find Democritus Junior anatomizing melancholy. He promises to show the reader "What it is, with all the kinds, causes, symptoms, prognostics and several cures of it, in three partitions, with their several sections, members, and subsections, philosophically, medically, historically opened and cut up". Donne, on the untimely death of Mistress Elizabeth Drury, resolved to make *An Anatomy of the World*,

- i, "Sick world, yea dead, yea putrified, since she,
Thy intrinsic balm, and thy preservative
Can never be renew'd, thou never live,
I - since no man can make thee live - will try
What we may gain by thy anatomy".

Donne is obviously referring to the experience of the dissecting room when he writes,

- ii. "As doth the pith, which lest our bodies slack,
Strings fast the little bones of neck and back,
So by the soul doth death string heaven and earth".

i. First Anniversary. L.56.
ii. Second Anniversary, L.211.

Vaughan, who was a Doctor of Medicine, has several allusions
 i. to the "rags of anatomy". The structure of the eye, the ear,
 and the brain, received especial attention. Donne, speaking
 of the soul when it is no longer fettered by the senses,
 declares,

ii, "Thou shalt not peep through lattices of eyes",
 which is an allusion to the delicate structure of the eye.
 Phineas Fletcher gives a most elaborate account of "Visus'
 double court". The stanza:-

iii.
 "Thus then is fram'd the noble Visus' bow'r;
 Th'outward light by the first wall's circle sending
 His beams and hundred forms into the tow'r,
 The wall of hom, and that black gate transcending,
 Is light'ned by the brightest crystalline,
 And fully view'd in that white nettyshine
 From thence with speedy haste is posted to the mind".

- is a brief summary of his figurative treatment of the subject.

Sir Thomas Browne gives a similar account of the eye, in his
 iv. endeavour to prove that "all things are seen quincuncially".
 Preachers availed themselves of the new science for illustra-
 tions, as may be seen from Evelyn's account of Dr. Burnett's
 v. sermon, "anatomically describing the texture of the eye".

In his Litany Donne petitions,

vi. "That our ears' sickness we may cure
 And rectify those labyrinthys aright".

Phineas Fletcher tells us that the part of the ear,

vii. " in twenty byways bending
 Is call'd the labyrinth, in hundred crooks ascending",

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- i. Charnel House.
 - ii. Second Anniversary. L.296.
 - iii. Purple Island. C.v.
 - iv. Garden of Cyrus. Ch.iv.
 - v. Diary. March 9th. 1690.
 - vi. St.xxv. also Sec. Anniv. L.297.
 - vii. Purple Island. C.v.

which labyrinth is further compared to the maze of Daedalus and to the cave of Woodstock where,

"Fair Rosamond, fled jealous Ellenore".

- i. The structure of the brain is explained by Fletcher in great detail while Donne, searching for crucial forms as eagerly as Browne for quincunxes informs us that,

- ii. "the brain through bony walls doth vent
By sutures which a cross's form present"-

All the previous work in anatomy was but preparing the

- iii. way for William Harvey (1578-1657) not only doctor medicinae, as Fuller said, but also doctor medicorum. After studying at Caius College, Cambridge, he proceeded to the medical school of Padua in 1597. The Professor of Anatomy was Fabricius of Aquapendente - a worthy successor of Vesalius, the father of the science. He was the discoverer of the valves in the veins, and it may readily be imagined that he would point them out to his pupils with great pride. Harvey, according to his own account, was first led to think of the circulation of the blood, from considering the purpose which the valves fulfilled. On his return to England he practised medicine in London, being elected a Fellow of the Royal College of Physicians in 1607, and in 1615 was appointed Lecturer in Anatomy to that foundation. In 1616 he probably began to explain his doctrine of the circulation of the blood to his students, although his epoch making *De Motu Cordis et*

- i. Purple Island.
- ii. The Cross. (e.f. In Memoriam. xliv. L.4).
- iii. Authorities. (a), Medical History from the earliest Times by Withington (London 1894). (b), Origin and Growth of the Healing Art. Ed. Berdoe. London 1893. (c), Life of Harvey by Aubrey and Fuller.

