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Edited by James F. Palmer

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The Works of John Hunter, F.R.S.

The surgeon and anatomist John Hunter (1728–93) left a famous legacy in the Hunterian Museum of medical specimens now in the Royal College of Surgeons, and in this collection of his writings, edited by James Palmer, with a biography by Drewry Ottley, published between 1835 and 1837. The first four volumes are of text, and the larger Volume 5 contains plates. Hunter had begun his career as a demonstrator in the anatomy classes of his brother William, before qualifying as a surgeon. He regarded surgery as evidence of failure – the mutilation of a patient who could not be cured by other means – and his studies of anatomy and natural history were driven by his belief that it was necessary to understand the normal physiological processes before attempting to cure the abnormal ones. Volume 4 contains Hunter's works on animal physiology, with notes by the distinguished palaeontologist Richard Owen.

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THE
WORKS
OF
JOHN HUNTER, F.R.S.
WITH
NOTES.

EDITED BY
JAMES F. PALMER,
SENIOR SURGEON TO THE ST. GEORGE'S AND ST. JAMES'S DISPENSARY; FELLOW
OF THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY OF LONDON, ETC.

IN FOUR VOLUMES.
ILLUSTRATED BY A VOLUME OF PLATES, IN QUARTO.
VOL. IV.

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OBSERVATIONS
ON
CERTAIN PARTS
OF
THE ANIMAL ŒCONOMY,

INCLUSIVE OF SEVERAL PAPERS FROM
THE PHILOSOPHICAL TRANSACTIONS, ETC.,

BY
JOHN HUNTER, F.R.S.

WITH NOTES,
BY
RICHARD OWEN, F.R.S.,

FELLOW OF THE LINNEAN, GEOLOGICAL, AND ZOOLOGICAL SOCIETIES OF LONDON.
CORRESPONDING MEMBER OF THE ROYAL ACADEMY OF SCIENCES OF BERLIN; OF
THE ROYAL ACADEMY OF MEDICINE AND PHILOMATHIC SOCIETY
OF PARIS; AND OF THE ACADEMY OF SCIENCES OF
PHILADELPHIA, MOSCOW, ERLANGEN, ETC.
PROFESSOR OF ANATOMY AND PHYSIOLOGY, AND
CONSERVATOR OF THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS IN LONDON.

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TO SIR JOSEPH BANKS, BART.,

PRESIDENT OF THE ROYAL SOCIETY, &c. &c. &c.

DEAR SIR,

*As the following Observations were made
in the course of those pursuits in which you have so warmly
interested yourself, and promoted with the most friendly
assistance, I should be wanting in gratitude were I not to
address them to you, as a public testimony of the friendship
and esteem with which I am,*

Dear Sir,

Your obliged and

Very humble Servant,

JOHN HUNTER.

Leicester Square,
Nov. 9, 1786.

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To the First Edition of the Animal Œconomy, 1786.

THE nine following papers have been read at the Royal Society, and published in the Philosophical Transactions; but in a work of so general a nature, and of which physiological inquiries make so small a part, the few facts and observations which I have given upon such subjects may probably be overlooked by those who are not members of that Society. That they may be more easily procured by students in medicine, and other readers, I have, by an application to the President and Council of the Royal Society, obtained leave to reprint such of them as I consider to be connected with the principles and actions of the Animal Œconomy; and I have added such observations and remarks as have occurred to me since the time they were read before the Royal Society.

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To the Second Edition of the Animal Œconomy, 1792.

ELEVEN of the following papers have been read at the Royal Society, and published in the Philosophical Transactions; but in a work of so general a nature, and of which physiological inquiries make so small a part, the few facts and observations which I have given upon such subjects may, probably, be overlooked by those who are not members of that Society. That they may be more easily procured by students in medicine, and other readers, I have, by an application to the President and Council of the Royal Society, obtained leave to reprint them, in this work, as being connected with the principles and actions of the Animal Œconomy; and I have added such observations and remarks as have occurred to me since the time they were read before the Royal Society.

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P R E F A C E.

