NICOLAI STENONIS

ELEMENTORVM

MYOLOGIÆ SPECIMEN,

SEV

Muſculi deſcriptio Geometrica.

CVI ACCEDVNT

CANIS CARCHARIÆ DISSECTVM CAPVT,

ET

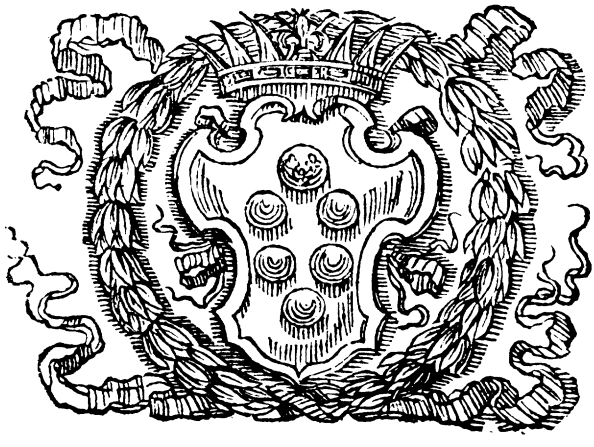
DISSECTVS PISCIS EX CANVM GENERE.

A D

SERENISSIMVM

FERDINANDVM II.

MAGNVM ETRVRIÆ DVCEM.



FLORENTIÆ,

Ex Typographia ſub ſigno STELLÆ. MDCLXVII.
Superiorum Permiſſu.

NIELS STENSEN'S

SPECIMEN OF ELEMENTS OF MYOLOGY

OR

Geometrical Description of the Muscles.

TO WHICH ARE ADDED

DISSECTION OF THE HEAD OF A CARCHARIAS-SHARK

AND

DISSECTION OF A DOGFISH.

DEDICATED TO THE MOST SERENE

FERDINAND II

GRAND DUKE OF TUSCANY.

FLORENCE,

From the Printing Shop under the Sign of THE STAR. 1667.

With permission of the Superiors.

SERENISSIME MAGNE DVX.

VM in me nihil magni meritum magna ſauoris Tui argumenta exſtare publicè profiteor, nec Tuo exactiſsimo iudicio quicquam detrahitur, nec mihi ab ambitionis labe periculum eſt. Dantis benignitatem, non accipientis meritum ſuperiorum fauores teſtantur; & vt prouidentiam Numinis non euertit, quod minus dignis proſpera eueniant, ſic principum prudentiam non imminuit, quod non ſolis magna meritis faueant.

Annotations to this section begin on page «231».

MOST SERENE
GRAND DUKE.

WHILE I publicly acknowledge that I do not at all deserve the great proofs of your favor, that does not diminish your very accurate judgment nor constitute any risk of my striving after honors. The favors of the greats disclose the generosity of the giver rather than the merits of the receiver. As the providence of the Divine Power is not overturned because the less worthy experiences good fortune, so the sagacity of princes is not diminished by the fact that they shower great favors not only on those who deserve them.[1]

Endnotes to this section begin on page « 229 ».

Id verò magnum fauoris Tui argumentum interpretor, quod in Italia, quod Florentiæ, quod in Aula ingenijs florentiſsima, Princeps ob ſolidam rerum cognitionem toto literato orbe celeberrimus, mihi ſeptentrionali homini, vix mediocribus ingenijs accenſendo, ex illis horis quaſdam dare volueris, quibus, vt curis publicis defatigatum animum relaxes, eam in naturæ, & artis myſterijs delectationem inuenis, quam in ludis, iociſq; alij quærerent. Huic accedit, quod in vrbe hoſpitium mihi aſsignaueris, ſtudijſque meis, & experimentis, quæ inſeruire potuerint, omnia ne expectanti quidem vltrò obtuleris. Taceo plura alia meritis meis longè maiora beneficia, quibus Tuum in me fauorem indies teſtari voluiſti.

Si facundiæ dono pollerem, laudum Tuarum commemoratione animum gratum oſtenderem, Anatomęq; ſimul, ac alijs artibus gratulando, Te omnium non modò beneuolum Mœcenatem, verùm

I do, indeed, interpret it as a great manifestation of your favor that in Italy, in Florence, in the palace[2] blooming with arts, O Prince, most renowned among men of letters the world over for your firm grasp of affairs, you have chosen to give me, a man from the North who scarcely rises above mediocrity in talent, some share in those hours in which you relax your mind, when, wearied by official responsibilities, you take that delight in the mysteries of art and nature which others would seek in games and pleasure. Moreover, you have given me hospitable reception in the city and have allotted me everything which might possibly be of service for my studies and experiments. You have freely accommodated me beyond my expectation. I pass over the many and greater kindnesses far beyond my merits by which from day to day you displayed your benevolence toward me.

If I had the gift of eloquence, I would show my gratitude by recalling your fame, by congratulating you on Anatomy and the other arts. I would demonstrate that you are, not only the beneficent Mæcenas of all,

rùm etiam peritiſsimum iudicem demonſtrarem. Sed nec in loquendi exercitio verſatus ego ſum, & ipſi artis magiſtri materiam hanc viribus ſuis ſuperiorem agnoſcunt, etiamſi in vnum omnia congerant, quæ de ſummis Mœcenatibus, de ſapientiſsimis Principibus ſeorſim a diuerſis celebrantur. Cum itaque alia grati animi indicia nulla mihi ſint, plantas imiter oportet, quarum fructus aëris clementiam, terræ liberalitatem facundo ſilentio loquuntur. In eum finem cum hiſtoriam Anatomicam non parùm auxerint, quæ mihi conceſsiſti aperienda varia animalia, præſens *Elementorum Myologiæ Specimen cum adiunctis illi duabus hiſtorijs anatomicis*, nomini Tuo inſcriptum, Tibi ſubmiſsè offero.

Volui eo ſpecimine oſtendere non poſſe in muſculo diſtinctè partes eius nominari, nec motum eiuſdem conſiderari feliciter, niſi Matheſeos pars Myologia fieret. Et quidni muſculis id daremus, quod Cœlo Aſtronomi, quod Terræ Geographi,

but even also the most expert critic. But I am not versed in the exercise of speaking. The masters of that art recognize that this matter is beyond their abilities, even if they should bring together into one all the things which are separately proclaimed by different people about the greatest benefactors and wisest Princes. Since I have no other token of my gratitude, it behooves me to imitate the plants whose fruits speak in silent eloquence of the mildness of the air and of the generosity of the earth. The various animals which you allowed me to dissect have contributed not a little to the description of anatomy. I now humbly present, dedicated to you, this *Specimen of Elements of Myology with two descriptions of anatomical dissections appended.*

I wished to demonstrate in this dissertation that unless Myology becomes part of Mathematics, the parts of muscles cannot be distinctly designated nor can their movement be successfully studied. And why should we not give to the muscles what Astronomers give to the sky, what Geographers to the earth,

Geographi, &, vt ex Microcoſmo exemplum adducam, quod oculis rei opticæ ſcriptores conceſſere? Res naturales mathematicè tractarunt illi, quo diſtinctior earum eſſet cognitio; & muſculos mathematicè explicandos illorum fabrica quadam quaſi neceſsitate poſtulat. Sed quid muſculis ea vendico, quæ toti corpori debentur? Organum eſt corpus noſtrum ex mille organis compoſitum, cuius veram cognitionem, qui abſq; Matheſeos ope inueſtigandam credit, ſine extenſione materiam, ſine figura corpus credat, oportet. Nec alia ſcaturigo eſt innumerabilium errorum, quibus humani corporis hiſtoria fœdè inquinatur, quàm quod Matheſeos leges Anatome hactenus indignata fuerit. Namq; dum legitimi principis imperium non agnoſcens, ſuo, ne dicam cœco arbitrio omnia adminiſtrauit, pro certis dubia, pro veris falſa, pro notis incognita nobis obtruſit; adeoq; eò rem tandem deduxit, vt homine nihil homini manſerit ignotiùs. Quam

benè

and, to take an example from microcosm, what writers on optics concede to the eyes? These writers treat natural things mathematically so that they may be more clearly understood. The structure of the muscles requires almost necessarily that they be explained mathematically. But why do I claim for the muscles alone what is due to the entire body? Our body is an organism composed of a thousand organs. Whoever thinks that its true understanding can be sought without Mathematical assistance must also think that there is matter without extension, and body without figure.[3] Nor is there any other cause of the many errors which have foully defiled the description of the human body than that Anatomy has hitherto disdained the laws of the Mathematics. For, while ignorant of the rule of the legitimate prince,[4] in its, may I not say, blind judgment, Anatomy has governed all things; it has thrust on us the dubious for the certain, the false for the true, the unknown for the known. Anatomy finally has brought the matter to such a point that nothing remains more unknown to man than man himself.

benè nobis, quam benè toti humano generi conſuluiſſent maiores noſtri, ſi, qui totam ætatem in exercitijs anatomicis contriuere, non niſi ſola certa poſteritati tradidiſſent. Minùs ampla eſſet cognitio noſtra, ſed & minùs periculoſa: & ſi certis hiſce principijs innixa Medicina dolores ægris non tolleret, non adderet illis nouos. Modò vaſtiſsima habemus Anatomes, & Medicinæ volumina: nihilominus inter mille cruciatus miſeram animam trahimus, per mille tormenta ad mortem etiam ſiccam tendimus; &, quæ ſumma noſtra infelicitas eſt, ſæpe cum prodeſſe credimus, tum demum maximè nocemus. Dum communem miſeriam deplorando cauſam eius expono, remedium a me nullum promitto, ab alijs cum tempore inueniendum ſpero. Et quidni magna ſperare liceret, ſi eò reduceretur Anatome, vt in ſolis certis experientia, in ſolis demonſtratis ratio acquieſceret, id eſt, in Matheſeos verba Anatome iuraret? Sed alios, qui mente, manuque plus

How fortunate it would have been for us, how fortunate for all human kind, if our ancestors had decreed that those who spent a life time in the study of Anatomy would pass on to posterity only that which is well established. Our knowledge would not be so wide but it would be less hazardous. And if Medicine, based on these established principles did not relieve the sick of their pain, it would not add to this pain. Now we have enormous books on Anatomy and Medicine. Nevertheless, we drag the wretched sufferer among thousand tortures, we even drive him to a thirsty death through a thousand torments. Our greatest misfortune is that often when we deem to be helpful, then indeed we are most harmful. While deploring this common misery, I expose its cause, but I do not promise any remedy of my own. I hope that in time one will be discovered by others. And why would it not be permitted to hope for great things, if Anatomy was transformed so that experimental knowledge would rely only on well established facts and reason accepted only what has been demonstrated; in other words, if Anatomy used the language of Mathematics. But this work remains for others,

plus valent, hic labor manet: ego breuiori gyro circumſcriptus in muſculis periculum facere volui; vbi noua methodo veram eorum fabricam expono, contractioniſque modum per ſpirituum inflationem a pleriſque hactenus expoſitum, incerto fundamento ſuperſtructum demonſtro.

Quod ſi in hoc nouo auſu exſpectationi minùs ſatisfecero, in herba adhuc eſt ſcientia illa, & ab vlteriori inueſtigatione, ſtudioq; ſi non maturitatem, ſaltem incrementa exſpectat; idque ſelici admodum augurio, quandoquidem Tuę manus primæ ſint, quibus ſe teneram, blandè tractari lætatur. Vale Sereniſsime Princeps, & diù incolumis viue, diù feliciter regna.

NICOLAI

abler in mind and hand than I. Limiting myself to a short incursion in muscles, I wished to make an attempt. I expose there their true structure by a new method and I demonstrate that the mode of contraction through inflation of spirits such as proposed by the majority hitherto is built on a very shaky foundation.

But if in this new bold undertaking I shall have given little satisfaction to your expectation, this knowledge is still in the seedling stage and expects increments at least, if not maturity, from further investigation and study. This is of a good omen since this tender knowledge delights in being treated gently by your hands first. Farewell, Most Serene Prince! Live long unharmed, reign happily for many years to come.

NIELS

NICOLAI STENONIS
ELEMENTORVM MYOLOGIÆ
SPECIMEN.

EX quo nouam fibræ motricis fabricam experientia detexit, non modò in ſingulis iam tum cognitis muſculis a nemine hucuſque conſiderata illorum fabrica innoteſcere cœpit, ſed etiam aperta via eſt ad illorum muſculorum inueſtigandam cognitionem, quos nemo hactenus nec præparare dextrè, nec diſtinctè potuit explicare. Triennium ferè eſt, ex quo in corde, lingua, œſophago alijſque nonnullis leue eius ſpecimen edidi, ſed ſine figuris: modò in alijs, tum ante notis muſculis, tum hactenus quaſi incognitis, per figuras idem illuſtrabo, eum in finem hìc adducendas, vt pateat *muſculorum ſyſtema geometricum*, quod hìc propoſiturus ſum, non eſſe ab ingenio confictum, ſed ab experientia depromptum.

Et hoc quidem paruulum quoddam *Elementorum*

NIELS STENSEN'S SPECIMEN OF [5]ELEMENTS OF MYOLOGY

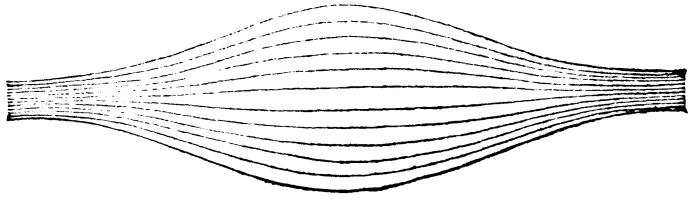
SINCE experience revealed a new structure of the motor fiber, the structure of the muscles, so far not considered by anybody in the different muscles already known, begins to be recognized, but a way is also open for an investigation of those muscles, which in the past nobody could prepare properly nor explain clearly. Almost three years ago I published a Specimen[6] on the muscles of the heart, tongue, oesophagus, and some other organs, but without illustrations. I will now illustrate it with figures, partly of already known, partly of unknown muscles. These illustrations are shown here with the aim of making clear that the *geometrical structure of the muscles* which I am to propose is not just an artefact, but is derived from experience.

This thus will be a small *Specimen of Elements of Myology.*

myologiæ Specimen erit ; quod ſi publico non diſplicuerit, data occaſione integram ad noua hæc principia reformandam muſculorum hiſtoriam aggrediar ; cum nullus ſit muſculus, de quo non peculiare quid poſſit afferri, plurimi verò dentur, de quibus non niſi pauca admodum hactenus dicta ſunt. Sed & oſſium vera fabrica nec dum ab vllo tentata, tendinum continuatione ſecundum haſce obſeruationes facilis ſimul, & manifeſta euadet.

Deſideraui iam tum ſæpiùs illi me labori ſeriò accingere: ſed tantùm mihi tribuere nunquam volui, vt, quod mihi hæc arriderent, reliquis accepta futura crederem. Cœcus amor prolis veteri verbo dicitur, & frequenti experientia conſtat, alijs omnibus diſplicuiſſe ſæpe, quæ ipſis Autoribus maximè placuere.

Muſculi Syſtema antiquum. Muſculi fabricam hìc appoſita figura explicuere hactenus multi tum Philoſophi, tum Anatomici.



De ea in præſens nihil dicam, niſi quòd Autoribus notiſſima Naturæ omnino ſit incognita. Mihi viſum tutiſſimum eo modo fabricam muſculorum repræſentare, quo in multis ſimplicibus muſculis eam inuenio,

If it does not displease the public, on some occasion I intend to give a complete description of the muscles according to these new principles. There is no muscle of which there cannot be said anything specific. Of many only very little has been said so far. But also the true structure of the bones, as yet studied by no one, will altogether emerge easily and clearly from these observations, since the tendons are inserted in the bones.

I have often desired to undertake this work. But I would never pretend that what pleases me should be accepted by all others. According to an old saying, love makes people blind to their own progeny, and it is a frequent experience that what displeases other people is often what pleases authors most.

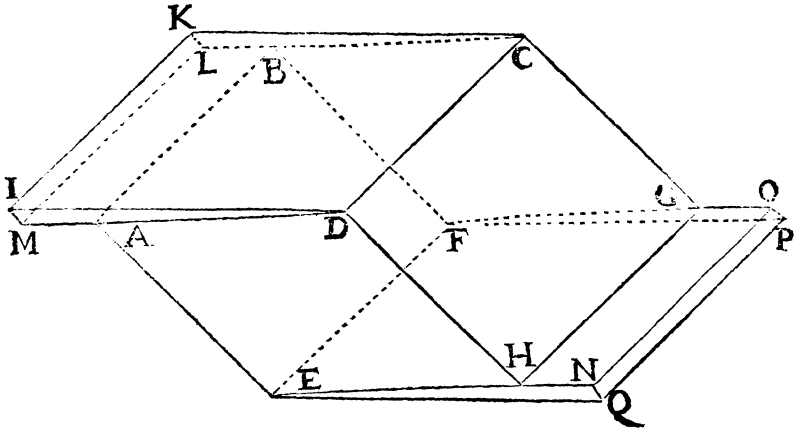
The structure of muscles in antiquity.

Hitherto philosophers as well as anatomists have explained the structure of the muscles according to the illustration.