Sanguinis, was not published till 1628. The treatment is so clear that the work is classical to this day. In his modest dedication he says "I profess both to learn and to teach anatomy, not from books but from dissections: not from the positions of philosophers but the fabric of nature", and the spirit of the work is essentially Baconian, though Harvey is quite independent of his influence. The introduction gives an account of the fantastic theories which were then in vogue to explain the origin of the blood. As soon as anatomical examinations were made it was discovered that the arteries have much thicker walls than the veins, which collapse when death has taken place. To explain this circumstance, it was supposed that the arteries contained vital spirits; or a mixture of blood and air. All through 17th. century literature we have allusions to this belief. Burton is referring to an unfortunate superstition which led to the banishment i. and death of Vesalius, when he explains, "Arteries are long and hollow, with a double skin to convey the vital spirits; to discern which the better they say that Vesalius the anatomist was wont to cut up men alive". Fletcher tells us ii. in a note that the arteries have thicker walls, "for the conveyance of that more sprightly blood which is elaborate iii. in the heart", while Denham and Dryden, both supporters of iv. the circulatory theory, mention the "vital spirits". To the objection that the heart was divided by a partition

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- i. Anat. of Mel. P.i. S.i. M.ii. S.iii.
 - ii. Purple Island. C.2. Note 8.
 - iii. Progress of Learning.
 - iv. Astraea Redux. L.165.

containing holes like a sieve, Harvey characteristically replied "The septum of the heart is of a denser and more compact structure than any portion of the body, except the bones and sinews". Harvey was the first to prove that the whole of the blood flows through the heart, and his discovery is incomparably the most important in the history of medical science. Malpighi, it will be remembered, established the truth of the theory in 1661, when he actually saw the arteries and veins connected by the network of the capillaries.

According to Aubrey the vulgar imagined that the author of the treatise on the circulation of the blood was crack-brained, but in literature Harvey's name is always honoured. Some ingenious commentators have discovered that Shakespeare was aware of the circulation of the blood from certain

- i. passages in which its movement and connection with the heart
- ii. are mentioned. The Faerie Queene shows an even more curious instance, but such references are all capable of other than a quasi-scientific interpretation. The fact that some blood visited the heart, after passing through the lungs was known in all probability, before the time of Harvey, though Spenser and Shakespeare are hardly likely to have been acquainted with a circumstance known only to a few anatomists. Donne had heard of the new doctrine, and to answer the following question affirmatively implies a complete knowledge of the circulatory system,

i. e.g. Julius Caesar. Act ii. Sc.i. Coriolanus Act i. Sc.i
 ii. F.Q. Bk.i. C.ix. St.51.

- i. "Know'st thou how blood, which to the heart doth flow,
Doth from one ventricle to th'other go?"

Fletcher's Purple Island was inspired by the discovery, and we find a detailed account of fair Kerdia, the Heart, and descriptions of the veins containing "purple coloured dew", and the arteries which incarnadine the isle of man. Though the whole poem, notes included, does not reveal the power to vframe Donne's incisive query it would be ungracious to refuse Thirsil's apology,

- ii. "You gentle shepherds - - - - -
Too well I know my rudeness, all unfit
To frame this curious isle, whose framing yet
Was never throughly known to any human art"

In later editions of the Pseudodoxia Browne refers to the "honoured Doctor Harvey", while in the sixth edition he

- iii. describes the "cordial relation" of the ring finger as a nicety of less consideration "by the new and noble doctrine of the circulation of the blood".

The later poets almost all accepted the doctrine of the circulation of the blood. Cowley's Ode upon Dr. Harvey strikes a modern reader as somewhat ludicrous, although it at any rate shows a keen appreciation of the difficulties under which the discovery was made. The poet imagines Nature to play a game of hide and seek with Harvey, to escape from whom,

"She leapt at last into the winding streams of blood",
en route for the heart. Having reached this refuge, she soliloquized,

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- i. Second Anniversary. L.271.
ii. C.iii.
iii. Bk.iv. Ch.iv.

"The heart of Man, what Art can e're reveal?
 A wall impervious between
 Divides the very parts within,
 And doth the heart of man ev'n from itself conceal".

Nature, however, had under-estimated the skill of the indefatigable doctor,

"She spoke, but e're she was aware
 Harvey was with her there".

Leaving details Cowley rises to an altogether higher plane,

"Thus Harvey sought for Truth in Truth's own book
 The creatures, which by God himself was writ,
 And wisely thought 'twas fit,
 Not to read comments only upon it,
 But on th'original itself to look
 Methinks in Art's great circle others stand
 Lock't up together, hand in hand
 Every one leads as he is led,
 The same bare path they thead,
 A dance like fairies', a fantastic round
 But neither change their motion nor their ground
 Had Harvey to this road confin'd his wit,
 His noble circle of the blood, had been untrodden yet."