ALWAYS an admirer of the genius of Hunter, and of late years obliged by official duties to make frequent reference to his numerous and varied productions, especially to those which are scattered through different volumes of the Philosophical Transactions and other works, I have often felt the inconvenience that resulted from the absence of a uniform edition of the whole of the extant works of that great and original thinker. When, therefore, Mr. Palmer first communicated to me his design of publishing a new edition of Hunter's works, I heard with peculiar satisfaction his intention to include in the proposed collection every memoir of the author that could be found in print, and I gladly lent my assistance, which, however, the previous assiduous researches of Mr. Palmer rendered of little moment, towards completing a list of all the published essays or observations on various parts of the 'Animal Œconomy' which had not before been included in the work so entitled. The proposal which Mr. Palmer at the same time made to me to edit this portion of the works of Hunter I declined, from a sense of the inadequacy of my powers to grapple with so vast a range of important physiological subjects as the contemplated volume must necessarily embrace, and I sincerely hoped that Mr. Palmer would have found a coadjutor better qualified than myself to do justice to this portion of his most useful and praiseworthy undertaking.

After a lapse of nearly two years Mr. Palmer again applied to me to revise the papers on the Animal Œconomy, and I then acceded reluctantly to his request, led, by the sole motive of accelerating the appearance of a much wished for edition, to a task, to which I have since dedicated a great proportion of my

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leisure hours, without the slightest expectation of profit or honour, the experiment having only served to convince me of the difficulty of adding the observations demanded by the progress of science to the text of Hunter in the spirit of its author, and a retrospect of my annotations leading me to suspect that often, with every wish to avoid it, I may have tacitly implied an ignorance on the part of Hunter of facts with which he was probably well acquainted, and to perceive that, in general, the addition of such details tends to overload and destroy the force of the original observations in the text.

It is with much more satisfaction that I refer to the additions which have been made to the present edition of the *Animal Œconomy* of the hitherto uncollected or unpublished writings of its original author.

These consist of the following essays.

From the *Philosophical Transactions* :

“On the Anatomy of the Siren or Amphibious Bipes (1766).”

“On the Electric Organs of the Torpedo (1773).”

“On the Electric Organs of the Gymnotus (1755).”

“Experiments and Observations on Vegetables with respect to the power of producing Heat (1775).”

“A case of Small-pox communicated by the Mother to the Fœtus (1780).”

“Anatomical Remarks on a New Marine Animal (1785).”

“Observations on the Structure and Œconomy of Whales (1787).”

“On Bees (1792).”

“On the Fibrous Structure of the Crystalline Lens (1793).”

“On the Fossil Bones of the Caverns of Gailenreuth (1794).”

“Six Croonian Lectures read before the Royal Society by Hunter in the years 1776, 1777, 1779, 1780, 1781 and 1782,” but withdrawn from publication by the Author.

From the *Medical Commentaries of Dr. Wm. Hunter* :

“Experiments on Absorption by Veins.”

From the *Transactions of a Society for the Promotion of Medical and Chirurgical Knowledge*, vol. ii. (1794) :

“Description of the Human Uterus and Ovum in the First Month of Pregnancy.”

“Observations on the Growth of Bone.”

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There is also added,

“An Account of the Anatomy of the Jerboa,” contributed by Hunter to the Appendix to Russel’s *History of Aleppo*. And, lastly,

“Descriptions of Five Marsupial Quadrupeds,” from the Zoological Appendix to White’s *Voyage to New South Wales*. (1790.)

In order to bring these different memoirs in juxtaposition with papers on analogous subjects in the original edition of the *Animal Œconomy*, a slight alteration has been made in the arrangement of the different essays composing that work. Those which relate to generation are brought together at the beginning of the volume; then follow the observations on digestion, animal heat, and other physiological subjects; and lastly, the papers of a descriptive character, which refer more immediately to comparative anatomy and zoology. Thus for the first time are collected into one volume the physiological and anatomical stores, from which, in connexion with the materials composing his museum or destined for its illustration, an adequate idea may be formed of the nature of the great work in which Hunter had purposed to record the sum of his vast experience.