At present I shall say nothing about this figure, except that what is best known to Authors is totally unknown to Nature. It seems to me most trustworthy to represent the structure of muscles the way I found it in many simple muscles,

inuenio, & in omnibus compoſitis me demonſtraturum ſpero.

Huic fundamento innixus muſculum repræſento per *fibrarum motricium collectionem ita conformatam, vt mediæ carnes parallelepipedum obliquangulum conſtituant, tendines verò oppoſiti duo priſmata tetragona componant.* *Muſculi Syſtema nouum.*



ABCDEFGH eſt parallelepipedum carnium, DAMICBLK, EHNQFGOP duo priſmata tetragona tendinum.

Videor mihi videre multos, qui ad prima hæc verba pedem figentes, nouam muſculi fabricam, nouam chimæram pronuntiaturi ſunt. Sed illos ego perhumaniter rogatos volo, donec totum diſcurſum peruoluerint, ſententiam ſuſpendere ne recuſent. Agnoſcent enim me Naturæ veſtigijs inſiſtentem, ſine neceſſitate nihil attuliſſe.

and I hope to demonstrate it in all compound muscles.

Relying on this basis I represent a muscle as *a collection of motor fibers arranged so that the flesh in the middle forms an oblique parallelepiped and the tendons form two opposite tetragonal prisms.*

The new muscle structure.

A B C D E F G H is the flesh parallelepiped, D A M I C B L K and E H N Q F G O P are the two tetragonal tendon prisms.

I can imagine that a number of people will stop after these introductory remarks and decide that this new muscle structure is just a new chimera. But I hope that these people will be kind enough to wait until they have read the entire dissertation before expressing their opinion. They will indeed realize that I follow the track of Nature closely, presenting nothing unnecessary.

Quò diſtinctiùs hæc muſculi conformatio intelligatur, terminorum omnium explicationes, vt à Geometris fieri ſolet, ordine Synthetico, & definitionum titulo proponam, à fibra motrice incipiendo.

DEFINITIONES.

Fibra motrix. 1. *FIBRA MOTRIX eſt minutiſsimarum fibrillarum ſibi mutuò ſecundum longitudinem immediatè iunctarum certa compages, cuius intermedia pars ab extremis differt conſiſtentia, craſsitie, & colore, & ab intermedia parte vicinarum fibrarum motricium ſeparata eſt per tranſuerſas fibrillas propriæ muſculorum membranæ continuas.* Fibram motricem repræſentat figura 1. Tab. 1. vbi B C intermedia eius pars eſt, A B, C D partes extremæ. Quicquid in hac deſcriptione proponitur, in quolibet noſtri corporis muſculo demonſtrari poterit.

Cur motrix dicatur. Motricem eam appello, quòd mihi videatur verum motus animalis organum; muſculus enim, cui illud hactenus datum nomen eſt, non eſt niſi talium fibrarum certa collectio, id, quod eius analyſis ſenſibus oſtendit, nec agit, niſi dum ſingulæ harum fibrarum agunt, id quod viuorum ſectio demonſtrat.

Dum fibram motricem verum motus animalis organum appello, non determino, an illa eius pars, quæ breuior fit, in ſe ipſa coeat, an verò tranſuerſim per eam incedentes fibrillæ illam criſpando breuiorem reddant, alioue quocunque demum modo contractio

In order to understand the composition of the muscles more clearly, I put together a list of explanations of all the terms used, in the form of definitions, as the geometricians usually do and I shall begin with the motor fiber.

DEFINITIONS.

The motor fiber.

1. *A MOTOR FIBER is a definite structure of very tiny fibrils, immediately joining together lengthwise. Its intermediate part differs from its extremities in consistency, thickness and color, and is separated from the intermediate part of the adjacent motor fibers by transverse fibrils continuing into the aponeurosis.* Fig. 1 in Plate I represents a motor fiber. B C is the intermediate part, and A B and C D are the extreme parts. What is proposed in this description can be demonstrated in any muscle of our body.

Why it is called motor.

I name this fiber motor, because it seems to me to be the true organ of the movement of an animal. The entire muscle which hitherto was given this name is nothing else than a well-determined collection of such fibers as its analysis shows to the senses. The muscle does not act unless its single fibers act, as dissecting living animals demonstrates.

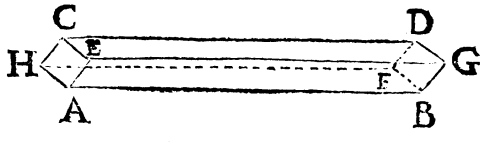
When I name the motor fiber the true organ of the movement of an animal, I do not determine whether that part, which shortens is shortened in itself,

contractio peragatur : quicquid enim horum contigerit, fibra motrix potiùs, quàm muſculus, motus animalis organum appellanda eſt.

Dum fibrillas immediatè iunctas dico, non talem intelligo earum contactum, quo omne fluidum intermedium excluditur, adeoque fibrillæ iſtæ continuæ potiùs, quàm contiguæ fierent; Sed qualem in rebus mechanicis videmus, cum duo cubi, aliaue duo corpora quæcunque ſibi mutuò immediatè imponi dicuntur, etiamſi ambiens fluidum non in totum excludatur. Sic duo ſpecula plana, quæ madida ſunt, immediatè ſibi imponi dicuntur, etiamſi vtriuſque ſpeculi ſuperficiem intermedia aqua ſeparet, quantulacunque demum ea aqua fuerit, immediata hæc impoſitio immediatus contactus dicitur, quòd nullum aliud ſolidum intermedium ſit. *Quomodo fibrillæ immediatè iunctæ intelligantur.*

2. *CARO eſt intermedia pars fibræ motricis tranſuerſis fibrillis membranoſis circumdata, mollis, lata, craſſa, colore in variis animalibus vario, in multis enim rubicunda eſt, in alijs cinericea, in quibuſdam alba.* Memini me in eodem Cuniculi pede, & albos muſculos, & rubros vidiſſe: de carne cruda loquor, cùm cocta in pleriſque alba ſit. *Caro.*

3. *Repreſentari poterit per parallelepipedum* A B C D, *cuius plana extrema* A C, B D, *ſcilicet ea*, *Carnis Syſtema.*



qu.e

or whether it is crimped by fibrils going transversely through it, or whether the contraction is carried out in any other way. Whatever of these occurs, the motor fiber rather than the muscle is what must be termed the animal's organ of movement.

How to understand that fibrils lie in immediate contact.

When I say that fibrils are joined immediately together, their close contact excludes all fluid in between. These same fibers would be continuous rather than contiguous. But we see such a phenomenon in mechanics, when two cubes, or any other two bodies, are said to be superimposed in whatever way immediately one upon the other, even if ambient fluid is not totally excluded. Thus two plane mirrors, which are moistened, are said to be superimposed immediately one on the other, even though water in between separates their surfaces. Whatever small amount of water may be in between, they are said to be in immediate contact because nothing solid is in between.

The flesh.

2. *THE FLESH is the intermediate part of the motor fiber surrounded by transverse membranous fibrils. The flesh is soft, of a certain width and thickness, and it has different colors in different animals, reddish in many, grey in others, and even white in some.* I remember having seen both red and white muscles in the same paw of a rabbit. I am here speaking of raw flesh, since most meat whitens when cooked.

Structure of the flesh.

3. *THE STRUCTURE OF THE FLESH could be represented by a parallelepiped* A B C D, *whose end surfaces* A C *and* B D,

quæ tendinibus continua ſunt, obliquos angulos cum planis tranſuerſis E D, A F *comprehendunt, plana verò lateralia* E B, C F *recta ſunt & ad plana extrema* A C, B D, *& ad plana tranſuerſa* E D, A F. Naturali maiorem hanc figuram expreſſi, quò diſtinctiùs plana eius conſpicerentur.

Tres in carnis Syſtemate difficultates.

Tres hìc moueri poſſunt difficultates: primò, quòd extremitates carnis tendinibus continuas, planas dixerim; ſecundò quòd plana lateralia ad reliqua quatuor plana recta ſuppoſuerim; tertiò quòd plana tranſuerſa ad plana extrema voluerim inclinata.

Reſpõdetur omnibus ſimul.

Potuiſſem vnica reſponſione omnibus ſatisfacere, dicendo, me ſolam fibram regularem, aliarum omnium normam, hìc deſcribere, quod mihi non minus liceret, ac alijs omnibus, qui difficultates, quæ in rebus compoſitis, & minus ordinatis occurrunt, per ordinatas, & ſimplices explicant: Sed ne quid ſine ratione attuliſſe videar, ſingulis obiectionibus ſeorſim reſpondebo, dictorum meorum fundamentum, experientiam allaturus.

Reſpõdetur primæ difficultati de planis extremis.

Itaque quod extrema carnis ſpectat, memini me in Galli Africani pede ſemel vidiſſe carnes, neſcio quo morbo, liberatas ab expanſione tendinoſa, vbi carnium extrema eodem modo plana mihi apparuere, quo mediæ carnes tranſuerſim diſſectæ planæ conſpiciuntur, ſed & in coctis, vbi à carne ſeceſſit tendo, extrema carnium plana videntur.

Quod ad plana lateralia, fateor eſſe carnes tenues

i.e., those which continue into tendons, form oblique angles with the transverse surfaces E D *and* A F, *whereas the lateral surfaces* E B *and* C F *form right angles with both the end surfaces* A C *and* B D, *and with the transverse surfaces* E D *and* A F. In order to show their surfaces more clearly, I have drawn them larger than nature.

Three objections concerning the structure of the flesh.

Three objections may arise here: First, I say that the extremities of the flesh, which continue into the tendons, are plane; Second, I supposed that the lateral surfaces form right angles with the other four surfaces; Third, I have determined that the transverse surfaces are inclined on the end surfaces.

Answer to all objections together.

I could give one answer to meet all three objections, just by saying that I describe here one regular fiber as a norm for all other fibers, which would be no less permissible for me than for all the others, who explain problems in complex and extraordinary things by means of ordinary and simple examples. But in order not to be considered as presenting something without giving a reason, I will answer each of the three objections separately by reporting the experiment which is the foundation of what I say.

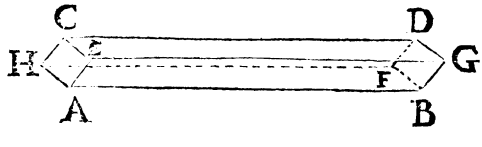
Answer to the first objection concerning the end surfaces.

Thus, concerning the end surfaces of the flesh, I remember having seen once in the leg of a turkey-cock, after I do not know what disease,[7] that the flesh had parted from the tendon expansion; the end surface of the flesh appeared to me to be flat, as they are seen when the middle of the flesh has been cut transversely. But also in boiled meat, when the tendon parts from the meat, the end surfaces of the flesh appear flat.

nues admodum, vt non poſſit certò eorum ad plana tranſuerſa determinari ſitus, ſed cum in multis locis videamus in collectionibus carnium plana lateralia ad plana tranſuerſa eſſe perpendicularia, poterit non ſine ratione, ſingulis carnibus eaſdem collectiones conſtituentibus, ſimilis dari planorum ſitus. In planis extremis multorum muſculorum exemplo manifeſtè demonſtratur, recta eſſe ea ad plana lateralia, vt adeòque facilè admitti poſſit, plana lateralia ad reliqua quatuor plana eſſe recta. *Reſpõdetur ſecũdæ difficultati de planis lateralibus.*

Quod verò angulos obliquos attinet, plana extrema cum planis tranuerſis obliquos angulos comprehendere euidentibus experimentis conſtat, & in ipſis extremitatibus carnium à tendinibus liberatarum, & in medijs carnibus diſſectis per planum planis extremis parallelum. *Reſpõdetur difficultati tertiæ de angulis obliquis.*

Nollem tamen Lectori imponere, ac ſi omnes omnium animalium muſculos examinaſſem, adeoque certò crederem, vbique talem eſſe planorum inter ſe in omnium carnibus ſitum, qualem modò eum deſcripſi: quocirca id duntaxat certò hic affirmo me in plurimis talem deprehendiſſe; id quod ſufficit ad demonſtrandum ſimplicem hanc, & regularem carnis fabricam, reliquarum menſuram gratis a me non afferri.



4. *Ex definitione parallelepipedi carnoſi demonſtratur, plana* *Qualia carnis plana?*

With regard to the lateral surfaces, I admit that the flesh is so extremely delicate that it is not possible to determine with any certainty its location in relation to the transverse surfaces. But, since in lumps of meat we see at many places the lateral surfaces as perpendicular to the transverse surfaces, it is not without reason then to assume the same relation of the surfaces in the single parts constituting these lumps of meat.[8] The end surfaces of many muscles are clearly demonstrated to be at right angles with the lateral surfaces, so it can be easily admitted that the lateral surfaces form right angles with the other four surfaces.

Answer to the second objection concerning the lateral surfaces.

As far as the oblique angles are concerned, experiments obviously show that the end surfaces form oblique angles with the transverse surfaces. This appears at the extremities of the flesh freed from tendons, as well as in the middle of the flesh when cut through a plane parallel to the end surfaces.

Answer to the third objection concerning the oblique angles.

However, I do not wish to impose on the reader the impression that I have examined all muscles in all animals and that I believe for certain that the position of the surfaces in relation to each other is everywhere such as I have described. I claim only with certitude to have found this position of the surfaces in many cases. The demonstration of this simple and regular structure of the flesh is based on these observations. It is thus not without reason that I propose it as a model for all others.

4. *According to the definition of the parallelepiped of*

How are the surfaces of the flesh?

plana lateralia E B, C F, *eſſe obliquangula, plana verò tranſuerſa* E D, A F, *& plana extrema* A C, B D *eſſe rectangula.*

Vt horum planorum latera diſtinctè proponantur,

Latera carnoſa carnis. 5. *LATERA CARNOSA illa dico, quæ planis tranſuerſis cum planis lateralibus communia ſunt:* vt A B, & reliqua illi parallela.

Latera tẽdinoſa carnis. 6. *LATERA TENDINOSA, quæ planis extremis cum planis lateralibus communia ſunt:* vt E A, & reliqua illi parallela.

Latera tranſuerſa carnis. 7. *LATERA TRANSVERSA, quæ planis tranſuerſis cum planis extremis communia ſunt:* vt E C, & reliqua illi parallela.

Longitudo carnis. 8. *LONGITVDO CARNIS eſt recta inter plana eius extrema lateribus carnoſis parallela, adeoque iiſdem æqualis:* vt *A B.*

Latitudo carnis. 9. *LATITVDO CARNIS eſt diſtantia inter plana lateralia, adeoque æqualis lateri tranſuerſo, B F.*

Craſſities carnis. 10. *CRASSITIES CARNIS eſt diſtantia inter plana tranſuerſa.*

Tendo. 11. *TENDO eſt extrema pars fibræ motricis, tenuis, dura, alba,* cum vtraq; fibræ motricis extremitas eiuſdem ſit conſiſtentiæ, & coloris, vtramque tendinem appellabo, ligamenti voce illi tendinum parti relicta, quæ inter duo oſſa fertur.

Planum fibræ motricis. 12. *Oppoſiti tendines* K M, I N *in eadem fibra motrice* M K, I N, *cum ſint in plano* M N, *quod planis lateralibus* A G, H D *parallelum plana tranſuerſa* C G, H B

flesh it appears that the lateral surfaces E B *and* C F *have oblique angles, while the transverse surfaces* E D *and* A F, *and the end surfaces* A C *and* B D *are rectangles.*

In order to define the edges of these surfaces I propose:

Lateral edges of the flesh.

5. I call *FLESH EDGES those edges shared by the transverse and the lateral surfaces*, such as A B and its parallels.

Tendon edges of the flesh.

6. *THE TENDON EDGES are those edges shared by the end surfaces and the lateral surfaces*, such as E A and its parallels.

Transverse edges of the flesh.

7. *THE TRANSVERSE EDGES are those edges shared by the transverse surfaces and the end surfaces*, such as E C and its parallels.

Length of the flesh.

8. *THE LENGTH OF THE FLESH is the line between the end surfaces and parallel to the lateral edges of the flesh and thus equal to these*, such as A B.

Width of the flesh.

9. *THE WIDTH OF THE FLESH is the distance between the lateral surfaces and thus equal to the transverse edge,* B F.

Thickness of the flesh.

10. *THE THICKNESS OF THE FLESH is the distance between the transverse surfaces.*

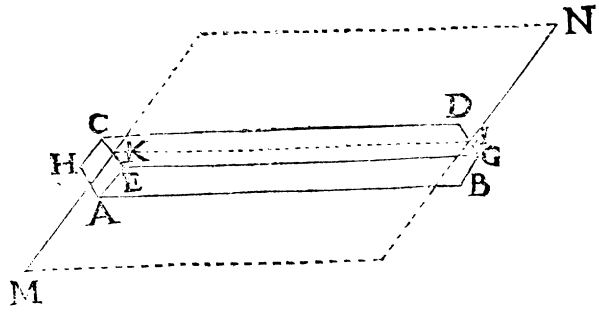
Tendon.

11. *THE TENDON is the extreme part of the motor fiber*; it is thin, hard and white. Since both ends of a motor fiber have the same consistency and color, I will call both of them tendons, while I call ligament the remaining of the tendons which joins two bones.