Denham does not enter into particulars but tells us briefly,

- i. "Our knowledge, like our blood, must circulate".
- ii. while Dryden has a similar allusion in the Annus Mirabilis and also numbers Harvey among the inheritors of renown,
- iii. "The circling streams, once thought but pools of blood,
 (Whether life's fuel, or the body's food),
 From dark oblivion, Harvey's name shall save;
 While Ent keeps all the honour that he gave"

Harvey, according to Aubrey, wrote "very bad Latin" and he suggests that his "circuitus sanguinis", was translated into that language by his friend and brother physician Sir George Ent.

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- i. Progress of Learning. L.216.
 - ii. Stanza 2.
 - iii. To Dr. Charleton.

At the close of the century we find Harvey enthroned as a demi-god in the Elysian fields. Celsus, in Garth's Dispensary pays a visit

- i. "to that delightful plain
Where the glad manes of the blest remain
Where Harvey gathers simples, to bestow
Immortal youth on heroes' shades below".

to obtain advice from the venerable doctor.

Harvey excited more literary interest than any other English scientist of the century, but none of the poems in which his discovery is celebrated have thrown the grace of art about his name. Under Milton's imaginative touch astronomy and poetry became one in the person of Galileo, but Harvey's admirers were not equally powerful.

The work of Francis Glisson, Thomas Sydenham and Thomas Wallis is of great importance in the history of medicine but does not seem to have had any direct effect upon literature.

The great medical controversy known as the Paracelsian v. Galenist quarrel aroused general interest. Paracelsus (1493-1541) was not only the founder of the iatro chemical school but has been also styled *Lutherus Medicorum*. Although frequent attempts have been made to deprive him of this honourable title, (first bestowed as a term of opprobrium), his name formed the rallying cry in the fierce battle which ended in the defeat of dogmatic medicine, founded on Galen and the ancients. Misconceptions have arisen from the fact that Paracelsus, not unlike other iconoclasts, had a new dogma to replace the one he intended to destroy. His theory

- i. that man is a miniature copy of the external world, a microcosm which is an exact replica of the microcosm, leads to the inevitable conclusion that it is safer for the physician to study the world writ large rather than the body of man. Moreover since the two worlds exactly correspond, plants and animals bearing fortuitous resemblances to the parts of the human body were considered to be the remedies ordained by nature for the cure of diseases of those parts. Thus arose
- ii. the doctrine of signatures so often mentioned in seventeenth century literature, and the following lines, taken from a lengthy passage in Britannia's Pastorals, will show the way in which the Paracelsian theory was applied:-
- iii. "in physic by some signature
Nature herself doth point us out a cure;
The liverwort is by industrious art
Known physical and sovereign for that part
Which it resembles"

Paracelsus would not have explained the matter thus bluntly for his whole treatment of the subject is accompanied with a penumbra of mysticism.

Pernicious as his theory was, it probably induced him to employ mineral preparations as internal remedies, an innovation which led to the revolt of medicine against Galen, an event only comparable with the revolt of philosophy and science against Aristotle, and of geography and astronomy against Ptolemy. When mineral drugs were introduced into France, the members of the University of Paris were absolutely forbidden to use them, and many were expelled for infringements

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- i. Adversely criticized by Bacon. Adv. Bk.ii. x. 2.
 - ii. e.g. Repentance (Vaughan); Samson Agonistes, Preface of Tragedy; Hudibras. P.iii. C.i. L.329.
 - iii. Bk.iii. Song 1. L.652-673.

of the rule. Chemical medicines were first heard of in England during Elizabeth's reign and were at once condemned by the College of Physicians and Society of Apothecaries. According to Fuller, William Butler, "the Aesculapius of our age", was "the first Englishman who quickened Galenical physic with a touch of Paracelsus, trading in chemical receipts with great success".