In the year 1786, when Hunter published a collection of his detached memoirs in the first edition of the *Animal Œconomy*, he observes, with reference to the subject of digestion, “I cannot at present spare sufficient time to give my opinions at large on this subject, with all the experiments and observations I have made upon it, but as soon as I have leisure I shall lay them before the public.” And again, in describing the organ of hearing in fishes, he premises that he reserves a more complete investigation of this part of natural history “for a larger work on the structure of animals, which I one day hope to have it in my power to publish,” and he states that ever since the year 1760 his researches have been continued in every part of the animal œconomy. Hence instead of regarding the uncommon structures which he discovered in his dissections of different animals as individual peculiarities, he was enabled to advance beyond the anatomists of his own times, and view them from the same eminence to which subsequent induction has raised the observers of the present day: and referring to the

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series of preparations in his museum, he boldly states with reference to the structure of the organ of hearing in fish, that it is “only a link in the chain of varieties displayed in the formation of this organ of sense in different animals, descending from the most perfect to the most imperfect in a regular progression.”

The importance of these views, and the nature and amount of the knowledge which they indicated, could not be appreciated by the contemporaries of Hunter in the absence of a detailed exposition of the evidences on which they were founded. It is no wonder, therefore, that we find his earlier eulogists sometimes founding his claims to scientific eminence on insecure grounds; some, for example, lauding him as the author of a theory of the organizing energy, which may be traced to the time of Aristotle, or as the originator of the doctrine of the vitality of the blood, which is supported with so much eloquence by Harvey and his immediate successors; while others, taking more definite grounds, have often unfortunately selected as his discoveries precisely those subjects of Hunter's special researches in which he had but revived and extended the ideas of his predecessors. Of this we have a striking example in the introductory observations on the character of Hunter contained in Sir Everard Home's *Lectures on Comparative Anatomy*, vol. i. p. 6, in which the independent function of the *vesiculæ seminales* and the determination of the organ of hearing in fishes are adduced as Hunterian discoveries.

The true originators of these and of other ideas and facts which Hunter may have regarded as his discoveries, and which he doubtless did discover so far as independent and original research constitutes a claim to that honour, I have been careful to point out in every case where my reading has led me to detect in an older author a clear anticipation of Hunter.

It cannot be doubted, however, that the ascription to Hunter, by his friends and admirers, of facts and opinions to which he had no title as the original discoverer, must have contributed to lower his character in the estimation of continental anatomists; whose acquaintance with the vast accumulation of facts in comparative anatomy due to the labours of the numerous

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cultivators of that science in the sixteenth and seventeenth centuries, easily enabled them to detect the weakness of such claims, without perhaps their possessing such a knowledge of Hunter's labours as to justly appreciate their scope and tendency, and to view them, as they deserve to be viewed, in the light of a first great attempt to arrange in one concatenated system the diversified facts in comparative anatomy.

Cuvier, for example, in his review of the progress of science in the latter half of the eighteenth century, a period which may be regarded as a second revival of comparative anatomy and physiology, places Hunter in an inferior category of contributors to those sciences. After eulogizing the share which the erudite Haller took in demonstrating the importance of comparative anatomy to the advancement of physiology, and the corresponding effects which the labours of Daubenton and Pallas produced in establishing sounder ideas of the classification of animals, the historian of the natural sciences goes on to state: "John Hunter in England, the two Monros in Scotland, Camper in Holland, and Vicq D'Azyr in France were the first who followed their footsteps. Camper," he observes, "cast, so to say, a passing glance of the eye of genius on a number of interesting objects, yet almost all his labours were but sketches. Vicq D'Azyr, with more assiduity, was arrested by a premature death in the midst of a brilliant career; but their works inspired a general interest, which has ever since been on the increase."

With reference to the nature or influence of the labours of Hunter, Cuvier is silent; he limits himself to an indication in a marginal note of the Treatise on the Teeth and "les autres écrits de Hunter insérés en partie dans les *Transactions Philosophiques**."