Plane of the motor fiber.

12. *The two opposite tendons* K M *and* I N *in the same motor fiber* M K, I N *are in the same plane* M N, *which is parallel to the lateral surfaces* A G *and* H D *and divides the transverse surfaces* C G

H B *bifariam ſecat, hoc planum* M N, *dici poterit* *PLANVM FIBRAE MOTRICIS.*



13 *FIBRA MOTRIX INFLEXA dicitur, cum in plano fibræ motricis* M N, *tendines* K M, I N, *verſus carnem* H G, *ad angulos obtuſos* M K I, K I N, *inflectuntur, qua parte plana extrema* C A, D B, *cum planis tranſuerſis* C G, H B, *acutos angulos* E A B, B G E *comprehendunt*. Idem etiam exhibet Tab. 1. Fig. 2. vbi Tendines A B, & C D verſus carnem B C inflexi, cum ea angulos alternos A B C, D C B, obtuſos conſtituunt. *Fibra motrix inflexa.*

14 *FIBRA MOTRIX RECTILINEA dicitur, cuius caro in rectam lineam extenſa*. De curuilinea, cuius caro incurvata eſt, hìc nullus eſt agendi locus, cum non niſi muſculo rectilineo explicando neceſſariæ definitiones hìc afferantur. *Fibra motrix rectilinea.*

15 *FIBRAE MOTRICES AEQVALES INTER SE ſunt, quæ totæ inter ſe ſunt æquales.* *Fibræ motrices æquales inter ſe.*

16. *FIBRAE MOTRICES AEQVALITER AEQVALES INTER SE ſunt, quarum caro æqualis eſt* *Fibræ motrices æqualiter æquales inter ſe.*

and H B *in two. This plane* M N *can be called THE MOTOR FIBER PLANE.*

13. *A motor fiber is said to be INFLECTED, when in the motor fiber plane* M N, *the tendons* K M *and* I N *are inclined on the flesh* H G *at obtuse angles* M K I and K I N, *whereas the end surfaces* C A *and* D B *form acute angles* E A B *and* B G E *with the transverse surfaces* C G *and* H B. This is also shown in Plate I, Fig. 2, in which the tendons A B and C D are inflected towards the flesh B C, both tendons forming obtuse alternate angles A B C and D C B with the flesh. *Inflected motor fiber.*

14. *A motor fiber is said to be RECTILINEAR when the flesh of the motor fiber forms a straight line.* Curvilinear fiber, the flesh of which is bent into curves will not be dealt with here, since the definitions given here apply only to the rectilinear muscle. *Rectilinear motor fiber.*

15. *EQUAL*[9] *MOTOR FIBERS are those which are equal to each other in all respects.* *Equal motor fibers.*

16. *EQUALLY EQUAL*[10] *MOTOR FIBERS are fibers, the flesh of which is equal,* *Equally equal motor fibers.*

carni, & tendines ſinguli vnius, ſingulis tendinibus alterius ſunt æquales, ſi ſumantur qui ſibi mutuò reſpondent.

Fibræ motrices inæqualiter æquales.

17. *FIBRAE MOTRICES INAEQVALITER AEQVALES ſunt, quarum caro carni æqualis eſt, & tendines vnius ſimul ſumpti, æquales tendinibus alterius ſimul ſumptis, ſed tendines ſinguli vnius, cum tendinibus ſingulis alterius collati, inter ſe ſunt inæquales*, vt in Tab. 1. Fig. 3. vbi nouem fibræ motrices repræſentantur inæqualiter æquales.

Fibræ motrices ſecundum tendinum exceſſum diſpoſitæ.

18. *FIBRAE MOTRICES INAEQVALITER AEQVALES SECVNDVM TENDINVM EXCESSVM DISPOSITAE dicuntur, cum ſinguli tendines, qui ad eaſdem partes ſunt, ſe mutuò æqualiter excedunt*; vt in Tab. 1. Fig. 3. Tendines omnes in ſpatio B A E F, quemadmodum etiam omnes tendines ab altera parte in ſpatio D C G H, ſe mutuò æqualiter excedunt.

Ordo.

19. *ORDO eſt ſeries fibrarum motricium rectilinearum, inæqualiter æqualium, ad eoſdem angulos inflexarum & ſecundum tendinum exceſſum diſpoſitarum, qua carnes carnibus ſecundum plana tranſuerſa, tendineſque tendinibus eo modo immediatè imponuntur, vt omnium carnium latera tendinoſa ſint in ijſdem duabus rectis.*

Quò diſtinctiùs intelligeretur Ordinis compoſitio, Tab. 1. tres adduxi figuras, ſcilicet 3. 4. & 5. Figura tertia exhibet fibras motrices rectilineas inæqualiter æquales, & ſecundum tendinum exceſſum diſpoſitas. Figura 4. exhibet eaſdem fibras motrices, æqualiter vtrinque inflexas, ſed necdum vnitas.

and the corresponding tendons of which are equal.

Unequally equal motor fibers.

17. *UNEQUALLY EQUAL MOTOR FIBERS are fibers the flesh of which is equal and the tendons taken together are equal, while the individual tendons of one muscle compared with the individual tendons of the other are unequal*, as in Plate I, Fig. 3, which shows nine unequally equal fibers.[11]

Unequally equal motor fibers arranged according to the increment of the tendons.

18. *UNEQUALLY EQUAL MOTOR FIBERS ARE SAID TO BE ARRANGED ACCORDING TO THE INCREMENT OF THE TENDONS when the single tendons which are on the same side exceed each other by an equal amount* as in Plate I, Fig. 3. All the tendons in the space B A E F as well as those in the space D C G H on the other side increase by equal increments.

The Order.

19. *An ORDER*[12] *is a series of rectilinear motor fibers unequally equal inflected at the same angle and arranged according to the increment of the tendons in such a way that flesh parts are set upon flesh parts at the transverse surfaces, and the tendons set upon tendons directly so that all the tendon edges of the flesh parts form the same two straight lines.*

To understand better the compound nature of the Order, I displayed in Plate I three more illustrations, Figs. 3, 4, and 5. Figure 3 shows the rectilinear, unequally equal motor fibers, arranged according to the increment of the tendons. Figure 4 shows the same motor fibers equally inflected on both sides, but not yet united.

tas. Figura 5. exhibet eaſdem iam vnitas, vbi inter carnes relicta ſpatia ſunt maioris perſpicuitatis gratia. F B, G C, ſunt illæ duæ rectæ, in quibus ſunt extrema carnium.

Potuiſſem in ſolido Ordinis parallelepipedum carnium, & tendinum oppoſitorum priſmata deſcribere, ſed cum mihi animus ſit ad oſtentationem nihil, ad vſum omnia accommodare, illa ſola deſcribo, quorum vſus in ſequentibus neceſſarius erit.

20. *Ex definitione ordinis demonſtratur, omnium fibrarum motricium plana in idem planum* A H *coincidere, id quod planum ORDINIS APPELLO, vbi oppoſiti tendines duo trapezia Scalena* A B F E, H G C D, *carnes verò parallelogrammum obliquangulum* F C *conſtituunt, comprehenſum ſub latere carnoſo* F G, *& recta* G C, *compoſita ex lateribus tendinoſis omnium carnium, quam rectam itidem LATVS TENDINOSVM appello.* Pro maiore, vel minore numero fibrarum motricium, ordinem componentium, parallelogrammum carnium modò Rhombus eſt, modò Rhomboides. *Planum Ordinis.* *Tab. I. F. 5*

21. *ALTITVDO ORDINIS eſt diſtantia inter latera tendinoſa* G C, F B. *Altitudo Ordinis.*

22. *CRASSITIES ORDINIS eſt diſtantia inter latera carnoſa* F G, B C, *quam æqualem eſſe craſsitiebus carnium ſimul ſumptis ex ordinis definitione patet.* *Craſſities Ordinis.*

23. *ORDINES SIMILES ſunt, quorum parallelogramma inter ſe ſimilia ſunt.* *Ordines ſimiles.*

24. *Cum duo ordines inter ſe conferuntur, LATERA carnoſa* *Latera homogenea ordinum.*

Figure 5 shows the same, now with the fibers united, in which, however, spaces have been left between the flesh parts in the illustration for more clarity. F B and G C are the two straight lines at each end of the flesh.

I could have described the parallelepiped of flesh and the attached prisms of the opposite tendons in a solid [three-dimensional] Order. However, I do not intend to introduce anything here just to impress and every thing must have a purpose. For this reason I describe those matters alone which will necessarily be used in what follows.

Plane of the Order. Plate I, Fig. 5. [page «226»]

20. *From the definition of the Order it follows that the planes of all the motor fibers coincide with the same plane* A H, *which I call THE PLANE OF THE ORDER, in which the opposite tendons form two scalene trapezia* A B F E *and* H G C D, *while the flesh parts form an oblique parallelogram* F C *comprehended by the flesh edge* F G *and the straight line* G C *formed by the tendon edges of all the flesh parts. I, therefore, call this line the TENDON EDGE.* Depending on the larger or smaller number of constituent motor fibers forming an Order, the flesh parallelogram may acquire the form of a rhombus or of a rhomboid.

Height of the Order.

21. *THE HEIGHT OF AN ORDER is the distance between the tendon edges* G C *and* F B.

Thickness of the Order.

22. *THE THICKNESS OF AN ORDER is the distance between the flesh edges* F G *and* B C, *which, according to the definition of the Order, is equal to the sum of the constituent motor fibers' thicknesses.*

Similar Orders.

23. *SIMILAR ORDERS are Orders the parallelograms of which are similar.*

Homogeneous edges of Orders.

24. *When comparing two Orders, THE EDGES of flesh are* said to be

carnoſa carnoſis, tendinoſa tendinoſis HOMOGENEA dicuntur, ſi ſumantur ea, quæ ſimiliter ſita ſunt.

Ordo compoſitus. 25. ORDO EX ORDINIBVS COMPOSITVS dicitur, cum plurium ordinum plana in eodem plano ſunt ſibi mutuò iuncta.

Verſus. 26. VERSVS eſt ſeries fibrarum motricium rectilinearum æqualiter æqualium, & ad eoſdem angulos inflexarum, qua cum plana fibrarum motricium inter ſe parallela ſint, carnes carnibus ſecundum plana lateralia eo modo immediatè imponuntur, vt latera tranſuerſa omnium carnium ſint in ijſdem rectis.

Quot, & qualia in verſu plana. *Tab. 1. F. 6.* 27. Ex compoſitione patet, eſſe in verſu I D, tria diſtincta plana rectangula, quorum intermedium K C, eſt RECTANGVLVM CARNIVM, extrema I B, L D, ſunt RECTANGVLA TENDINVM.

Rectangulũ carnium. 28. RECTANGVLVM CARNIVM K C comprehenditur ſub latere carnoſo B C, & recta C L, compoſita ex lateribus tranſuerſis omnium carnium, quam rectam itidem LATVS TRANSVERSVM appello.

Latitudo verſus. 29. LATITVDO VERSVS eſt diſtantia inter latera carnoſa B C, K L, quam æqualem latitudinibus ſingularum carnium ſimul ſumptis ex definitione verſus demonſtratur.

Verſus inæqualiter æquales. 30. VERSVS INAEQVALITER AEQVALES ſunt, quorum rectangula carnium æqualia inter ſe ſunt, & duo rectangula tendinum vnius verſus ſimul ſumpta æqualia duobus rectangulis tendinum alterius verſus ſimul ſumptis, ſed ſingula rectangula tendinum vnius cum ſingulis rectangulis tendinum alterius collata inter ſe ſunt inæqualia.

Duplex

HOMOGENEOUS, and the EDGES of the tendons are said to be HOMOGENEOUS, when considering edges which are in similar positions.

Compound Order.

25. *An ORDER is said to be COMPOUND when the surfaces of several Orders are mutually joined to each other in the same plane.*

The Rank.

26. *A RANK is a series of equally equal rectilinear motor fibers inflected at the same angle. The planes of the motor fibers are parallel. The flesh parts are set immediately upon flesh parts along the lateral surfaces of the motor fibers in such a way that the transverse edges of all flesh parts are on the same straight lines.*

How many and what surfaces are in a Rank. Plate I. Fig. 6.

27. *From its composition it is clear that in the Rank* I D *there are three distinct rectangular surfaces the middle one of which* K C *is THE RECTANGLE OF FLESH PARTS, while the end surfaces* I B *and* L D *are THE RECTANGLES OF THE TENDONS.*

The rectangle of flesh parts.

28. *THE RECTANGLE OF FLESH PARTS* K C *is delineated by a flesh edge* B C *and a straight line* C L *made of the transverse edges of all flesh parts. I call this straight line THE TRANSVERSE EDGE.*

Width of the Rank.

29. *THE WIDTH OF A RANK is the distance between the flesh edges* B C *and* K L, *which, according to the definition of the Rank, is equal to the sum of the widths of all the single flesh parts.*

Unequally equal Ranks.

30. *UNEQUALLY EQUAL RANKS are such ranks in which the rectangles of flesh parts are equal, while the sum of the two tendon rectangles of one rank is equal to the sum of the two tendon rectangles of the other rank, but the individual tendon rectangles of one rank are unequal to those of the other rank.*

Duplex muſculi afferri poterit deſcriptio, prout conſideratur vel ex ordinibus, vel ex verſibus conformatus.

31. *MVSCVLVS ſimplex rectilineus eſt corpus compoſitum ex pluribus ordinibus æqualibus, ſimilibus, parallelis inter ſe, & ſibi mutuò immediatè ita impoſitis, vt toti ordines totis ordinibus congruant.* *Muſculus vt ex ordinibus componitur.*

32. Vel *MVSCVLVS eſt corpus compoſitum ex verſibus inæqualiter æqualibus, ſimilibus, & ſecundum exceſſum tendinum diſpoſitis, vbi carnes carnibus, tendineſque tendinibus eo modo immediatè imponuntur, vt toti verſus totis verſibus congruant.* *Muſculus, vt ex verſibus componitur.*

33. *Ex definitionibus patet, quocunque modo componatur muſculus, eſſe in eo vnum parallelepipedum carnium & duo priſmata tetragona tendinum, quo modo ſuperiùs muſculum repræſentaui.* Sed cum in motu muſculi explicando tendinum craſſities nullum vſum habeat, pars verò eorum extra carnem protenſa (quam *tendinum continuatorum partem extantem* appello) notabilem differentiam rarò producat, præſtat tantùm conſiderare illa tendinum plana, in quibus extrema plana carnium ſunt, vt adeòque in muſculo, dum motum eius conſideramus, non niſi tria planorum paria occurrant, ijſdem nominibus, quibus in carnis deſcriptione vſus ſum, deſignanda. Sunt autem illa *plana extrema, plana tranſuerſa, & plana lateralia.*

34. *PLANA EXTREMA, compoſita ex planis extremis carnium ſibi mutuò immediatè impoſitis, ſunt rectangula ſub latere tranſuerſo, & latere tendinoſo ordinum horum:* *Plana extrema muſculi.*

There can be two descriptions of a muscle depending on whether this is considered as made of Orders or of Ranks.

31. *A simple rectilinear MUSCLE is a body made of several equal Orders, similar, parallel and set immediately upon each other, so that all Orders are congruent with all other Orders.* *Muscle as made of Orders.*

32. *Or, a MUSCLE is a body made of unequally equal, similar Ranks arranged according to the increment of the tendons, with flesh parts set immediately upon flesh parts and tendons upon tendons in such a way that all Ranks are congruent with all other Ranks.* *Muscle as made of Ranks.*

33. *From the definitions it appears that whatever the composition of the muscle, there is in it one parallelepiped of flesh parts and two tetragonal tendon prisms as represented above.* Since, however, the thickness of the tendons is not needed to explain the movement of the muscle, and that part of the tendon protruding beyond the flesh (which I call the extruding part of the tendon continuations) rarely produces any noticeable difference, it is better to consider only those tendon surfaces in which the end surfaces of the flesh parts are. Thus, to consider the movement of a muscle it is not necessary to choose more than three pairs of surfaces. They are named according to the description which I used for the flesh. They are the end surfaces, the transverse surfaces, and the lateral surfaces.

34. *THE END SURFACES, made of the end surfaces of the flesh parts in immediate contact are rectangles delineated by the transverse edge and the tendon edge of the Orders.* *End surfaces of the muscle.*

Baſis muſculi. horum alterutrum BASIS MVSCVLI dicitur.

Plana trāſuerſa muſculi. 35. PLANA TRANSVERSA ſunt extremorum verſuum in muſculo carnoſa plana, adeòque etiam, vt illa, ſunt rectangula ſub latere tranſuerſo & latere carnoſo comprehenſa.

Plana lateralia muſculi. 36. PLANA LATERALIA ſunt extremorum ordinum in muſculo plana, adeòque, vt illa, ſunt parallelogramma obliquangula ſub latere tendinoſo, & latere carnoſo comprehenſa.

Hinc patet iam ante explicatis terminis latera muſculi exprimi poſſe, qualia ſunt,

Latus trāſuerſum muſculi. 37. LATVS TRANSVERSVM, quod idem eſt cum latere tranſuerſo verſuum.