The acrimonious quarrel of the doctors is often mentioned by seventeenth century writers. It may be noticed that the mineral medicines supplied by a Paracelsian doctor were more concentrated, and were supposed to act more quickly and powerfully than the vegetable preparations, of which the luckless patient had to consume copious draughts, given by the Galenist physician. One of the earliest references to the subject is to be found in Shakespeare. When Lafeu, Bertram, and Parolles, are wondering at Helena's marvellous cure of the king, we hear,

- i. Lafeu: "To be relinquished of the artists -
Parolles: So I say; both of Galen and Paracelsus,
Lafeu: Of all the learned and authentic fellows".

and yet, to give the "brief and tedious" of the conversation, to survive. Bacon in his New Atlantis describes subterranean laboratories in which artificial metals were made for use in medicines, but Donne was by no means favourably disposed towards the Paracelsians. He advises Sir Henry Wotton

- ii. "Only in this be no Galenist - to make
Court's hot ambitions wholesome, do not take
A dram of country's dullness; do not add
Correctives, but, as chemics, purge the bad".

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- i. All's Well. Oct ii. Sc.iii.
 - ii. Verse Letter. L.59; also First Anniversary.L.159, and The Cross. L.27.

i. Thomas Fuller meditates, "I read in a learned physician how our provident mother Nature, foreseeing men (her wanton children) would be tampering with the edge tools of minerals, hid them far away from them in the bowels of the earth; whereas she exposed plants and herbs more obvious to their eye as fitter for their use. But some bold empirics, neglecting the latter as too common, have adventured on these hideous minerals, oft times (through want of skill) to the hurt of many and hazard of more".

Butler of course could not let the opportunity of doctor's disagreeing escape him,

ii. "Divines of all sorts, and physicians,
Philosophers, and mathematicians,
The Galenist, and Paracelsian,
Condemn the way each other deals in"

When Dryden wishes to show that, contrary to Aristotle, he believes the Epic poem to have greater and more lasting effect on the reader, than Tragedy, he draws an illustration from

iii. the medical quarrel. "Chymical medicines are observed to relieve oftener than to cure: for 'tis the nature of spirits to make swift impressions but not deep. Galenical decoction to which I may properly compare an epic poem, have more of body in them, they work by their substance and weight".

The sciences of astronomy, chemistry, and medicine excited most interest in seventeenth century writers, but it would be difficult to say which was the favourite.

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- i. Good Thoughts in Worse Times. (Occasional Meditation xv)
 - ii. Hud. P.iii. C.iii. L.473.
 - iii. Dedication of the Aeneis (1697).

GENERAL EFFECTS.

The influence of the new scientific thought combined with other forces to affect the general character of seventeenth century literature. It obviously played an important part in the evolution of a concise, easily manipulated, work-a-day prose style. Bacon's own writings give an indication of the scientific ideal; he does not elaborate his ideas (*Franciscus Baconus sic cogitavit - - - itaque visum est ei - - -*), and a single sentence in one of his essays would have been expanded into a paragraph by the nineteenth century essayists, though modern writers are returning to the scientific style, designed "to come home to men's business and bosom's," without circumlocution. It must be admitted, however, that Bacon's desire

- i. for succinctness sometimes beguiles him into obscurity and the use of equivocal terms, so that the reader shares Lady Bacon's inability to construe her son's "folded enigmatical writing".

- ii. Ben Jonson's declaration "Pure and neat language I love, yet plain and customary" would have received the cordial approval of the virtuosi of later times, and though this preference has its origin in classical rather than scientific interests, it had an effect similar to the Baconian style itself, in that it made easier the path of later reformers.

The influence of science in clarifying prose style would have been still more definite if men like Gilbert, Napier, and Harvey had published their works in the vernacular instead of

i. e.g. *Essays of Truth; Of Envie.*
 ii. *Discoveries.* cxviii.

in the Latin tongue, thus providing actual examples for guidance. That these writers aimed at simplicity and directness consciously, may be seen from Gilbert's explanation that

- i. he has not introduced into his treatise "any graces of rhetoric any verbal ornateness, but have aimed simply at treating knotty questions about which little is known, in such a style, and in such terms, as are needed to make what is said clearly intelligible".