This was meting out but scanty justice to the author of the Treatise on the Blood and of the Observations on the Animal Economy, which abound with so many general propositions in comparative anatomy and physiology. If, however, this opinion of Cuvier be excusable under the circumstances under which it was written, it would be unpardonable not to appeal against it upon the evidence of the higher claims of Hunter afforded by

Histoire des Progrès des Sciences Naturelles, depuis 1789, tom. i. p. 302.

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the present edition of his works and by those manuscripts which have already appeared in the catalogue of his Physiological collection published by the Royal College of Surgeons. Had these manuscripts, explanatory of the design of the Hunterian collection, been published before Cuvier wrote the work from which we have just quoted, that astonishing result of Hunter's labours might perhaps have claimed a passing notice from one whose statements all Europe now receives and all posterity will regard with confidence and respect.

"*Les autres écrits*," the "other writings" of Hunter to which Cuvier alludes, are indeed devoted rather to the development of general principles in physiology than to the detail of the anatomical observations upon which he founded them. Many of the facts ascertained in the course of his higher and more comprehensive inquiries, and incidentally alluded to in the narration, are however fully as interesting and important as those which other anatomists have sometimes thought worthy of being made the subjects of express monographs.

But Hunter had higher aims than the reputation of a mere collector of facts in comparative anatomy; and this he not only felt but had expressed in an early period of his career. In a manuscript, copied by Mr. Clift, relating to a dissection of a turtle, he says, "The late Sir John Pringle, knowing of this dissection, often desired me to collect all my dissections of this animal, and send them to the Royal Society; but the publishing of a description of a single animal, more especially a common one, has never been my wish."

Howsoever we may regret this feeling, which has undoubtedly deprived the world of the results of much inestimable labour, and has operated in various ways disadvantageously to Hunter's own reputation, yet it indicates the expanded views of the man who entertained it.

Had Hunter published *seriatim* his notes of the structures of the animals which he dissected, these contributions to comparative anatomy would not only have vied with the labours of Daubenton as recorded in the *Histoire Naturelle* of Buffon, or with the Comparative Dissections of Vicq d'Azyr which are inserted in the early volumes of the *Encyclopédie Méthodique* and in the *Mémoires de l'Académie Royale de France*, but they would have exceeded them both together.

It would be tedious to enumerate, name by name, the different species of animals whose organization was investigated and recorded by Hunter. Mr. Clift has evidence* that he left written descriptions, from autopsy, of the anatomy of the following Mammalia :

Of Quadrumana	.	.	21 Species.
Carnivora	.	.	51
Rodentia	.	.	20
Edentata	.	.	5
Ruminantia	.	.	15
Pachydermata	.	.	10
Cetacea	.	.	6
Marsupiated	.	.	10
Of Birds	.	.	84 Species.
Reptiles	.	.	25
Fishes	.	.	19
Of Insects	.	.	29 Species.

Of other invertebrate animals, as mollusca, red-blooded worms, and radiata, upwards of twenty. From the titles of manuscripts, therefore, it appears that Hunter possessed, at the period of his decease, original records of the dissections of three hundred and fifteen different species of animals.

In addition to these, Hunter's preparations testify that he had dissected twenty-three species of mammalia, sixteen species of birds, fourteen species of reptiles, forty species of fishes, forty-two different mollusca, and about sixty species of articulate and radiate animals ; all species of animals of whose anatomy we have no evidence that he left written descriptions. So that by adding these undescribed dissections to those of which we derive the evidence from the list of the manuscripts, and of which described dissections his anatomical collection in like manner contains evidences in the dissected and preserved organs, there is proof that Hunter anatomized at least five hundred different species of animals, exclusive of repeated dissections of different individuals of the same species, besides the dissections of plants to a considerable amount.

* See " Evidence before the Medical Committee of the House of Commons."