Latus tendinoſum muſculi. 38. LATVS TENDINOSVM, quod idem eſt cum latere tendinoſo ordinum.

Latus carnoſum muſculi. 39. LATVS CARNOSVM, quod verſibus, & ordinibus commune eſt.

Tres huius parallelepipedi dimenſiones tribus rectis exprimuntur, quas appellare liceat, altitudinem, latitudinem, & craſſitiem.

Altitudo muſculi. 40. ALTITVDO MVSCVLI, eſt diſtantia inter plana extrema, & eſt æqualis altitudini ordinum.

Latitudo muſculi. 41. LATITVDO MVSCVLI, eſt diſtantia inter plana lateralia, quæ coincidit cum latere tranſuerſo.

Craſſities muſculi. 42. CRASSITIES MVSCVLI eſt diſtantia inter plana tranſuerſa, & eſt æqualis craſsitiei ordinum.

Longitudo muſculi quot modis intelligatur. 43. LONGITVDO MVSCVLI eſt recta inter auerſas extremitates oppoſitorum tendinum: ſi pro muſculo ſolum parallelepipedum habueris, erit longitudo eius, diſtantia

Each of the two is called BASE OF THE MUSCLE.

Transverse surfaces of the muscle.

35. *THE TRANSVERSE SURFACES are the flesh surfaces of the outermost Ranks in the muscle and, like them, rectangular, being delineated by a transverse edge and a flesh edge.*

Lateral surfaces of the muscle.

36. *THE LATERAL SURFACES are formed by the surfaces of the outermost Orders in the muscle, and, like them, they form oblique parallelograms delineated by a tendon edge and a flesh edge.*

From this it appears that the edges of the muscle can be expressed in the terms already explained, which are:

Transverse edge of the muscle.

37. *THE TRANSVERSE EDGE is the same as the transverse edge of the Ranks.*

Tendon edge of the muscle.

38. *THE TENDON EDGE is the same as the tendon edge of the Orders.*

Flesh edge of the muscle.

39. *THE FLESH EDGE is the edge shared by the Ranks and the Orders.*

The three dimensions of this parallelepiped are thus expressed in the three straight lines, which can be called the height, the width, and the thickness.

Height of the muscle.

40. *THE HEIGHT OF THE MUSCLE is the distance between the end surfaces, and is equal to the height of the Orders.*

Width of the muscle.

41. *THE WIDTH OF THE MUSCLE is the distance between the lateral surfaces, and is equal to the transverse edge.*

Thickness of the muscle.

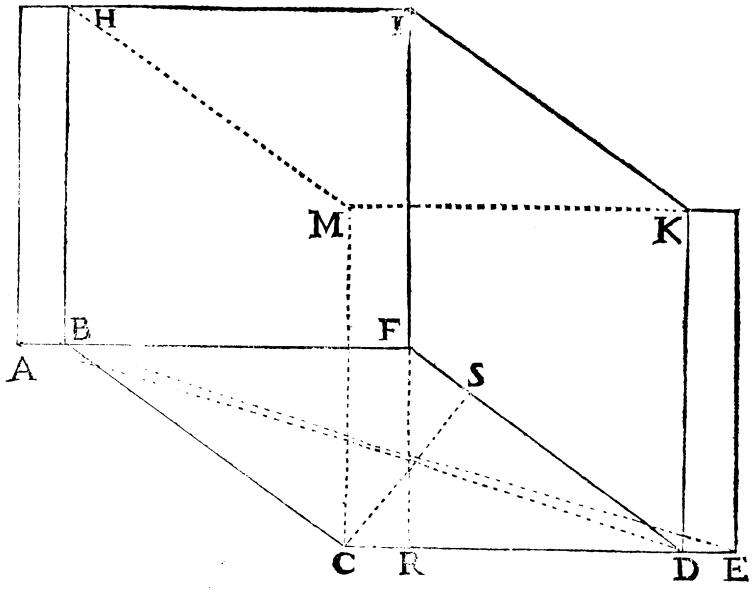
42. *THE THICKNESS OF THE MUSCLE is the distance between the transverse surfaces, and is equal to the thickness of the Orders.*

Different understandings of the length of the muscle.

43. *THE LENGTH OF THE MUSCLE is the straight line between the outer extremities of the opposite tendons; if for a muscle you have only the parallelepiped, the length is the distance*

tia inter latera tranſuerſa, quæ à ſe maximè diſtant, adeoque æqualis diagonali longiori in parallelogrammo ordinum.

44. *Muſculus CONTRAHI dicitur, cum longitudo eius breuior fit.* *Contractio muſculi.*



In præſenti figura; B I, C K, plana extrema: B M, F K, plana tranſuerſa: B D, H K plana lateralia: K D, & reliqua illi parallela, latera tranſuerſa: C D, & illi parallela, latera tendinoſa: B C, & illi parallela, latera carnoſa: F R, diſtantia inter B F, C D, ſeu altitudo muſculi: D K, diſtantia inter I K, F D, ſeu latitudo muſculi: C S, diſtantia inter B C, F D, ſeu craſſities muſculi: A E, vel B D, longitudo muſculi.

Varia

between the transverse edges at their maximum distance, thus it is equal to the longer diagonal in the parallelogram of the Order.

44. *The muscle is said to CONTRACT when its length becomes shorter.* *Muscle contraction.*

In the present figure:
B I and C K are the end surfaces;
B M and F K are the transverse surfaces;
B D and H K are the lateral surfaces;
K D and its parallels are the transverse edges;
C D and its parallels are the tendon edges;
B C and its parallels are the flesh edges;
F R is the distance between B F and C D, or the height of the muscle;
D K is the distance between I K and F D, or the width of the muscle; C S is the distance between B C and F D, or the thickness of the muscle; and A E or B D is the length of the muscle.

Varia hìc inter deſcriptiones recenſentur, quæ inter propoſitiones reponenda eſſent ex ſtructura carnis, ordinis, verſuum, & muſculi, demonſtrandas. Quod hìc factum, cum non mihi animus ſit ipſa elementa myologiæ proponere, ſed duntaxat tale illorum ſpecimen edere, quod ſufficeret fabricæ muſculi diſtinctè intelligendæ. Id quod cum in hactenus propoſitis à me præſtitum crediderim, reliquum eſt, vt huius fabricæ vſum in motu muſculorum explicando, paucis oſtendam, non quidem verum motus modum explicando, quem mihi incognitum profiteor, ſed ab alijs propoſitum modum, nec dum ſatis certum eſſe, oſtendendo.

Nouæ muſculorum fabricæ vſus ad demonſtrandum, poſſe intumeſcere muſculos in contractione eorũ, etiãſi noua materia non accederet.

Dum contrahitur muſculus, fluidæ ſubſtantiæ in eo contentæ quantitas, vel augetur, vel imminuitur, vel eadem manet; hinc tres diuerſi modi exſurgunt motum muſculorum, & explicandi, & mechanicè ſecundum noſtras obſeruationes repræſentandi.

Tanquam rem indubiam ſuppoſuere plurimi, dum contrahitur muſculus, molem eius augeri, quod in multis humani corporis locis tum temporis manifeſtus tumor ſentiatur, rati muſculum, veſicæ ſimilem eſſe, quæ quò plenior, eò breuior. Vt pateat, non ſufficere ſolum tumorem ad nouæ materiæ acceſſionem in contractione muſculi aſſerendam, demonſtrabo: *in omni muſculo, dum contrahitur, tumorem contingere, etiamſi muſculus contractus æqualis maneret muſculo non contracto:* in quem finem neceſſe eſt ſequentia partìm ſupponere, partìm demonſtrare.

SVPPO

These descriptions include different matters which should rather be placed under propositions to be demonstrated according to the structure of the flesh, the Order, the Rank, and the muscle. But they are given [as definitions], as I am not going to propose all the elements of Myology, but only to provide those which are sufficient for a clear understanding of the muscle structure. Since I believe that in the above presentation I have accomplished this, it now becomes my task briefly to show how this structure is used to explain the movement of the muscles; not that I am giving the true explanation of the movement, which I admit I do not know, but rather I will show that what has been presented by others is far from certain.

Use of the new muscle structure to demonstrate that muscles can swell during contraction even without the arrival of new substance.

When a muscle contracts, the amount of fluid substance contained in it either increases, or diminishes, or remains unchanged. Thus, there are three different ways to explain the movement of the muscles and to represent their mechanics according to our observations.

Many have supposed it to be an unquestionable fact that, during contraction, the mass of the muscle increases, because an obvious swelling is perceived at many places in the human body during the contraction. These people[13] then reason, that the muscle is like a bladder which becomes shorter the more it is filled. To make it clear that a swelling alone is not sufficient to make one assert that new material arrives into the muscle during contraction, I will demonstrate: In every muscle that contracts there is a swelling, even if the contracted muscle remains equal to the non-contracted muscle; to this end it is necessary in what follows to make some suppositions and some demonstrations.

SVPPOSITIONES.

1. *Dum contrahitur muſculus, latera tendinoſa non mutantur.*

2. *Dum contrahitur muſculus, ſingulæ in ijſdem planis carnes contiguæ ſibi manent.*

3. *Dum contrahitur muſculus, ſingulæ carnes toto ductu æqualiter mutantur, & breuiores fiunt.*

4. *Dum caro breuior fit, latitudo eius manet eadem.*

5. *Muſculus contractus æqualis eſt eidem muſculo non contracto.*

Quænam ex allatis ſuppoſitionibus certæ, quæ incertæ?

Ex hiſce ſuppoſitionibus tres priores certas eſſe, experimentis alibi demonſtrabo: de quarta conſtat, non augeri latitudinem carnium; an imminuatur, poſſet dubitari. Si certum eſſet imminui, manifeſtior demonſtraretur in contracto muſculo tumor; ſed etiamſi non imminuatur, tumorem manifeſtum futurum oſtendam. Quintam ſuppono, non quod eam certam credam, ſed quo demonſtrem, ea poſita, in ſingulis muſculis tumorem futurum, dum contrahuntur. Sunt alij, qui hanc quintam ſuppoſitionem certiſſimam credunt, dicuntque latitudini muſculi id accedere, quod longitudini eius decedit; pari ratione, ac dum rectangulum oblongum in quadratum æquale mutatur. Sed vt necdum ab vllo vidi hanc meam ſuppoſitionem certò demonſtratam, ſic neque per rectangula explicatio Naturæ conuenit, vt cætera taceam, quæ hìc poſſent afferri.

C LEMMA

SUPPOSITIONS.

1. *When a muscle contracts, the tendon edges do not change.*

2. *When a muscle contracts, the individual parts of flesh contiguous in the same plane remain such.*

3. *When a muscle contracts, the individual parts all along the flesh move and shorten equally.*

4. *When the flesh shortens, its width remains the same.*

5. *A contracted muscle is equal to the same muscle non-contracted.*

Which of these suppositions are certain and which are uncertain.

Among these suppositions the first three are certain, as I will demonstrate experimentally elsewhere. As far as the fourth supposition is concerned it appears that the width of the flesh parts does not increase. Whether it diminishes remains questionable. If it were certain that the width diminishes, a swelling in the contracted muscle would manifest itself more clearly. But even if the width is not diminished I will show that contraction will result in a swelling. I made the fifth supposition, not because I believe it is certain, but, if it is admitted, I demonstrate that a swelling will occur in the individual muscles when they contract. There are some who take the fifth supposition for granted, saying that the width of the muscle increases as much as the muscle's length decreases, following the same principle as when an oblong rectangle is changed into an equal quadrate.[14] But, so far, neither have I seen my fifth supposition truly proven by anyone, nor does an explanation with rectangles agree with Nature, not to mention several other things which might be added.

LEMMA I.

De parallelepipedo muſculi.

DVM CONTRAHITVR MVSCVLVS, NON CESSAT ESSE PARALLELEPIPEDVM.

Cum ſingulæ carnes in contractione Muſculi toto ductu
(a) *ſupp.* 3 *æqualiter* (a) *mutentur, ſibiq; in ijſdem planis* (b) *contiguæ*
(b) *ſupp.* 2
(c) *def.* 19. & 31. *maneant, vt ante contractionem rectæ* (c) *& æquales inter ſe fuere, ſic & poſt contractionem rectæ, & æquales inter ſe manebunt. Vt itaque plana earum oppoſita quæcun-*
(d) *def.* 13. *que ante contractionem parallela* (d) *inter ſe fuere, ſic etiam poſt contractionem parallela inter ſe manebunt, adeoque parallelepipedum Muſculi, ex ſingularum carnium parallelepipedis compoſitum, in contractione muſculi non ceſſat eſſe parallelepipedum.*

COROLL.

Cum muſculus contractus ſit parallelepipedum, erunt anguli oppoſiti, oppoſita plana, & oppoſita latera inter ſe
(e) *def.* 43. *æqualia; adeoq; cum extremitates muſculi ſint* (e) *duo eius oppoſita latera tranſuerſa a ſe mutuò maximè diſtantia, reſpectu muſculi, idem erit, quæcunque extremitas in motu maiorem reſiſtentiam offendat, adeoq; extremitas quieſcens euadat.*

LEMMA II.

De latitudine muſculi.

DVM CONTRAHITVR MVSCVLVS, LATITVDO EIVS NON MVTATVR.

Eſto muſculus parallelepipedum C H I D, *cuius latitudo*

[15]LEMMA I.

On the parallelepiped of muscle.

WHEN A MUSCLE CONTRACTS IT DOES NOT CEASE TO BE A PARALLELEPIPED.

When the single parts of flesh are in contraction, all parts change equally (a) over the whole length of the muscle. They remain in the same planes (b) contiguous to themselves. Those parts which were straight and equal (c) before contraction will remain so after contraction. In the same way their opposite surfaces which were parallel (d[16]) before contraction will remain parallel after contraction. Thus the muscle parallelepiped made of single flesh parallelepipeds does not cease to be a parallelepiped during contraction.

(a) *supp.* 3
(b) *supp.* 2
(c) *def.* 19. & 31.
(d) *def.* 33.

COROLLARY.

Since a contracted muscle is a parallelepiped, the opposite angles, the opposite surfaces, and the opposite edges will be equal. Hence, since the extremities of the muscle (e[17]) are its two opposite transverse surfaces most distant from each other, it will not matter with respect to the muscle whichever extremity meets the greater resistance during the movement, and accordingly becomes the immobile base.

(e) *def.* 43.

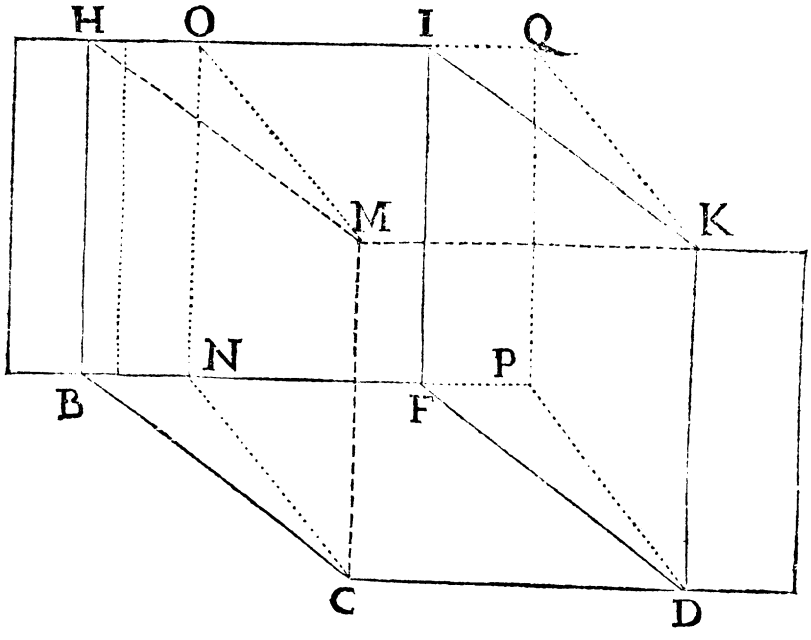
LEMMA II.

On the width of the muscle.

WHEN A MUSCLE CONTRACTS, ITS WIDTH DOES NOT CHANGE.

Let the muscle be a parallelepiped C H I D *in*

latitudo H B, *extremitas quieſcens* D K, *contrahatur*, *& fiat muſculus contractus* C O Q D, *cuius latitudo* O N.



Dico rectam O N, *in muſculo* C O Q D, *æqualem eſſe rectæ* H B, *in muſculo* C H I D.

Dum muſculus contrahitur (a) *ſingulæ carnes in ijſdem planis ſibi contiguæ manent: at ſingularum carnium latitudo* (b) *non mutatur, ergo nec ex plurium carnium latitudinibus ſibi mutuò contiguis* (c) *compoſita recta mutabitur, ſed latitudo* H B, *in muſculo non contracto* C H I D, (d) *eſt recta ex plurium carnium latitudi-*

[a] *Sup.* 2.

[b] *Sup.* 4.

(c) *ax.* 19. *primi.*

(d) *Defin.* 42. *& 29.*

which H B *is the width and* D K *the immobile end. Let it contract to form the contracted muscle* C O Q D, *the width of which is* O N.