Sprat's pronouncement in the History of the Royal Society shows unmistakeably the direction in which the scientific influence was trending. After explaining the methods which the society pursued in the investigation of natural phenomena he

- ii. continues "Thus they have directed, judged, conjectured upon, and improved experiments. But lastly in these and all other businesses that have come under their care; there is one thing more, about which the society has been most solicitous, and that is the manner of their discourse, which, unless they had been very watchful to keep in due temper, the whole spirit and vigour of their design had been soon eaten out, by the luxury and redundance of speech They have therefore been most vigorous in putting in execution, the only remedy that can be found for this extravagance and that has been, a constant resolution to reject all the amplifications, digressions, and swellings of style: to return back to the primitive purity and shortness, when men delivered so many things, almost in an equal number of words. They have exacted from all their

i. Preface to the Reader. De Magnete.
 ii. History. P.ii. S.xx.

members a close, naked, natural way of speaking, positive expressions, clear senses, a native easiness, bringing all things as near the mathematical plainness as they can, and preferring the language of artizans, countrymen, and merchants, before that of wits and scholars".

In the first place these requirements were meant only to apply to scientific writings but as the interest in the experimental philosophy spread there was an attempt to make purely literary works conform to this standard. Moreover in those early days the members by no means confined their attention to pure science, for they were ready to welcome intellectual ability of any description. Men of letters like Cowley, Evelyn, Waller, and Dryden, were members as well as scientists like Boyle and Wilkins. From the society emanated a proposal for erecting an English Academy, and as early as 1664 a committee was appointed "for improving the English tongue". The

i. letter which Evelyn addressed to Pepys explains the constitution and history of the committee. "In order to it three or four meetings were begun at Grey's Inn by Mr. Cowley, Dr. Sprat, Mr. Waller, the Duke of Buckingham, Mart Clifford, and Mr. Dryden", but owing to "the death of the incomparable Mr. Cowley, distance and inconvenience of the place, the contagion and other circumstances intervening it crumbled away and came to

ii. nothing". Sprat, whose style of writing was admired by Burnet Glanvil, and Dr. Johnson, evidently felt a keen interest in the proposed Academy, for he enters into a somewhat lengthy

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- i. August 12th. 1689 (quoted. Spingarn's Critical Essays of the Seventeenth Century. v.ii. P.313 ff
 ii. History; Plus Ultra. Ch. xii.; Life of Sprat.

i. digression on the subject in his History. He apologizes for its introduction but pleads in extenuation, "I shall affirm that the Royal Society is so far from being like to put a stop to such a business that I know many of its members, who are as able as any other, to assist in the bringing it into practice".

ii It has been surmised that Sir Thomas Browne's exclusion from the Royal Society was due to the heedless and towering splendour of his style, to atone for which laborious experiment and refutations of Vulgar Errors availed him nothing. Browne's magnificent rhetoric would be anathema to a society which had

iii. decided with Glanvil that, "Plainness is ever the best eloquence and 'tis the most forcible; so that our study should be to represent what we have to deliver in proper and easy expression neglecting and despising all starchedness of set and affected speaking". There can be little doubt that the effect of the scientific influence upon the development of prose was almost wholly beneficial. It clarified the vocabulary, checking the aspirations of writers like Sir Thomas Browne to soar "into expressions beyond mere English apprehensions"; it brought the tortuous and involved sentences to something like nervous order and simplicity; it suggested the style of which Cowley's prose is the promise and Dryden's the perfect fruit. Dr. Johnson's well known description of Dryden's Prefaces, is a complete expression of the ideal for which the Royal Society were striving.

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- i. History of the R.S. P.i. S.xix. and xx. "By Mr. Edmund Gosse."
- iii. Essay concerning Preaching.

The taste for simplicity extended also to poetry^{for}, with or without metre,

"Truth shines brightest through the plainest dress".

The science of the moderns and the rules of the ancients were equally opposed to the Gothic and strange in literature. We

- i. thus find the opinion that "the excellence and dignity" of rhymed verse "were never fully known till Mr. Waller taught it", universally accepted, for the neat couplet form specially appealed to an age that desired mathematical exactitude. Sprat
- ii. had urged that the experimental philosophy "will cure our minds of romantic swelling, by showing all things familiarly to them just as they are", and it would appear that the scientific spirit combined with other causes to hasten the passing of Romanticism and assist the rise of Neo-classicism.