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With respect to the rarer and less known invertebrate animals, Hunter was not content with merely recording their structure, and displaying its leading peculiarities in preparations; but he caused most elaborate and accurate drawings to be made from the recent dissections; for which purpose he retained in his family many years an accomplished draughtsman, Mr. William Bell, better known as the author of two papers in the Philosophical Transactions, descriptive of the Sumatran Rhinoceros and the Ecan Bonna (*Platax arthriticus*, Cuv.). Several examples of these beautiful designs have already been published by the Council of the Royal College of Surgeons in the illustrated catalogue of the Hunterian Museum: they relate to the anatomy of the Sepia and Solen, of the Ascidia and Salpa; they illustrate the circulation of the blood in the Crustacea and Anellida; and the figure which Mr. Hunter has given of the circulation in the *Chlocia capillata*, a red-blooded worm, far surpasses in beauty and detail any of those with which Cuvier illustrates the memoir* dedicated to what he regarded to his latest breath as one of his most interesting discoveries.

Hunter had also minutely investigated the anatomy of the cirripeds†; but of his dissections of these, as of many other animals, it is to be lamented that the preparations and drawings are now the sole evidences. The illustrations of the anatomy of the Echinodermata, both of the spiny species and of the unarmed Holothuria, have never been surpassed either as to minuteness or accuracy; and, excepting the disputed article of the nervous system, little is added in the elaborate and well-known monograph of Tiedemann, to the anatomy of the Holothuria as it is displayed by Hunter‡.

Now the anatomical labours of Daubenton were confined to that class of animals whose structure most nearly resembles man; he describes the position and length and breadth and number of parts with most praiseworthy zoological precision, but never appears to raise his thoughts to the relations of the structures he detected with the habits of the species, or their adaptation to function. Hence he has been said to have made

* *Bulletin de la Soc. Philomath.*, 1791, p. 146.

† *Ser Physiological Catalogue of the Hunterian Collection*, vol. i. p. 255. pl. IV.

‡ *Ibid.*, p. 231, pl. III.

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more discoveries of which he was unconscious than any other cultivator of comparative anatomy.

Vicq-d'Azyr, on the contrary, adorns his descriptions with many beautiful and philosophical views, but he did not carry his scalpel beyond the vertebrate series; while Hunter explored every modification of animal structure, from man down to the polype.

If Hunter surpassed his contemporaries in the value and amount of the materials which he collected in comparative anatomy, he rises far above them in the application of his facts.

By a profound and unremitting meditation on the diversities of structure presented to his view, he derived more accurate notions than were current amongst his contemporaries of the parts essential to the performance of the different functions, and every idea or doubt thus suggested he tested by the most varied, ingenious; and accurate experiments.

"Many things," he observes, "arise out of investigation which were not at first conceived; and even misfortunes in experiments have brought things to our knowledge that were not, and probably could not have been, previously conceived. On the other hand, I have often devised experiments by the fire-side or in my carriage, and have also conceived the result; but when I tried the experiment the result was different, or I found the experiment could not be attended with all the circumstances that were suggested*." Few physiologists indeed, if any, have made more numerous, various, and conclusive experiments than Hunter. Yet he says, "I think it may be set down as an axiom that experiments should not be often repeated which merely tend to establish a principle already known and admitted, but that the next step should be the application of that principle to useful purposes†."

By this series of labours of mind and hand, prosecuted uninterruptedly from year to year, Hunter at length came to establish a body of physiological doctrines, to the happy influence of which on the treatment of the various "ills that flesh is heir to," every cultivator of the healing science now bears grateful testimony.

* Animal (Economy, p. 124 (the pages throughout refer to the present edition).

† Ibid, p. 86.

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Most of the enlightened physiologists of this country have acknowledged the high merit and beneficial influence of Hunter's labours; but the general terms in which his merits have been expressed have not availed in raising him from the secondary category of contributors to comparative anatomy, in which he has been classed by Cuvier, and from which some continental writers have lately been disposed to degrade him*.

The present seems, therefore, to be a fitting opportunity to attempt to define the grounds for assigning a higher station to Hunter, considered as a physiologist and comparative anatomist. In this endeavour, however, to prove what Hunter was as a discoverer, we must also fairly state what he was not.