I claim that the straight line O N *in the muscle* C O Q D *is equal to the straight line* H B *in the muscle* C H I D.

When the muscle contracts (a) the single parts of flesh in the same surfaces remain contiguous. But the width (b) of the single parts of flesh does not change. Thus, [ergo] the straight line made of (c) the contiguous widths of several parts of flesh will not change. But the width H B *in the non-contracted muscle* C H I D *(d) is the straight line made of the widths of the several parts of the flesh. Therefore, [ergo] it will be equal to the straight line* O N *in the contracted muscle*

(a) sup. 2.

(b) sup. 4.

*(c) ax. I.*2.*

(d) defin. 42. & 29.

* Reference numbers to Euclid changed to Heiberg's definitive text numbers in translation. See p. « 243 ».

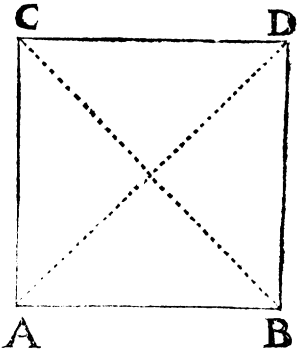
nibus compoſita, ergo erit æqualis rectæ O N, *in muſculo contracto* C O Q D, *adeòque dum contrahitur muſculus, latitudo eius non mutatur.*

LEMMA III.

De baſi muſculi.

DVM CONTRAHITVR MVSCVLVS, BASIS EIVS MANET EADEM.

Eſto muſculi baſis planum A D, *latera tendinoſa* A B, C D, *latera tranſuerſa* A C, B D, *diagonales eius* A D, B C.



Dico baſin A D, *dum contrahitur muſculus manere eandem, quæ erat ante contractionem.*

Baſis muſculi, ſeu quod idem
(a) *def.* 34. *eſt* (a) *planorum extremorum alterum, eſt rectangulum ſub latere tendinoſo* A B, *& latere*
(b) *ſup.* 1. *tranſuerſo* B D, *at latera tendinoſa non mutantur* (b)
(c) *def.* 42. *& latera tranſuerſa* (c) *ſunt æqualia latitudini muſculi,*
(d) *lem.* 2. *quæ itidem* (d) *non mutatur; erunt itaque latera baſis eadem in muſculo contracto, quæ erant in muſculo non contracto. Sed & diagonales* A D, B C *inter ſe manent æquales:*
(e) *def.* 34. *cum enim baſis muſculi* (e) *ſit rectangulum compoſitum ex rectangulis extremis carnium ſibi mutuò immediatè appoſitis, erunt diagonales inter ſe æquales, ac ideo in vtròq; diagonali idem extremorum carnium ſitus, numeruſque; adeòque cùm æqualia ex partibus æqualibus eodem modo*

ſitis

C O Q D. *Thus, when the muscle contracts, its width does not change.*

LEMMA III.

On the base of the muscle.

WHEN A MUSCLE CONTRACTS, ITS BASE REMAINS THE SAME.

Let the base of the muscle be the surface A D *with the tendon edges* A B *and* C D, *the transverse edges* A C *and* B D, *and the diagonals* A D *and* B C.

I claim that the base A D *of the muscle remains the same when the muscle contracts as it was before the contraction.*

(a) def. 34. *The base of the muscle, or in other words (a), one of the muscle's end surfaces, is a rectangle delineated by the tendon edge* A B *and the transverse edge* B D. *(b) sup.* 1. *But the tendon edges do not change (b), and the transverse edges (c*[18]*) are equal to the width of the muscle,* *(c) def.* 41. *(d) lem.* 2. *which likewise (d) does not change. As a consequence, the edges of the base remain the same in the contracted muscle as they were in the non-contracted muscle. But the diagonals* A D *and* B C *also remain equal. Since* *(e) def.* 34. *indeed the base of the muscle (e) is a rectangle made of the end rectangles of the parts of flesh immediately adjacent, its diagonals are equal to each other. Therefore in both diagonals there will be the same position and number of extremities of flesh parts. Therefore,*

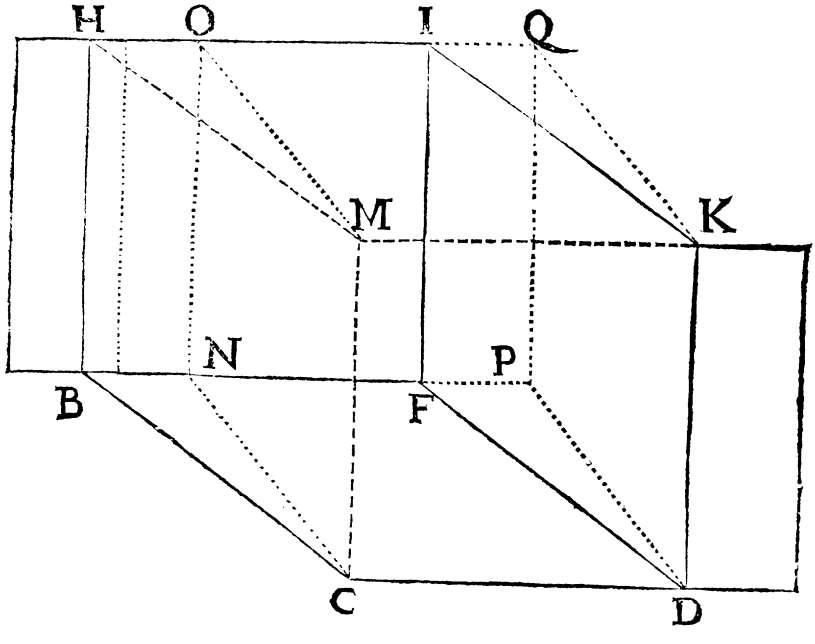
ſitis compoſita æqualiter (t) *mutentur , erunt diagonales etiam in muſculo contracto inter ſe æquales; cum itaque latera baſis* A B, B D, *eadem ſint in muſculo contracto, quæ erant in muſculo non contracto , & diagonales baſeos in muſculo contracto maneant inter ſe æquales , ideſt baſis muſculi contracti maneat rectangula , manifeſtum eſt , cum contrahitur muſculus , baſin non mutari .*

(t) *ſup.* 3.

LEMMA IV.

ALTITVDO MVSCVLI CONTRACTI AEQVALIS EST ALTITVDINI MVSCVLI NON CONTRACTI .

De altitudine muſculi.



Eſto muſculus C H I D , *in quo plana extrema* H F,

since composites made of equal (f) parts similarly arranged change equally, the diagonals in the contracted muscle will also remain equal. Since the edges of the base A B *and* B D *are the same in the contracted and in the non-contracted muscle, and the diagonals of the base remain equal in the contracted muscle, i.e., the base of the contracted muscle remains a rectangle, it is obvious that the base does not change, when the muscle contracts.*

(f) sup. 3.

LEMMA IV.

On the height of the muscle.

THE HEIGHT OF A CONTRACTED MUSCLE IS EQUAL TO THE HEIGHT OF THE NON-CONTRACTED MUSCLE.

Let be a muscle C H I D *in which the end surfaces*

H F, M D, *baſis* M D, *extremitas quieſcens* D K, *contrahatur idem, & fiat muſculus contractus* C O Q D, *vbi plana extrema* O P, M D, *baſis* M D.

Dico altitudinem muſculi C H I D, *æqualem eſſe altitudini muſculi* C O Q D.

(a) *lem.* 1. (b) *lem.* 3. (c) *ſup.* 5. (d) *con.* 29. 11.

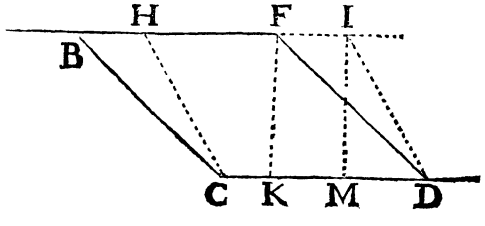
Dum contrahitur muſculus (a) *non ceſſat eſſe parallelepipedum*; *& baſis* M D, *in muſculo contracto* (b) *eſt eadem, quæ erat in muſculo non contracto*; *ac ipſe muſculus contractus* C O Q D, (c) *æqualis eſt muſculo non contracto* C H I D. *Sed parallelepipeda æqualia ſupra eandem baſim* (d) *ſunt æquealta*; *ergo erit altitudo muſculi contracti æqualis altitudini muſculi non contracti.*

LEMMA V.

De plano laterali.

PLANVM LATERALE IN MVSCVLO CONTRACTO EST AEQVALE PLANO LATERALI IN MVSCVLO NON CONTRACTO.

Eſto in muſculo non contracto planum laterale parallelogrammum B D, *vbi latera tendinoſa* B F, C D, *altitudo* F K, *contrahatur idem muſculus, & ſit in eo contracto planum laterale* H D, *vbi latera tendinoſa* H I, C D, *altitudo* I M.



Dico

are H F *and* M D, *the base is* M D, *and the immobile extremity is* D K, *and let the muscle contracted be* C O Q D *in which the end surfaces are* O P *and* M D, *and the base is* M D.

I claim that the height[19] *of the muscle* C H I D *is equal to the height*[20] *of the muscle* C O Q D.

(a) lem. 1. *When the muscle contracts (a), it does not cease to be a parallelepiped; and its base* M D *is the same in*

(b) lem. 3. *the contracted (b) as it was in the non-contracted*

(c) sup. 5. *muscle; also the contracted muscle* C O Q D *(c) is equal to the non-contracted muscle* C H I D. *But equal*

*(d) XI.*29. *parallelepipeds with the same base (d) have the same height. Thus, [ergo] the height of the contracted muscle is equal to the height of the non-contracted muscle.*

LEMMA V.

On the lateral surface.

THE LATERAL SURFACE IN A CONTRACTED MUSCLE IS EQUAL TO THE LATERAL SURFACE IN THE NON-CONTRACTED MUSCLE.

Let the lateral surface in a non-contracted muscle be a parallelogram B D, *in which the tendon edges are* B F *and* C D, *and the height is* FK. *This muscle contracts. The lateral surface of the contracted muscle becomes* HD *in which the tendon edges are* H I *and* C D, *and the height is* I M.

Dico planum laterale H D, *æquale eſſe plano laterali* B D.

Altitudo plani lateralis, ſeu (a) *quod idem eſt, altitudo ordinis in muſculo* (b) *eſt æqualis altitudini muſculi, adeòque* F K, *altitudo plani lateralis* B D, *æqualis altitudini muſculi non contracti, &* I M, *altitudo plani lateralis* H D, *æqualis altitudini eiuſdem muſculi contracti: at dum contrahitur muſculus,* (c) *altitudo manet eadem; ergo* F K, *æqualis* I M: *ſed & latera tendinoſa* (d) *non mutantur; ergo* C D, *latus tendinoſum in plano laterali* B D, *eſt æquale* C D, *lateri tendinoſo in plano laterali* H D. *Cum ergo* B D, *&* H D, *ſint parallelogramma æquialta, & ſupra eaſdem baſes, erunt* (e) *& inter ſe æqualia, adeòque planum laterale in muſculo contracto erit æquale plano laterali in muſculo non contracto.*

(a) *def.* 36. (b) *def.* 40. (c) *lem.* 4. (d) *ſup.* 1. (e) 35. 1.

LEMMA VI.

DVM CONTRAHITVR MVSCVLVS, ANGVLI EIVS ACVTI FIVNT AMPLIORES. *De angulis acutis muſculi.*

Eſto in muſculo non contracto planum laterale B D, *vbi latera tendinoſa* B F, C D, *latera carnoſa* B C, F D, *anguli acuti* F D C, F B C, *extremitas quieſcens* D, *contrahatur, ſitque planum laterale* H D, *latera tendinoſa* H I, C D, *latera carnoſa* H C, I D, *anguli acuti* I D C, I H C. *Vide figuram Lemmatis* 5.

Dico angulos C H I, *&* I D C, *maiores eſſe angulis* C B F, *&* F D C.

Dum

I claim that the lateral surface H D *is equal to the lateral surface* B D.

The height of the lateral surface or (a), which is the same as the height of the Order in the muscle (b), is equal to the height of the muscle. Thus, F K, *the height of the lateral surface* B D *is equal to the height of the non-contracted muscle, and* I M, *the height of the lateral surface* H D, *is equal to the height of the same muscle when contracted. But, when a muscle contracts, (c) its height remains the same. Thus, [ergo]* F K *is equal to* I M. *But the tendinous edges (d) do not change either; thus, [ergo]* C D, *the tendon edge of the lateral surface* B D, *is equal to* C D, *the tendon edge of the lateral surface* H D. *Since [ergo]* B D *and* H D *are parallelograms of equal height and have the same base, (e) they are equal. Consequently, the lateral surface in the contracted muscle will be equal to the lateral surface in the non-contracted muscle.*

(a) *def.* 36.
(b) *def.* 40.
(c) *lem.* 4.
(d) *sup.* 1.
(e) *I.*35.

LEMMA VI.

On the acute angles of the muscle.

WHEN A MUSCLE CONTRACTS, ITS ACUTE ANGLES WIDEN.

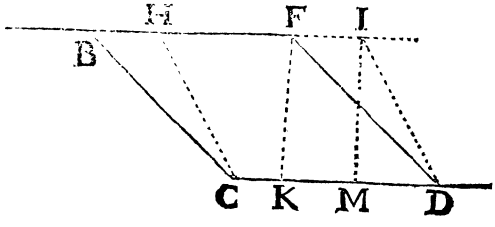
Let the lateral surface in a non-contracted muscle be B D *in which the tendon edges are* B F *and* C D, *the flesh edges are* B C *and* F D, *the acute angles are* F D C *and* F B C, *the immobile extremity is* D, *and let the muscle contract. Now the lateral plane becomes* H D, *the tendon edges are* H I *and* C D, *the flesh edges are* H C *and* I D, *and the acute angles are* I D C *and* I H C.

See fig. Lem. 5.

I claim that the angles C H I *and* I D C *are larger than the angles* C B F *and* F D C.

(a) *lem.* 5. *Cum plana lateralia* B D, H D, (a) *æqualia ſint, eorumque baſis* C D

(b) *ſup.* 1. (b) *non mutetur, & ſint ad eaſdem partes, (ſunt enim in eodem muſculo)*

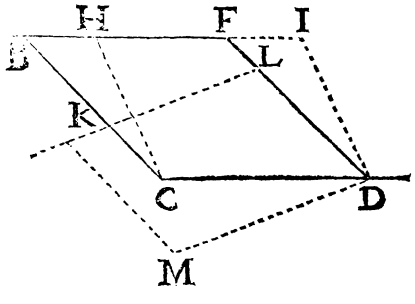


(c) *con.* 35. 1. *erunt* (c) *inter eaſdem parallelas* B I, C D: *erit itaque in*

(d) 16. 1. *triangulo* C B H (d) *angulus externus* C H I, *maior*

(e) 34. 1. *interno, & oppoſito* C B H, *ſed angulus* (e) I D C, *eſt æqualis angulo* C H I, *& angulus* F D C, *æqualis angulo* C B F, *vel* C B H, *ſunt enim oppoſiti in parallelogrammis anguli. Ergo anguli* C H I, *&* I D C, *maiores ſunt angulis* C B F, *&* F B C, *adeòque dum contrahitur muſculus, anguli eius acuti fiunt ampliores.*

Dum anguli acuti in muſculo ampliantur, modo latus carnoſum, modò latus tendinoſum quieſcit, pro vt hoc, vel illud maiorem reſiſtentiam inuenit, & hoc, quod ita quieſcit LATVS QVIESCENS dicitur: ſic in ordine B F, D C, *ſi latus* F D, *minorem reſiſtentiam inuenit, quàm latus* C D, *erit latus* C D, *quieſcens, & muſculus contractus* B F D C. *Si verò latus* C D, *minorem*



(a) *lem.* 5. (b) *sup.* 1. *Since the lateral surfaces* B D *and* H D *(a) are equal, and since their base* C D *(b) is not changed, and the surfaces are on the same side (they are indeed*

(c) *I.*35. (d) *I.*16. (e) *I.*34. *in the same muscle), they are (c) between the same parallel lines* B I *and* C D. *Therefore, in the triangle* C B H *(d) the external angle* C H I *is greater than the inner and opposite angle* C B H; *but the angle (e)* I D C *is equal to the angle* C H I, *and the angle* F D C *is equal to the angle* C B F, *or* C B H, *since they are opposite angles of the same parallelogram. Consequently [ergo] the angles* C H I *and* I D C *are larger than the angles* C B F *and* F B C. *Thus, when the muscle contracts, its acute angles widen.*

When the acute angles in the muscle widen, either the flesh edge, or the tendon edge is immobile, depending on which of them meets the greater resistance; and the one which is thus immobile is called the IMMOBILE EDGE.

Thus, in the Order B F, D C, *if the edge* F D *meets less resistance than the edge* C D, *then the edge* C D *will be immobile, and the contracted muscle will be* H I D C. *If, actually, the edge* C D

minorem reſiſtentiam inuenit, erit latus F D, *quieſcens, & muſculus contractus* K L D M.