- In the domain of literary criticism, the long, and in some respects barren, quarrel of the Ancients and Moderns, if it did not take its origin in, at least received an impetus from, the unprecedented advances which had been made in scientific knowledge, during the seventeenth century. Since the controversies which had excited astronomers and physicians, had proved the hopeless inferiority of the ancients, as scientists, it was argued (with some plausibility), that the Battle of the Books might be fought with a good hope of seeing the ancient classical authors similarly vanquished. Apart from this oftentimes
- iii. dilettante debate, Dryden's far-reaching question, "Why should

i. Dedication of the Rival Ladies.
 ii. History. P.iii. S.xii.
 iii. Preface to An Evening's Love or The Mock Astrologer (1671).

there be an ipse dixit in our poetry any more than there is in our philosophy?" shows that the scientific movement carried within itself an element essentially antagonistic to the blind worship of the ancients.

Many of the seventeenth century references to scientific facts can only be described as "conceits". In this connection Bacon's division of human minds into two great classes, the one noting the differences of things, the other marking the resemblances, is of importance. In the great scientists both powers are possessed to an abnormal degree, but in the early stages of scientific thought men were so anxious to obtain a classified body of facts that minds of the second type seemed to predominate. According to Dr. Johnson the metaphysical poets were characterized by a kind of wit which may be, "rigorously and philosophical considered as a kind of discordia concors; a combination of dissimilar images, or discovery of occult resemblances in things apparently unlike". Thus the scientific amateur or virtuoso, and the "conceited" poet were ready - often too ready - to go beyond the physical fact in the search for a law of connection, or an analogy with human life, and in this sense both may be described as metaphysical. In Donne and Cowley, to take two notable instances, and to a less extent in Dryden, the relationship is clear, so that the scientific movement may be charged, not unjustly, with intensifying the "metaphysical" craze.

ii. It is somewhat curious to find Sprat urging that the discoveries of the Royal Society will confer inestimable benefit

i. Nov. Org. Bk.i. Aph.55.

ii. History of the Royal Society. P.iii. S.xxxv.

upon the writers of his own and subsequent times. He explains "This I am provoked to mention by the consideration of the present genius of the English nation; wherein the study of wit, and humour of writing, prevail so much that there are very few conditions, or degrees, or ages of men, who are free from its infection". He examines the treasures from which poets have hitherto derived their illustrations, and after showing that they are well nigh exhausted, declares, "It is now therefore seasonable for Natural Knowledge to come forth, and to give us the understanding of new virtues and qualities of things, which may relieve their fellow creatures that have long borne the burden alone, and have long been vexed by the imaginations of poets. This charitable assistance experiments will soon bestow. The whole argument is clinched by a reference to the writings of the founder of the new science. "The use of experiments to this purpose is evident by the wonderful advantage that my Lord Bacon received from them. This excellent writer was abundantly recompensed for his noble labours in that philosophy, by a vast treasure of admirable imaginations which it afforded him, wherewith to express and adorn his thought about other matters".

Seventeenth century science was eager to provide a solution for the problem formulated by Phineas Fletcher:-

1. "Tell me, ye Muses, what our father ages
Have left succeeding times to play upon;
What now remains unthought on by those sages
Where a new Muse may try her pinion"?

Literature gladly accepted the proffered help and proceeded to annex the Purple Island, or any other territory which the

scientific pioneers had opened, to the province of poetry. It was not only Sir Positive At-all's but every man's humour, to be "a unus in omnibus" through all arts and sciences", and the subsequent attempt to make the Muse equally versatile, resulted in an olla podrida of metaphors and an increased appetite for "conceits".

- In the making of Jonson's "gorgeous gallery of gallant
i. inventions", and in the "humours" of his faithful disciple Shadwell, the narrow observation, characteristic of writers interested in science, is revealed in much the same way that the analytical plays and novels of to-day betray the scientific tastes of our own time, which are directed, however, more to the psychical than the physical sciences. The interest in the "characters" is also symptomatic of the research-spirit of the age. The Elizabethan time would not have troubled to chisel the many faceted portrait of the Envious Man or the Flatterer. It was so impetuously eager to penetrate into the heart of things that it had no desire to see A Piece of the World
ii. Characteriz'd, or London and the Country Carbonadoed and Quartered into Several Characters.

In these and similar devious ways the scientific spirit may be found leavening seventeenth century literature, but to pursue the enquiry further would perhaps be to consider too curiously of the matter, incidentally providing a better example of an Idol of the Cave than "Gilbertus our countryman".

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- i. Sullen Lovers. Act iii.
ii. By Earle and D.Lupton.

CONCLUSION.