He has been spoken of as the originator of the idea of a subtle imponderable principle operating in the fluids and solids of the organism, and causing the phænomena of life. But such a principle, under various names and with various attributes, has been assigned as the cause of organization by Aristotle, Harvey, Willis, Cudworth, Grew, Van Helmont, and Stahl.

As both Harvey and Hunter had spent laborious lives in earnest inquiries and repeated dissections and experiments, to ascertain relations between structure and function; as both had studied the changes which take place in the form and structure of animals from their embryo state to that of maturity; and as both had carefully traced the successive phænomena which occur in the egg during incubation,—the similarity of their opinions on the nature and powers of the vital principle is correspondingly close.

Both arrived at the conclusion, that an animating principle exists and operates in the ovum prior to the formation of any organ of the future animal. Both attributed the power by which the fecund egg resists putrefaction, while the unprolific one decomposes, to a principle of life, which Harvey more precisely terms the “*anima vegetiva*†.”

* See the *Esquisse Historique sur l'Anatomie Comparée*, prefixed to the French translation of the second edition of Carus' Comparative Anatomy, vol. i. p. xxx.

† “Plurimum itaque mecum ipse reputavi, quî fieret, ut ova improlifera gallinæ supposita, ab eodem calore extraneo corrumpantur, putrescant, et fœtida evadant; ovis autem fœcundis idem non contingat.” Harveii *De Generatione Animalium Exercitatio* 22.

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Hunter, however, carries his researches a step further; he submits the fecund egg to a low temperature, and ascertains a new property, of which Harvey was ignorant, a power, viz. of resisting cold: he also shows that when once frozen, and killed by cold, the dead impregnated egg yields to putrefaction like the unimpregnated one.

Both physiologists observed that if the phænomena of a vital principle were manifested in one part of the organization more than in another, it was in the blood. "For the blood," says Harvey, "is the first formed, and is the primary animate particle of the embryo; it is generated prior to the *punctum saliens*, before the first rudiment of the heart, and is endowed with the vital heat or principle before it begins to move, and from it does pulsation commence. For the thing containing is made to be serviceable to the thing contained.

"Nor is the blood therefore to be called the primogenial part, because that in and from it the organ of pulsation is derived, but also because the animal heat and vital principle are first implanted therein; and in it does life consist. For where heat and motion first begin, there also life doth first arise and last expire."—Harvey, *On Generation*, pp. 274, 275.

This explicit and beautiful enunciation of the pre-existence of the blood to the machine by which it is mainly circulated, and of its endowment of life, fell barren from the pen of Harvey (if we except the brief practice of transfusion to which it gave rise), and was forgotten, when Hunter resumed the inquiry. And why, it may be asked, was the doctrine of the vitality of the blood inoperative, as taught by Harvey? Because instead of establishing that doctrine by observations and experiments, from which alone it was susceptible of deriving further proof,—instead of applying the principle to the explanation of the phænomena of disease, and to a modification and improvement of

"Ovum itaque est corpus naturale virtute animali præditum; principio nempe motus, transmutationis, quietis, et conservationis." *Exercit.* 26.

"Cum enim in ovo macula prius dilatetur, colliquamentum concoquatur et præparetur, plurimæque alia (non sine providentia) ad pulli formationem et incrementum instituantur, antequam quidpiam pulli vel ipsa primogenita ejus particula appareat; quidni utique credamus calorem innatum animamque pulli vegetativam ante pullum ipsum exsistere?" *Exercit.* 57.

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remedial measures, Harvey obscures and forgets the conclusions of his cooler moments of observation, and, as the learned Barclay well observes, excited by the discovery which had extended his fame so widely over Europe, and had reflected such lustre on his name and country, he expatiates on the blood as something divine; he has recourse to hyperbole, and describes its properties in the extravagant language of romance.

Hunter, on the contrary, carries a series of calm and philosophical investigations on the vital properties of the blood to an extent which has never been surpassed; he examines it under every condition, both in the vessels and out of the vessels, during circulation and at rest, in health and in disease. He aims to establish the period in its formation at which it manifests the vital properties; and he fully details the changes which it undergoes, and the phænomena which supervene in the rest of the organism when these properties are lost. Lastly, he tells us how the blood, by means of its vital properties, assists in the restoration of parts when injured or diseased.