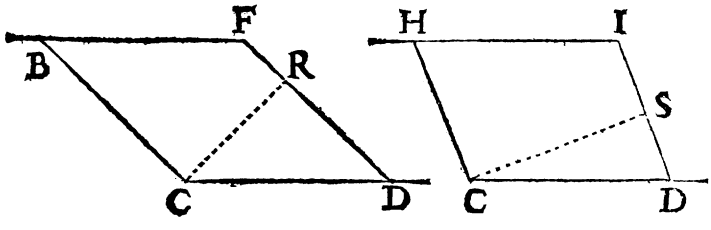
His ita præmiſſis, ad ipſam propoſitionem deueniendum eſt.

PROPOSITIO.

IN OMNI MVSCVLO, DVM CONTRAHITVR, TVMOR CONTINGIT. *De craſſitie muſculi.*

Cum tumor nil ſit, niſi aucta vna, vel plures in corpore dimenſiones, idem eſt craſsitiem muſculi augeri, ac tumorem in muſculo contingere.

Sit muſculi non contracti planum laterale B D, *in quo latera carnoſa* F D, B C, *craſsities muſculi* C R,



contrahatur, & ſit eiuſdem muſculi contracti planum laterale H D, *in quo latera carnoſa* H C, I D, *craſsities* C S.

Dico rectam C S, *eſſe maiorem recta* C R.

Planum laterale H D, *in muſculo contracto* (a) *eſt æquale plano laterali* B D, *in muſculo non contracto, at rectangulum ſub* C R, *&* F D, (b) *eſt æquale parallelogrammo* B D, *habent enim baſim* F D, *communem,* (a) *lem.* 5. (b) 51. 1.

D *& ſunt*

meets less resistance, then the edge F D *will be the immobile edge, and the contracted muscle will be* K L D M.

After these premises, we will now arrive at the proposition itself.

PROPOSITION.

On the thickness of the muscle.

EVERY MUSCLE SWELLS WHEN CONTRACTING.

Since swelling is nothing else than an increase of one or several dimensions, increase of the thickness of a muscle is the same as the occurrence of a swelling in the muscle.

Let the lateral surface of a non-contracted muscle be B D *in which the flesh edges are* F D *and* B C, *and the thickness of the muscle is* C R. *The muscle contracts. The lateral surface of the contracted muscle becomes* H D *in which the flesh edges are* H C *and* I D *and its thickness is* C S.

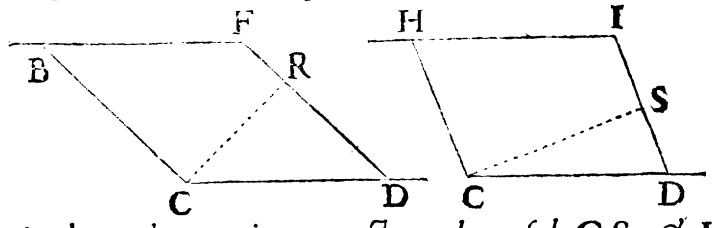
I claim that the straight line C S *is longer than the straight line* C R.

The lateral surface H D, *in the contracted muscle (a) is equal to the lateral surface* B D *in the non-contracted muscle, and the rectangle* C R *x* F D *(b) is equal to the parallelogram* B D. *They have indeed the same base* F D

(a) lem. 5.

*(b) I.*35.

& ſunt in ijſdem parallelis B C, F D, (*cum* C R,
(c) *def.* 22 *ſeu craſsities* (c) *ſit æqualis diſtantiæ laterum carnoſo-*



rum) *ob eandem rationem rectangulum ſub* C S, *&* I D,
(d) *a.* 1.1. *eſt æquale parallelogrammo* H D. *Ergo cum* (d) *ijſdem æqualia etiam inter ſe ſint æqualia, erit rectangulum ſub* C R, F D, *æquale rectangulo ſub* C S, *&* I D,
(e) 14. 6. *at* (e) *æqualium rectangulorum reciproca ſunt latera, ergo vt* F D, *ad* D I, *ſic* C S, *ad* C R, *at* F D, *maior quam* D I, *cum caro fibræ non contractæ ſit longior carne fibræ contractæ, ergo &* C S, *maior quàm* C R, *ideſt; craſsities ordinis in muſculo contracto maior craſsitie ordinis in muſculo non contracto: at craſsities muſculi, & craſsities ordinum eiuſdem muſculi ſunt inter ſe æquales. Ergo craſsities muſculi contracti maior eſt craſsitie muſculi non contracti; adeòque in omni muſculo dum contrahitur, tumor contingit.*

Potuiſſem idem ex 34. 11. *Eucl. in ſolido muſculi demonſtraſſe, planorum tranſuerſorum alterum pro baſi, eorumque diſtantiam pro altitudine habendo, ſed methodi legibus repugnat ſolidum adhibere, vbi planum ſufficit.*

Cum varia muſculorum conformatio, variuſque eorundem ſitus id efficiant, vt non eodem modo tumor ille in ſingulis obſeruetur; præcipuas quæ in ijs occurrere poterint, diuerſitates, paucis hìc euoluam.

Sit

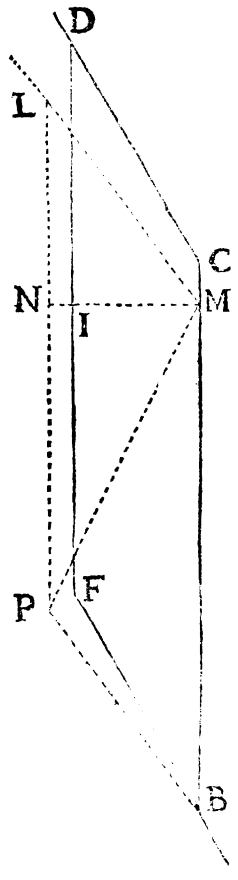
and they are between the same parallels B C *and* F D
(c) def. 22. *(since* C R, *or the thickness (c) is equal to the distance between the flesh edges). For the same reason, the rectangle* C S *x* I D *is equal to the parallelogram* H D.
(d) ax. I.1. *Therefore, since [ergo] (d) two [elements] which are equal to a third are equal to each other, the rectangle* C R *x* F D *will be equal to the rectangle* C S *x* I D.
(e) VI.14. *But (e) in equal rectangles the sides are inversely proportional; thus, [ergo]* F D / D I = C S / C R. *But* F D *is longer than* D I *since the flesh of a non-contracted fiber is longer than that of the contracted fiber. Thus, [ergo]* C S *is longer than* C R, *i.e., the thicknesses of an Order in a contracted muscle is greater than the thickness of the Order in the non-contracted muscle. But the thickness of a muscle and the thickness of the Orders of the same muscle are equal. Thus, [ergo] the thickness of the contracted muscle is greater than the thickness of the non-contracted muscle. Therefore, every muscle swells when contracting.*

I could have demonstrated the same according to Euclid XI:34 by considering the muscle as a solid [three-dimensional] structure with one of the transverse surfaces as the base and the distance between the transverse surfaces as the height. But it is against the rules of the method to use a solid [three-dimensional] structure when a plane [two-dimensional] structure is sufficient.

Because of the varying form and location of the muscles, this swelling will not be observed in the same manner in each case. I shall disclose here in a few words the principal variations that may occur.

De vario tumore musculorum carnes longas habentium pro vario eorum ſitu.

Sit 1. *muſculus* B D, *in quo carnoſa latera* F D, B C, *tendinoſis lateribus* D C, F B *tanto longiora, vt etiam cum fuerit maximè contractus muſculus ex gr.* B L *diagonalium breuior* P M, *cum oppoſitis tendinoſis lateribus* P B, M L, *angulos* M P B, P L M, *obtuſos conſtituant. In hoc muſculo, ſi ponatur planum laterale* B D *parti, cui incumbit muſculus, perpendiculare, extremitas quieſcens* B, *latus quieſcens* B C, *eidem parti proximum, & parallelum: ex præcedentibus patet, æqualem tumorem futurum toto ſpatio, quod latus* P L, *occupat, cum nullus alius hic ſit tumor, quam qui oritur, dum* (a) *craſsities, vel laterum carnoſorum in ordine diſtantia, augetur: huius tumoris menſura eſt exceſſus, quo* M N, *ſuperat rectam* M I.



(a) *def.* 22.

In eodem muſculo, ſi ponatur latus quieſcens B F, *parti, cui incumbit muſculus, obuerſum, non erit tumor æquabilis, vt in præcedenti caſu, ſed quo magis in plano tranſuerſo* B C, *ab extremitate fixa ad extremitatem mobilem digitum promoueris, eo maiorem ſenties tumorem,* *Fig ſequ.*

First, let be the muscle B D *in which the flesh edges* F D *and* B C *are so much longer than the tendon edges* D C *and* F B, *that even when the muscle is maximally contracted, for example* B L, *the shorter of the diagonals* P M *still form the obtuse angles* M P B and P M L *with the opposite tendon edges* P B *and* M L.

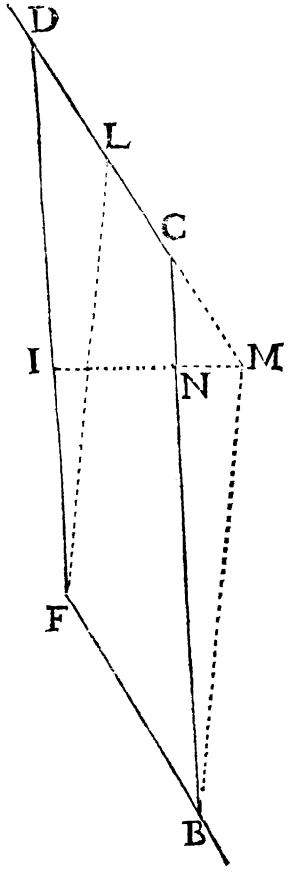
On the various swelling in long muscles depending on their different locations.

In this muscle the lateral surface B D *is supposed to be perpendicular to the part on which the muscle is supported, the extremity to be immobile* B *and the immobile edge* B C *to be close and parallel to the same part B D. From what precedes it appears that there will be an equal swelling over the entire space occupied by the edge* P L, *since this swelling is nothing else than that created when (a) the thickness or the distance between the flesh edges in the Order increases. The measure of this swelling is the excess of length of* M N *over the straight line* M I.[21]

(a) def. 22.

In the same muscle if the immobile edge B F *is supported to be directed towards the part on which the muscle is supported, the swelling will not be even as it was in the preceding case. The further you move a finger over the transverse surface* B C *from the fixed extremity towards the mobile extremity, the bigger you will feel the swelling.*

See the following fig.



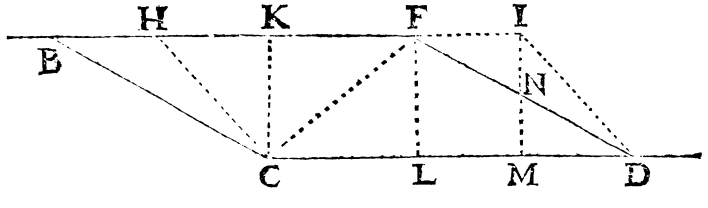
cum non modo B C, *ab* F D; *ſed etiam* F D, *a plano partis, cui incumbit muſculus, recedat, & huius tumorem maximum menſurat exceſſus, quo recta* M I, *ſuperat rectam* N I.

In eodem muſculo. Si ponatur, planum laterale B D, *parti, cui muſculus incumbit, parallelum, cum in contra-*
(a) *ſup* 4. *ctione muſculi* (a) *latitudo eius maneat eadem, nullus in hoc caſu ſupra partem obſeruabitur tumor.*

Hinc patet poſſe muſculos æquales diuerſo modo ita collocari, vt in vno verus ſentiatur tumor, in altero tumor vero maior, in tertio nullus.

De vario tumore muſculorũ carnes breues habentium pro vario illorum ſitu.

Sit 11. *muſculus* B D, *in quo carnoſa latera* B C,



F D, *tendinoſis lateribus* B F, C D, *tantò breuiora, vt*

Since not only B C *recedes from* F D [forming B M], *but even* F D *withdraws from the surface of that part on which the muscle is supported* [forming F L], *thus the maximum swelling is the excess of length of* M I *over the straight line* N I.[22]

In the same muscle the lateral surface B D *is supposed to be parallel to the part on which the muscle is supported. Since during contraction the width of the muscle (a) remains the same, no swelling will be observed above the supporting part in this instance.*

(a) sup. 4.

This shows that equal muscles can be placed in different ways so that in one a swelling is felt, in another an even larger swelling, and in a third no swelling is felt at all.

On the variable swelling in short muscles depending on their location.

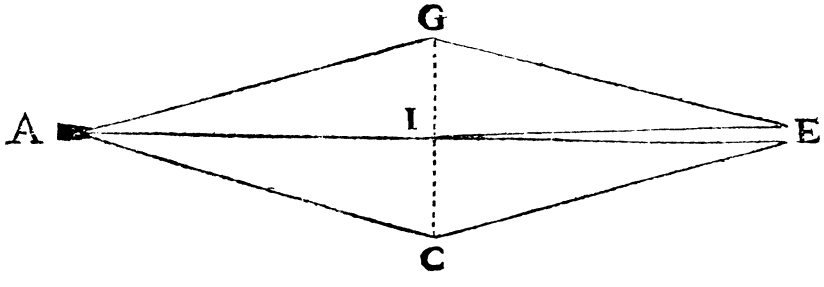
Second, in the muscle B D, *the flesh edges* B C *and* F D *are so much shorter than the tendon edges* B F *and* C D, *that even the shorter of the diagonals* F C *in*

vt etiam in non contracto muſculo diagonalium breuior F C, *cum tendinoſis lateribus* B F, C D, *angulos* B F C, F C D, *acutos conſtituat.*

In hoc muſculo, ſi ponatur extremitas quieſcens D, *latus quieſcens* D C, *parti, cui muſculus incumbit, proximum, & parallelum; ex ante demonſtratis liquet, toto ſpatio, quod latus tendinoſum* G F, *occupat, nullum tumorem obſeruandum; cum diſtantia inter latera tendinoſa* (a) *altitudo ſit, quæ ſemper* (b) *eadem manet: ſpatio autem* F D, *ſentietur tumor inæqualis, cum* (c) *angulus* F D C, *augeatur. Atque hic dum extremitas* F D, *ab* F, *ad* I, *procedit, ſi inter* F, *&* N, *ponatur digitus in latere* F D, *ſentietur tumor, & digitum eleuans, & ſub digito progrediens.*

(a) *def.* 21.
(b) *lem.* 4.
(c) *lem.* 6.

Licet de muſculis compoſitis ex ſimplicibus iudicium fieri poſſit, apponam nihilominus etiam vnum in hoc caſu exemplum.



Sit itaque III. *muſculus* A E, *compoſitus ex muſculis ſimplicibus* A C E I, *&* A G E I, *latera tendinoſa*

De tumore muſculi cõpoſiti.

the non-contracted muscle forms acute angles B F C *and* F C D *with the tendon edges* B F *and* C D.

In this muscle the immobile extremity is supposed to be D. *The immobile edge* D C *is close and parallel to that part on which the muscle is supported. From what has been previously demonstrated, it is clear, that in all that space occupied by the tendon edge* B F *no swelling is to be observed, since the distance between the tendon edges (a) is the height, which always remains the same (b). But in the space* F D *an uneven swelling is felt, since (c) the angle* F D C *widens. As the extremity* F D *proceeds from* F *to* I, *when one puts a finger on the edge* F D, *between* F *and* N, *one feels the swelling, which raises the finger and progresses under it.*

(a) def. 21.

(b) lem. 4.

(c) lem. 6.

Even though one may get an idea of the compound muscles from the simple ones, I will nevertheless give one example of the compound.

On the swelling of a compound muscle.

Third, a muscle A E *is made of the simple muscles* A C E I *and* A G E I.