Having shown the effects, direct and indirect, of the scientific renaissance upon seventeenth century literature, it may be desirable to indicate how far the treatment of science by the authors of that period may be regarded as ideal.

i Signs are not wanting to prove that the experimental philosophy was viewed with some suspicion by theology. Its opponents declared that the new movement would shake the established religion, and inculcate atheistical opinions, while its supporters indignantly repelled these accusations, declaring that all future discoveries could only serve *ad maiorem dei gloriam*. In the nineteenth century, a period in which similar revolutionary advances were made in human knowledge, there is to be found, not only the religious prejudice, but also the haunting fear that science, with its annihilating breath, would make poetry, like *Lamia*, melt into a shade. Yet irrefutable assertions like Leigh Hunt's, "there will be a poetry of the imagination as long as the first causes of things remain a mystery" are without parallel in seventeenth century literature. In the latter period such assurances were unnecessary, for men believed that science, as seen by the poet's eye, is itself poetry, and they unhesitatingly put their faith into practice. It is only when literature has this

i Opponent. Stubbe. *A Censure Upon Certain Passages in the History of the Royal Society*. 1670.
 Supporters. Bacon. *Essay on Atheism*. Adv. Bk I. I. III; Glanvil *Philosophia Pia*; Sprat. *History* P III. S. XIV. Milton hesitates. cf. P. L. Bk. III. 1. 694-704; Bk. VIII. 1. 66-69; and Bk. VII. 1. 119-130; and Bk. VIII. 1. 173-174. *Spirit of the Areopagitica* is favourable to the science "Methinks I see—"

complete confidence in its own divine right, and when the poppy of oblivion has fallen upon the ancient quarrel of the reason and the imagination, that scientific facts are capable of artistic treatment.

In the seventeenth century science was comparatively simple so that a man of average intelligence could keep abreast with the latest results of mathematical, astronomical, chemical, or medical research. This simplicity was of immense advantage to the writer who wished to deal with scientific matters, for it is essential that the poet should move easily among the facts which he wishes to employ, and that the reader should be able to follow him without lengthy preparation. If the poet is forced to exchange the mantle of the vates for the gown of a preceptor, the creating power of his own, and the re-creating power of his reader's imagination, receive a severe check.

Moreover the new worlds which seemed to be springing open on every side, aroused universal interest in the various sciences. "The man of science," says Wordsworth "seeks truth as a remote and unknown benefactor; he cherishes and loves it in his solitude: the Poet singing a song in which all human beings join with him, rejoices in the presence of truth as our visible friend and hourly companion." But in the seventeenth century the scientist did not seek truth in solitude, for the whole nation was engaged in the same task, while the poet who told of the wonders of science was singing a song in which all his contemporaries right willingly bore a part.

Despite the fact that seventeenth century writers had these advantages in dealing with matters of science, few people would care to say that the scientific allusions, of which this essay contains so many examples invariably give artistic pleasure. To the modern mind they seem to lack spontaneity and to be not a little fantastic. Revising the Johnsonian phrase, they frequently appear far fetched and hardly worth the carriage. It is probably true that contemporaries had particular associations which made such illustrations natural and pleasing to them, but the fact remains that even if they satisfied their own age, they do not delight for all time.

In one other important aspect the seventeenth century treatment of science fails, but almost all attempts to relate literature (especially poetry) and science have met with a similar defeat. The whole work appears to have passed through some transmuting medium, whose modifying influence the scientific allusion has escaped. The result is a feeling of strangeness similar to that which would be experienced on seeing a photograph incorporated into a landscape picture. The incongruity doubtless arises from the fact that the mood in which the whole is conceived is one of expansion and exaltation, while the scientific truth can only be realised by a voluntary limitation and concentration of the self.

That in the beginning Science and Literature were one, and that in the end they may again be united, is the belief of the best critics, but after all is said, the interval concerns us most. In spite of superficial attempts at reconciliation,

i Prose is, to some extent, more successful.

and suggestions that the twentieth century may see an epic poem founded on the sciences, (which hopes may be compared with the desiderated seventeenth century heroic poem), real divergences present themselves when poets begin to deal with scientific matters. There can be no finality in science and even the theories which withstand the critical attack of ages do not sink deep into the general heart of man. Science is one of the things which even the scientist forgets, when he is placed in the great elementary situations of life. It is the fact that all literature must be universal, which makes the path to the mountain where the Sciences, "terrible Muses," sit enthroned, so steep and treacherous.