Hunter subjects the blood to both mechanical and chemical analysis, and endeavours to determine the characteristic properties of its different constituents. It was not known in his time upon which of these constituents the act of coagulation depended. Hunter took advantage of a case in which the red globules subsided, as in some cases they do, more rapidly than usual, and skinning off the superincumbent colourless fluid, found that the fibrine, as it is now termed, immediately coagulated and formed a colourless clot*. A subsequent erroneous theory, which attributed the act of coagulation to the red globules, has recently been set aside by the application of an ingenious process for artificially separating the fibrine from the blood disks before coagulation takes place, and the opinions of Hunter on this point have been fully established by the experiments of Müller. With respect to the serum, Hunter instituted a number of experiments and made many ingenious observations to determine the relative quantity of the coagulable to the uncoagulable part. His deductions as to the amount of nutrient albumen in the blood of animals of different ages, and under different circumstances, as regards exercise or rest, &c. formed, from observing the quantity of gravy or uncoagulable

* Vol. III. p. 21.

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serosity which different roasted meats afforded, is highly characteristic of his original and ever active mind. In seeking to determine the respective importance of the different constituents of the blood, by the philosophical and most difficult inquiry into their respective periods of formation in the development of the embryo, Hunter made the interesting discovery that the vessels of the embryo of a red-blooded animal circulated in the first instance colourless blood, as in the invertebrate animals.

“The red globules,” he observes, “seem to be formed later in life than the other two constituents, for we see while the chick is in the egg the heart beating, and it then contains a transparent fluid before any red globules are formed, which fluid we may suppose to be the serum and the lymph*.”

I well remember the feelings of surprise with which I listened while at Paris in 1832 to a memoir read before the Academy of Sciences by MM. Delpech and Coste, the object of which was the announcement of the same fact as a novel and important discovery. The statement of the French observers was received with all the consideration which its importance justly merited, without its being suspected that our great physiologist had half a century before embraced it, with all its legitimate deductions, in the extended circle of his investigations.

In the same spirit in which he investigated the nature of the blood he also pursued his researches on the properties of the solids; he endeavours to determine the specific powers and vital phenomena of the nervous system and of the stomach; he compares these important parts of the animal body, with reference to the degree of energy with which their functions are manifested; he considers the influence which they reciprocally exert in maintaining the vitality of the blood, and the relative dependence of the whole organism on the integrity of their vital powers. He also dwells at great length on the sympathies resulting from these mutual relations and dependencies.

In all his physiological researches we may see that instead of dogmatising on the powers and virtues of an abstract essence, Hunter endeavours to analyse the vital forces peculiar to each

* Vol. III. p. 66.

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organic element, and to classify, as it were, the phænomena of which life consists.

If we turn from Hunter's researches on life to his investigations on another equally difficult and recondite subject in general physiology, viz. Animal, or rather, Organic Heat, we see the same exercise of the powers of the same great and original mind.

He first determines the relative extent to which the power of generating heat or resisting cold is enjoyed in the two grand divisions of organic nature, plants and animals: he next investigates the degree in which that power is possessed by different classes of animals; then the relation subsisting between that degree and the perfection and complexity of the organization with which the power is associated. He anticipates some modern physiologists in determining the different power of generating heat manifested by the same species at different periods of life, and advances a step further by considering the different powers of resisting cold which different parts of the same organized body possess in relation to their respective ages and periods of formation*. He lastly analyses, so to say, the different functions, to determine in what degree the production of heat depends on their exercise; and reciprocally, the influence of the temperature of the body upon the active and healthy maintenance of their functions.

Throughout all this beautiful and justly celebrated inquiry we see the philosopher conscious of the extent of his powers, and of the kind of knowledge which the right exercise of those powers was adapted to acquire. We nowhere perceive a trace of a desire to establish a theory of the nature of animal heat in the abstract.