ſa C A, E I, G A, *latera carnoſa* E G, I A, F C, *anguli acuti ad* A, *&* *ad* E: *recta* C G, *longior erit in muſculo contracto, quam erat in eodem non contracto.*

(a) *lem.* 6. *Cum anguli acuti in contractione muſculi* (a) *amplientur, angulus* C A I, *erit maior in muſculo contracto, quam in eodem non contracto. Sed & angulus* G A I, *ob eandem rationem ampliatur. Ergo ex angulis* C A I, *&* G A I, *compoſitus angulus* C A G, *in muſculo contracto maior erit, quam erat in muſculo non contracto. Iam verò cum latera tendinoſa* A C, *&* A G

(b) *ſup.* 1. (b) *eadem ſint in muſculo contracto, quæ erant in muſculo non contracto, angulus verò lateribus æqualibus comprehenſus demonſtratus ſit maior in muſculo contracto, quam erat in muſculo non contracto, erit quoq; baſis* C G, *maior in muſculo contracto, quam erat in muſculo non contracto. In hoc caſu manifeſtus in medio tumor erit.*

Atque ita quidem abunde demonſtratum puto in omni muſculo, dum contrahitur, tumorem contingere, etiamſi nulla noua muſculo accederet materia: id quod me demonſtraturum promiſeram, tum quo pateret, vt vt ingenioſa ſint, nondum tamen eſſe certa, quæ de nouæ materiæ in muſculum influxu a multis proponuntur, tum vt fabricæ nouæ vſus in motu muſculorum explicando euaderet manifeſtus. Quod ſi iam demonſtrarem, quamlibet partem carnis in fibra motrice tranſuerſim diſſecta pari ratione contrahi, ac contrahebatur tota caro, idque reſectis etiam arterijs, venis, & neruis, nihil amplius de illorum ſyſtemate reſtaret; cum nec fabri-

ca

The tendon edges are C A, E I, *and* G A, *the flesh edges are* E G, I A, *and* E C, *and the acute angles are at* A *and* E. *The straight line* C G *will be longer in the contracted muscle than it was in the non-contracted muscle.*

Since the acute angles widen during contraction of
(a) lem. 6. *the muscle (a), the angle* C A I *is wider in the contracted than in the non-contracted muscle. And for the same reason the angle* G A I *also widens. Thus, [ergo] the angle* C A G *made of the angles* C A I *and* G A I *is wider in the contracted than it was in the noncontracted muscle. But since the tendon edges* A C *and*
(b) sup. 1. *A G (b) are the same in the contracted as they were in the non-contracted muscle and an angle formed by equal sides has been demonstrated to be larger in the contracted muscle than it was in the non-contracted muscle, the base* C G *will also be larger in the contracted than it was in the non-contracted muscle. In this instance a swelling will appear in the middle.*

I thus think it is amply demonstrated in every muscle that when it contracts swelling occurs, even if no new substance enters the muscle. This is what I had promised to demonstrate, in part to make it clear that, whatever clever arguments are proposed from several sides about an influx of new substance into the muscle, they are by no means proven, and in part to show the usefulness of the new muscle structure to explain the movement of muscles. If I demonstrated that any part of flesh in a motor fiber cut transversely contracts in the same proportion as did the whole flesh even after arteries, veins, and nerves have been removed, then there would remain nothing of their theory. Moreover, the structure they propose is unlike any

ca ab illis propoſita naturali fabricæ ſimilis ſit; nec argumentum, quo nouæ materiæ acceſſionem inferebant, certum; nec ipſa nouæ materiæ acceſſio vero ſimilis. Sed de his alio tempore diſſerendi locus erit.

In allatis propoſitionibus nullam tendinum extra carnes protenſorum rationem habui, longitudinem muſculi ſola diagonalium longiori metitus. Cum verò multi dentur muſculi, quorum vel vterq; vel alteruter tendo extra carnes protenditur, dubitari poſſet, ſi hæ tendinum portiones ante contractionem inter ſe parallelæ, poſt contractionem in vnam rectam cum diagonalium longiori extenderentur, anne mutatus ita tendinum ſitus longitudini muſculi reſtituere poſſit, quod contractio carnium illi detraxit. *De tendinũ portionibus extra muſculum exſtãtibus.*

Memini, hanc mihi difficultatem in illuſtri conſeſſu aliquando motam, quocirca, vt pateat, & iuſtam dubitandi occaſionem illi fuiſſe, qui hanc difficultatem propoſuit, & ſimul conſtet, quid de toto negotio ſtatuendum ſit, ex re fore iudicaui, ſequentia prioribus ſubiungere.

Eſto muſculus A E, *latera tendinoſa extra parallelogrammum carnium continuata* F A, C E, *partes tendinoſorum laterum extantes* B A, D E, *longitudo muſculi* A E, *extremitas quieſcens* E; *contrahatur, ſitque muſculus contractus* G E, *latera tendinoſa continuata* G I, C E, *partes laterum tendinoſorum extantes* G H, D E, *longitudo muſculi* G E, *diagonalis longior* H D. *Continue-*

tur

natural structure, and the reasoning by which they inferred the arrival of new substance is not certain, nor is the arrival of new substance itself likely. But this will be discussed another time.

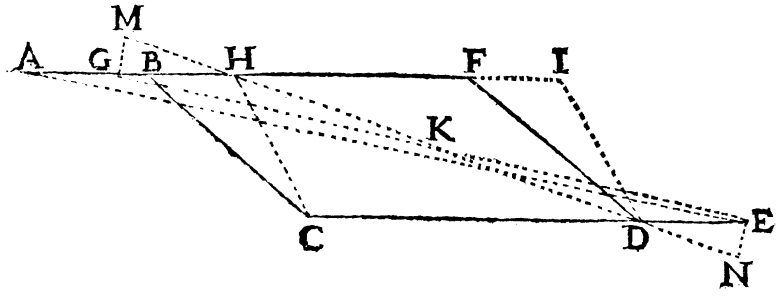
In the propositions thus presented, I have not mentioned the tendon parts protruding outside the flesh, since I have measured the length of the muscle by the length of its longer diagonal only. As, however, there are many muscles from the flesh of which either one or both tendons protrude outside the flesh, one might wonder whether those tendon parts, which were parallel before contraction, would extend into one straight line in continuation with the longer diagonal, or whether the change of position of the tendons could restore the length of the muscle which the contraction itself had shortened.

On the tendon parts outside the muscles.

I remember that this problem was presented to me once in a learned assembly. Therefore, to show that the one who raised this objection had a good reason to wonder, and altogether to make clear what must be said about the whole matter, I decided to add the following consideration.

A muscle A E *is supposed in which the tendon edges* F A *and* C E *continue outside the flesh parallelogram.* B A *and* D E *are the protruding parts of the tendons,* A E *is the length of the muscle, and* E *its immobile extremity. The muscle contracts. The contracted muscle is* G E. *The total tendon edges are* G I *and* C E, *their protruding parts are* G H *and* D E. *The length of the muscle is* G E, *and its longer diagonal is* H D.

(a) *poſt* 2. 1. *tur* H D, *vtrinque in infinitum* (a) *fiatque* H M,
(b) 4. 1. *æqualis* H G (b), *&* D N, *æqualis* D E.



Si placet rectam M N, *cum recta* G E, *comparare, patebit rectam* M N, *ſemper maiorem eſſe recta* G E.

(c) *ex conſtr.* (d) 20. 1. *Recta* H G (c) *æqualis eſt rectæ* H M, *at in triangulo* G H K, *latera* H G, *&* H K, *ſimul ſumpta* (d) *maiora ſunt tertio* G K, *ergo recta* M K, *æqualis iſtis duobus lateribus ſimul ſumptis maior eſt recta* G K, *eodem modo demonſtratur rectam* K N, *maiorem rectæ* K E. *Ergo cum ſingulæ partes rectæ* M N, *maiores ſint ſingulis partibus rectæ* G E, *erit ipſa* M N, *maior quam recta* G E, *adeoq; idem muſculus contractus longior eſt, ſi in eandem rectam cum diagonalium longiori extantes tendinum partes coinciderent, quam ſi toti tendines inter ſe manerent paralleli.*

Quod ſi verò rectam M N, *cum recta* A E, *compa-*
(e) *poſt* 2. 1. *rare libuerit: continuetur* (e) C D, *a parte* C, *in infi-*
(f) 4. 1. *nitum, fiatque* (f) D O, *æqualis* D M, *a puncto* A,
(g) 12. 1. *in rectam* D C, *continuatam cadat* (g) *perpendicularis* A P.

Triplex

Let the line H D *on both sides continue ad infinitum (a), and mark* H M *equal to* H G *(b), and* D N *equal to* D E.

(a) *post. I.2.*
(b) *I.4.*

Then please compare the straight line M N *and the straight line* G E. *It appears that the straight line* M N *will always be longer than the straight line* G E.

The straight line H G *(c) is equal to the straight line* H M. *In the triangle* G H K *the sum of the sides* H G *and* H K *(d) is larger than the third side* G K. *Thus, [ergo] the straight line* M K, *being equal to the sum of the two mentioned sides* [H G + H K], *is longer than the straight line* G K. *It is demonstrated in the same way that the straight line* K N *is longer than the straight line* K E. *Thus, [ergo] since the single parts of the straight line* M N *are longer than the single parts of the straight line* G E, M N *itself will be longer than the straight line* G E. *Therefore, the same contracted muscle is longer if the protruding parts of the tendons coincide with the longer of the diagonals than if both tendons remain parallel to each other.*

(c) *from the construction.*

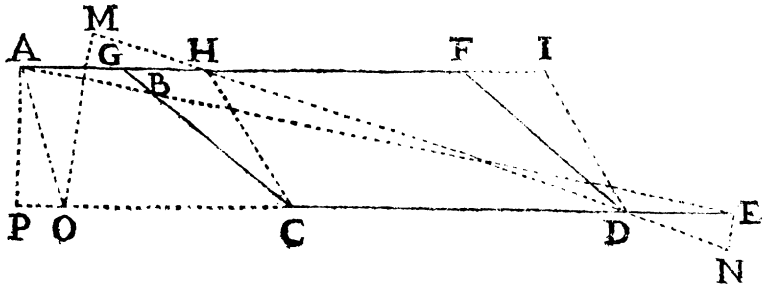
(d) *I.20.*

But actually if one wants to compare the straight line M N *with the straight line* A E,[23] *(e)* C D *is drawn ad infinitum from* C. D O *becomes equal to D M (f). A perpendicular* A P *is drawn from the point A (g) to the continuation of the straight line D C.*

(e) *post I.2.*
(f) *I.4.*
(g) *I.12.*

Triplex hìc dari poterit caſus ; cum perpendicularis A P, *cadere poſsit vel in ipſam extremitatem rectæ* O E, *vel intra eandem, vel extra.*

Siue in ipſam extremitatem rectæ O E, *cadat, ſiue extra eam, ſemper* M N, *erit minor, quàm* A E.



Sit P E, *æqualis* M N: *in triangulo* A P E, *angulus* A P E, (a) *eſt rectus, ergo* (b) *æqualis angulis duobus reliquis* P A E, *&* P E A, *ſimul ſumptis : Ergo maior angulo* P A E, *ſeorſim ſumpto : cum verò in eodem triangulo maior angulus* (c) *a maiori latere ſubtendatur, erit* A E, *maior quam* P E, *vel ipſi æqualis* M N. *Cadat perpendicularis extra punctum* O, *erit in triangulo* A P O, *angulus externus* A O E (d) *interno, & oppoſito* A P O, *maior, at hunc maiorem angulo* P A E, *iam ante demonſtraui, ergo erit multo maior angulo* O A E, *adeoque, & recta* O E (e) *minor recta* M N.

(a) *ex conſtr.*
(b) 32. 1.
(c) 18. 1.
(d) 16. 1.
(e) 18. 1.

Quod ſi perpendicularis A P, *caderet intra punctum* O, *verſus* C, *poſſet contingere vt angulus* E O A, *fieret æqualis angulo* E A O, *adeoque recta* E O, *ſeu*

E M N,

There may be three different cases: the perpendicular A P *can fall either on the extremity of the straight line* O E, *or inside or outside this extremity.*

Whether falling on the extremity itself of O E *or outside this extremity,* M N *will always be smaller than* A E.

Let P E *be equal to* M N. *In the triangle* A P E, *the angle* A P E *(a) is a right angle. Thus, [ergo] (b) it is equal to the sum of the other two angles* P A E + P E A. *Therefore, [ergo] it is larger than* P A E *alone. Since actually in the same triangle (c) a larger angle spans a longer side,* A E *will be longer than* P E *or its equal* M N. *If the perpendicular falls outside the point* O, *the outer angle* A O E *(d) in the triangle* A P O *will be larger than the inner and opposite angle* A P O, *which angle I have already demonstrated to be larger than the angle* P A E. *Thus, [ergo]* [the angle A O E] *is much larger than the angle* O A E. *Therefore the straight line* O E *(e) or* M N *is shorter than the straight line* A E.

(a) from the construction.
*(b) I.*32.
*(c) I.*18.
*(d) I.*16.
*(e) I.*18.

If the perpendicular A P *fell inside* O *towards* C, *it might happen that the angle* E O A *would be equal to the angle* E A O. *Therefore, the straight line* E O *or*

M N, *æqualis rectæ* A E, *imo poſſet contingere, vt angulus* E O A, *fieret maior angulo* E A O, *& per conſequens* M N, *maior quàm* A E: *ſed cum contractio nunquam exigua adeo ſit, vt hic caſus locum habere poſsit, illi amplius non immorandum eſt; præcipuè cum experientia demonſtret, eo modo oſsibus continuatos eſſe muſculos, eaque ratione aliorum muſculorum vicinia, membranarumque inuolucris conſtrictos, vt extantes tendinum portiones vix vnquam in rectam lineam cum diagonalium longiori poſſint extendi.*

Tabularũ explicatio. Expoſito ſic Elementorum myologiæ Specimine, reſtat exemplis ex ipſa Natura depromptis eorundem certitudinem demonſtrem, figuras variorum muſculorum oſtendendo potiùs, quàm explicando, cum res adeò euidens ſit, vt vel ſola inſpectio ſine explicatione ſufficere poſſit.

Figurarum plærę que plana ordinum referunt, vbi ſingula latera, ſingulique anguli eadem magnitudine exhibentur, qua in cadauere a me menſurata ſunt.

Tendines per trapezia expreſſi ſunt, nulla facta fibrarum diſtinctione, tum quod in motu muſculi explicando nullus eorum vſus, tum quod non potuiſſent in tam exiguo ſpatio omnes exactè repræſentari.

Antequam ad muſculorum figuras progrediar, ex Tabulę primæ explicatione, in ſuperioribus ſparſim propoſita, paucis hìc repetam, quæ neceſſaria mihi viſa ſunt ad fibræ motricis, ordinis, verſus, muſculi

M N *would be equal to the straight line* A E. *It might even happen that the angle* E O A *would become larger than the angle* E A O *and, consequently,* M N *larger than* A E. *But since the contraction can never be so slight that a situation like this could possibly occur, it is needless to dwell longer on this situation. Especially since experience indicates that the muscles themselves are in continuation with the bones, they are packed against one another, and are constricted by membranous envelopes in such a way that the protruding parts of the tendons at any time can hardly be extended into a straight line common with the longer diagonal.*

Explanation of the plates. [pp. «226–228»]

Now that some Specimens of Elements of Myology have been presented, I have to demonstrate that they are certain through examples taken from Nature itself. I shall do this rather by showing figures of different muscles (Plate I, II, III) than through explanation, since the whole matter is so evident that, without any explanation, inspection alone is sufficient.

Most of the figures show the surface of the Orders in which different single edges and different angles are displayed at the magnitude at which I have measured them in cadavers.

The tendons are drawn like trapezia without making any distinction as to their fibers because, on one hand, they are not needed to explain the movement of the muscle and, on the other hand, all of them could not be represented accurately in such a small space.

Before proceeding to the figures of muscles, let me repeat briefly in Plate I points proposed at different places above which to me seem necessary to understand more easily at a glance the motor fiber, the Order, the Rank, and the structure of the muscle.

ſculi fabricas vno intuitu conſpectas tanto facilius intelligendas.

TABVLA I.

Fig. I. A B C D, Fibra motrix rectilinea eſt; B C, caro; A B, C D Tendines. *Fibra motrix.*

Fig. II. A B C D, Fibra motrix rectilinea inflexa eſt, A B C, B C D anguli alterni obtuſi.

Fig. III. Exhibet nouẽ fibras rectilineas inæqualiter æquales, & ſecundum tendinum exceſſum diſpoſitas. *Ordo.*

Fig. IV. Exhibet eaſdem nouem fibras motrices inflexas.

Fig. V. Exhibet eaſdem nouem fibras motrices vnitas quo modo in ordine conſpiciuntur, vbi B C F G eſt parallelogrammum carnium, A B F E, H G C D duo trapezia tendinum. Inter carnes relicta ſpacia ſunt, quo diſtinctius omnia conſpicerentur.

Fig. VI. Exhibet fibras motrices æqualiter æquales eò ſitu, quo in verſu conſpiciuntur: vbi B C L K, rectangulum carnium eſt, A B K I, L C D M duo rectangula tendinum. Non potuere fibræ omnes eadem magnitudine exprimi, propter diuerſorum planorum non in eodem plano collocatorum ſitum ſecundum perſpectiuæ leges exprimendum. *Verſus.*

Fig. VII. Exhibet muſculum ex nouem ordinibus compoſitum, prout in definitione muſculi dictum eſt, A D primus ordo eſt, cui ſequentes octo paralleli ſunt. *Muſculus.*

TABVLA II.

Fig. I. A H planum ordinum in parte interiori Gaſterocnemij *Gaſterocnemius.*

PLATE I.

[See p. «226»]

Fig. I. A B C D is a rectilinear motor fiber; B C is the flesh; A B and C D are the tendons. *The motor fiber.*

Fig. II. A B C D is a rectilinear inflected motor fiber; A B C and B C D are the alternate obtuse angles.

Fig. III shows nine unequally equal [def. 17] rectilinear fibers arranged according to the increment of the tendons [def. 18].

Fig. IV shows the same nine motor fibers inflected.

Fig. V shows the same nine motor fibers united in the way they appear in an Order, in which B C F G is the flesh parallelogram, and A B F E and H G C D are the two tendon trapezia. Between the flesh parts empty spaces are left to show all more distinctly. *The Order.*

Fig. VI shows equally equal motor fibers located as they appear in a Rank. There, B C L K, is the flesh rectangle, and A B K I and L C D M are the two tendon rectangles. To create perspective according to the rules, it has not been possible to draw all the fibers at the same magnitude, because the different surfaces are not on the same plane. *The Rank.*

Fig. VII shows a muscle made of nine Orders as described in the definition of the muscle. A D is the first Order followed by eight parallel Orders. *The muscle.*

PLATE II.