Let any one compare the language of Harvey or of Willis, while expatiating on the *calidum innatum*, with the following just remark: "I shall not," says Hunter, "attempt to settle whether heat is a body or matter, or only a property of matter, which appears to me to be merely a difference in terms, for a property must belong to something†."

It is precisely in the same spirit that he conducts his re-

* p. 134.

† p. 137.

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searches on life ; and I would say, after a very careful study of the writings of Hunter, that of all physiologists he is one to whom a dogmatic theory of abstract life can least be attributed. But by those whose notions of Hunter's doctrines are founded solely on a perusal of the posthumous "Treatise on the Blood" he is liable to be misconceived, and in opinions expressed from that limited acquaintance with his writings to be misrepresented.

With the just ideas which Hunter had acquired of the laws of vitality and organic heat he was enabled to explain many of the phenomena of digestion more satisfactorily than had been done by his predecessors Spallanzani and Reaumur.

The following is a fair example of the different views and kinds of knowledge which these experimenters brought to the inquiry.

Spallanzani had observed that digestion did not go on in reptiles below a certain temperature, he thought therefore that heat was necessary to assist in the dissolving processes of the stomach ; Hunter, in reference to the same fact, shows that the influence here is not merely chemical, but that the heat operates by first raising the sensitive powers, these then transmit the stimulus to the respiratory and circulating functions, and lastly to the motive and other actions and faculties, and that the digestive organs are necessarily excited to corresponding actions, in order to supply the waste occasioned by the working of the machine, which the heat has thus called into play.

Hunter more accurately determined, and first applied and rendered fruitful, the fact which Grew incidentally mentions, viz. That it is the property of a living body or part to resist the action of the gastric juice ; and his celebrated paper "On the Digestion of the Stomach after Death," is a beautiful example of the application of his general views in physiology to the explanation of particular phenomena.

Of all his published writings, the papers on Digestion convey perhaps the best idea of the extent of Hunter's researches in Comparative Anatomy, and of the soundness of his reasonings in general physiology.

Hunter's claims to the originality of observations which have been reproduced as new by later physiologists, I have pointed out in the notes to these and other memoirs ; and have parti-

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cularly endeavoured to define the merits of Hunter as a discoverer in reference to the absorbent system.

Hunter's published writings on the Nervous System bear but a small proportion to the extent of his anatomical investigations on this subject, especially as they are manifested in the philosophical series of preparations in the Gallery of his collection, in which the nervous system is traced through its progressive stages of complication, from the simple filaments of the entozoon and echinoderm, to the aggregated masses which distinguish the organization of man. The *fibrous structure* of the brain, the discovery of which, though due to Coiter as early as 1573, has sometimes been attributed to Reil and Gall, is displayed by Hunter in preparations made to show the fact (Nos. 1335, 1336), and is expressly mentioned in the description of the Anatomy of the Whale Tribe*.

In treating of the comparative anatomy of the nervous system in his introductory observations to this division of his Collection†, Hunter rises to the following generalizations. He divides the animals which have brains, or visible aggregations of the nervous substance, into six classes, each characterized by a peculiar modification of the brain.

The '*first class*' has a brain in the form of a ring, through which passes the œsophagus, and from which the nerves arise, like radii from a centre. It consists of a pulpy substance, somewhat transparent, which is easily squeezed out when the brain is cut into. It is not inclosed in hard parts, and is not defended from pressure or injuries more than any other internal part.

The examples of this type in his Museum are selected from the gastropodous class of Mollusca. The same condition of the nervous system we now know, from the researches of Cuvier, to characterize the whole of a vast division of invertebrate animals, including, amongst the highest organized of that division, certain species,—the dibranchiate Cephalopods,—in which the character, as expressed by Hunter, is affected by the development of a cartilaginous cranium for the protection of the cerebral ring; but ulterior researches have not led to any modification of Hunter's description of the typical form of the brain in the Molluscan sub-kingdom.

* p. 373.

† Physiological Catalogue, vol. iii. p. 4.