[See p. «227»]

Fig. I. A H is the plane of the Orders in the interior part of the calf muscle, *Gastrocnemius muscle*

ſterocnemij, vbi A B F E, H G C D trapezia tendinum ſunt, B F G C parallelogrammum carnium. In hoc parallelogrammo latera F B, G C latera tendinoſa ſunt, latera verò F G, B C latera carnoſa. A extremitas ſuperior, H extremitas inferior G D ſuperficies interior, quæ Soleo contigua eſt. Sola inſpectione patet veritas eorum, quæ de ordine ſupra propoſuimus.

Hic muſculus ſimplex eſt, & ex eorum genere, in quibus Diagonalis breuior ſemper acutos angulos cum lateribus tendinoſis comprehendit, adeòque accommodari poſſunt illi, quæ ſupra de tumore muſculi in ſecundo exemplo allata ſunt. Pag. 28.

Biceps manus. *Fig. II.* E H eſt planum ordinum in bicipite manus, vbi E extremitas ſuperior, H extremitas inferior. In hoc muſculo duo notanda, quibus a precedenti differt, 1. quod compoſitus ſit ex duobus ſimplicibus muſculis A H, & a H ita ſibi mutuò appoſitis vt tendines inferiores D C G H, & d c G H, vnum tendinem conſtituant intra carnes reconditum, tendines verò ſuperiores A E F B, a E F b, carnem intra ſe contineant. 2. quod carnium hìc ea ſit longitudo, vt diagonales breuiores ſemper obtuſos cum oppoſitis tendinibus conſtituant angulos. In hoc muſculo dum contrahitur manifeſtus ſentitur tumor, cum angulus B E b, fiat amplior, & laterum carnoſorum B C, b c diſtantia, id eſt craſſities muſculi augeatur: Adde quod extremitas H eleuetur, adeoque angulus, quem recta H E, cum oſſe brachij con-

in which A B F E and H G C D are the tendon trapezia and B F G C the flesh parallelogram. In this parallelogram F B and G C are the tendon edges, and F G and B C are the flesh edges. A is the upper extremity, H is the lower extremity, and G D is the inner surface which is contiguous to the soleus muscle. The truth of what we proposed above concerning the Orders appears from a simple inspection.

This is a simple muscle of the kind of those in which the shorter diagonal always forms acute angles with the tendon edges. Therefore, what
Pag. 28. has been said above in the second example about the swelling of the muscle can apply to it.

Biceps muscle. *Fig. II.* E H is the plane of the Orders in the biceps muscle of the arm,[24] in which E is the upper extremity, and H the lower extremity. In this muscle two things must be noticed which differ from the previous muscle: 1) The muscle is composed of two simple muscles A H and a H put together in such a way that the lower tendons D C G H and d c G H constitute one tendon hidden inside the flesh, whereas the upper tendons A E F B and a E F b contain flesh inside themselves. 2) The length of the flesh parts here is such that the shorter diagonals always form obtuse angles with the opposite tendons. When this muscle contracts, an obvious swelling is felt, since the angle B E b widens and the distance between the flesh edges B C and b c, i.e., the thickness of the muscle, increases. Add that the extremity H is raised. Therefore, the angle formed by the straight line H E and the humerus

conſtituit, amplietur, quæ cauſæ ſimul concurrentes ſatis manifeſtum tumorem producere poſſunt, etiamſi nulla noua materia accederet.

Fig. III. A H muſculus ſemimembranoſus, cuius fabrica in eo differt a fabrica Gaſterocnemij, quod ſuperioris tendinis trapezium A B F E, inferioris tendinis trapezio H G C D, ſimile non ſit; cum fibræ motrices vtrimq; æqualiter non ſint inflexæ. Hinc factum vt multarum fibrarum tendines ſupra planum extremum carnium eleuati membranæ figuram repræſentent, adeoque muſculo ſemimembranoſi nomen pepererint. *Semimembranoſus*

Fig. IV. K R muſculus ſemineruoſus ita dictus, quod extremitas inferior R T tendines habuerit in figuram cylindraceam vnitos. Hìc alia compoſitionis ratio eſt, qua vnius muſculi ſuperior tendo cum alterius muſculi inferiori tendine ita vnitur, vt vtriuſq; muſculi carnes a mutuo contactu per hoc interſepimentum tendinoſum N O ſeparati maneant. *Semineruoſus.*

TABVLA III.

Fig. I. Muſculi Deltroidis elegantem fabricam exhibet, vbi duodecim ſimplices numerantur muſculi, eo modo ſinguli inter ſe vniti, & compoſiti, quo in bicipiti manus binos ſimplices inter ſe vnitos deſcripſi: ſpatia quæ hìc, & inferiùs, & ſuperiùs vacua apparent, carnibus etiam plena ſunt; ſed cum hac ſectione reſecetur pars altera tendinum, cui continuantur *Deltoides.*

widens. These concurrent causes can produce an obvious swelling even without the arrival of any new substance.

Semimembranous muscle.

Fig. III. A H is the semimembranous muscle the structure of which differs from that of the gastrocnemius muscle in that the upper tendon trapezium A B F E is not similar to the lower tendon trapezium H G C D, since the motor fibers are not equally inflected on the two sides. For this reason the tendons of many fibers raised above the end surface of the flesh parts form a membrane, thus giving the muscle its name the semimembranous muscle.

Semitendinous muscle.

Fig. IV. K R, the so-called semitendinous[25] muscle is so named because its lower extremity R T has tendons united in the shape of a cylinder. Here the explanation of this arrangement is that the upper tendon of one muscle is united with the lower tendon of another muscle in such a way that the flesh parts of the two muscles remain separated from each other by a tendinous curtain N O.

PLATE III.

[See p. «228»]

Deltoid muscle.

Fig. I shows the delicate structure of the deltoid muscle in which twelve single muscles are counted. They are united and arranged in the same manner as the two muscles which I have described in the biceps muscle. The empty looking spaces above and below are filled up with flesh. But with this resection another part of the tendons is resected into which

nuantur carnes iſtæ, ſolas illas hìc afferre volui quarum vtraque extremitas eſſet conſpicua.

Maſſeter. *Fig. II.* Exhibet planum ordinis ex illa Maſſeteris parte, quæ ab angulo maxillæ inferioris verſus anteriorem partem oſſis iugalis fertur. A eſt extremitas ſuperior, quæ oſſi iugali continuatur, D extremitas inferior, quæ maxillæ inferiori continuatur, latus A B D, oſſi maxillæ obuerſum.

Ex tribus diuerſis ordinibus compoſitus eſt hic ordo, quorum vnus D B A F, alter, D C A F, tertius D C G E, latera carnoſa B D, F A, D C, E G. latera tendinoſa B A, D F, C A, D E. manifeſtum huius muſculi in contractione tumorem eſſe, quilibet in ſe facile deprehenderit, maxillam inferiorem verſus ſuperiorem violentius adducendo. Qui tumor ex ſuperius expoſitis ſine nouæ materiæ acceſſione facile explicatur.

Explicatio tumoris, qui in maſſeteris contractione obſeruatur.

Cum angulus B D E, *compoſitus ſit ex trium muſculorum tribus angulis acutis* B D F, F D C, C D E, *eorumque quilibet* (a) *in contractione muſculi augeatur, etiam ipſe angulus* B D E, *augebitur; cum verò latus carnoſum* B D, *maxillæ obuerſum reſiſtentiam inueniat, oportet latus* D E, *moueatur.* Et hoc ipſis ſenſibus manifeſtum eſt: quod ſi enim digitum maxillæ inferiori prope angulum ſuppoſueris, ſenties tumorem verſus digitum deſcendere, qui non aliunde oritur, quam quod latus D E, a latere D B, recedat.

(a) *lemma 6.*

Sed & anguli B A F, F A C, *itidem ampliantur,* (b) *cum ſint acuti in muſculo anguli, ergo & circa os iugale*

(b) *lemm. 6.*

this flesh extends. I wished to show here those parts of flesh alone the extremity of which would be conspicuous.

Masseter muscle.

Fig. II shows the plane of an Order in that part of the masseter muscle which connects the angle of the mandible and the anterior aspect of the zygomatic bone. A is the upper end which continues into the zygomatic bone, D is the lower end which continues into the mandible. The side ABD faces the mandible.

This Order is made of three different Orders, the first of which is D B A F, the second D C A F, and the third D C G E. The flesh edges are B D, F A, D C, and E G, and the tendon edges are B A, D F, C A, and D E. Anybody can easily feel on himself a swelling during the contraction of the [masseter] muscle by clenching one's teeth. From what was said above, this swelling is easily explained without the arrival of new material.

Explanation of the swelling observed in the contraction of the masseter muscle.

Since the angle B D E *is made of the three acute angles of the three muscles* B D F, F D C, *and* C D E, *anyone of which (a) widens during contraction of the muscle, the angle* B D E *widens also. But since the flesh edge* B D *facing the mandible meets resistance, the edge* D E *has to move.* This is obvious: if you put a finger on your mandible close to its angle, you will feel the swelling descend towards your finger. This results from the fact that the edge D E recedes from the edge D B.

(a) lemma 6.

But the angles B A F *and* F A C *(b) widen in the same way since they are acute angles in the muscle. Thus, [ergo] about the zygomatic bone*

(b) lemma 6.

iugale, cui extremitas A *continuatur, tumor erit; circa medium maſſeteris, vbi minimi muſculi latus carnoſum* E G *deſinit, nempe in ſpatio* E G, *itidem tumor erit, cum angulus acutus* E G C, *augeatur. Patet itaque & in extremitatibus huius muſculi, & in medio eius tumorem ſentiendum. Quod ſi cui vlterius conſiderare libuerit tumores ab acutis angulis reliquarum duarum maſſeteris partium huic exteriori parti ſuppoſitarum, & ſimul maſſeteris ſitum verſus interiora ante contractionem incuruatum perpendere, non mirabitur amplius eadem in muſculo ſubſiſtente materia tumorem admodum manifeſtum futurum.*

Fig. III. De piſcium muſculis vix ab vllo facta mentio; elegans eorum artificium obſeruationes noſtras euidentiſſimè confirmat. Poſſem in eum finem varia exempla adducere, vt muſculorum intercoſtalibus noſtris reſpondentium, oculos, branchias, pinnas mouentium, aliorumque; ſed cum necdum in omnibus mihi ita ſatisfecerim, quin adhuc in quibuſdam eorum quædam mihi reſtent vlteriori inueſtigatione examinanda, ſuffecerit vnicum exemplum hìc adduxiſſe ex Cane Carcharia depromptum. *Piſcium muſculi.*

Planum hoc perpendiculare eſt in planum illud, in quo ſunt omnes vertebrarum ſpinæ, & parallelum lineæ, in qua ſunt extremitates ſpinarum. Recta A B, eſt communis ſectio plani huius, & plani ſpinæ: compoſitionis concinnitas ſola inſpectione patet.

Fig. IV. Volui quoq; ex cruſtaceis exemplum Aſtaci apponere

into which the extremity A *continues there will also be a swelling. About the middle of the masseter muscle where the flesh edge* E G *of the smallest muscle ends, i.e., in the space* E G, *there will be swelling in the same way, since the acute angle* E G C *increases.*

Thus it appears that a swelling must be felt at the extremities and at the middle of this muscle. And if somebody likes to consider further the swelling due to the acute angles of the other two parts of the masseter muscle set behind this exterior part and the other located in a curve behind the inner part, he will no longer be surprised that although the substance in the muscle is unchanged, an obvious swelling will occur.

Muscles of fish.

Fig. III. Hardly anyone has mentioned the muscles of fish. Their delicate pattern most obviously confirms our observations. I could bring forward several examples supporting this point of view, such as that of the muscles corresponding to our intercostal muscles or that of the muscles moving the eyes, the gills, the fins, etc. But since I still have not satisfied all of my own curiosity so that in some cases I still have to investigate further, it will be enough to present here one example, drawn from the shark, Canis Carcharia.

The plane here is perpendicular to that plane in which all the vertebral spinous processes are located, and parallel to the line of the extremities of all the spinous processes. The straight line A B is a section commonly shared by the former plane and the plane of the spinous processes. The elegance of the structure appear at a simple inspection.

Fig. IV. I wanted also to consider the example of the lobster among the crustaceans.

Muſculi adductores & abductores in chela Aſtaci.

apponere, quo nomine ex chela maiori muſculos extraxi, quibus eam aperit clauditque, quos more Anatomicis ſolito abductorem, & adductorem appellabo: maior figura exhibet fibrarum ordinem compoſitum in adductore, vbi A B, tendo inter carnes medius eſt parti mobili inſertus: E I, F K, tendines exteriores ſunt, parti quieſcenti adhærentes. Figura minor exhibet fibrarum ordinem compoſitum in adductore, vbi C D, tendo inter carnes medius parti mobili inſertus: G L, H M, tendines exteriores ſunt parti quieſcenti continui.

In quo conſiſtat vis chelarum.

Non dubito, quin Lectori gratum futurum ſit, ſcire in quo conſiſtat magna illa chelarum vis, qua corpora hic ſatis ſolida rumpunt; quocirca ſequentem figuram apponere volui, qua chelæ partem mobilem repræſento ſectam plano perpendiculari ad muſculorum illius plana lateralia, & parallelo ad plana eorundem extrema, imò cum planis extremis inter carnes ſitis coincidente, vbi lineæ continuo ductu deſcriptæ exhibent ſitum, quem habet ea pars, dum adductor contrahitur: lineæ verò ex punctis compoſitæ exhibent ſitum, quem habet eadem pars, cum abductor contrahitur.

B A C K, eſt chelæ pars mobilis, A K, longitudo eiuſdem partis, B A C baſis, A centrum motus, C extremitas, cui inſertus eſt abductor, B extremitas cui inſertus eſt adductor, C E, longitudo lateris tendinoſi in adductore, D B, longitudo lateris tendinoſi in adductore, F G latitudo adductoris,

The adductor and abductor muscles of the lobster's claw.

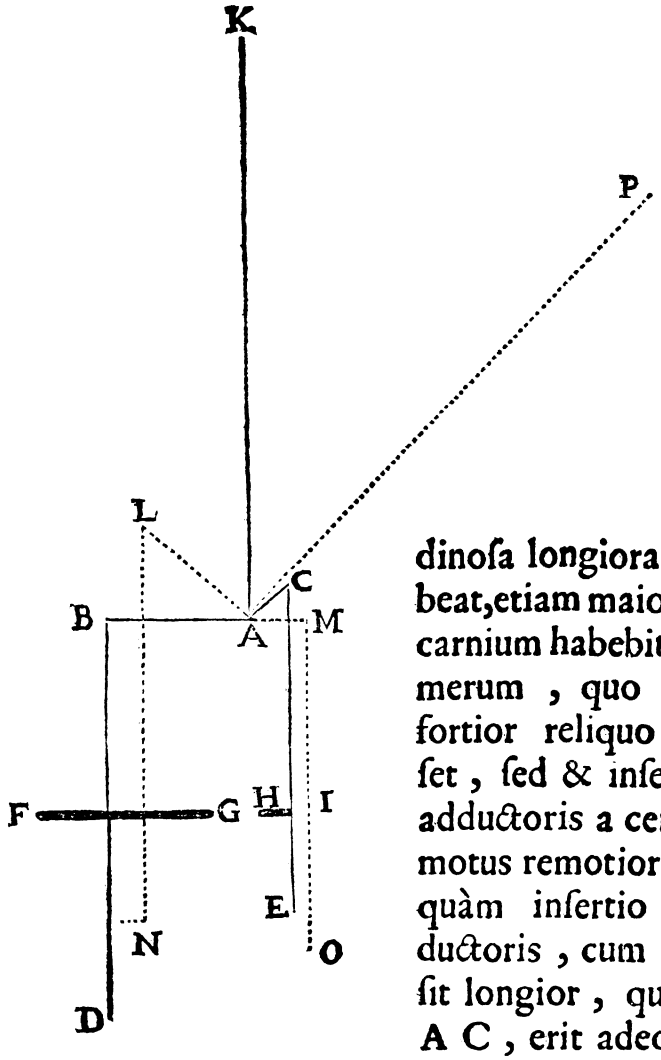
To this end I pulled out the muscles of the major claw, which open and close the claw. In accordance with the usage of anatomists, I shall call them the abductor and the adductor muscles. The larger figure shows a compound Order of fibers in an adductor muscle. There, A B, the tendon inside the flesh, is inserted into the mobile part. E I and F K are the outer tendons adhering to the immobile part. The smaller figure displays a compound Order of fibers in an abductor muscle. There, C D, the tendon inside the flesh, is inserted into the mobile part. G L and H M, the outer tendons, continue into the immobile part.

Of what consists the power of the claws?

I do not doubt that readers will be pleased to know of what the great power of the claws which break fairly hard bodies consists. Therefore, I wanted to show the following figure in which I represent the mobile part of the claw divided by a plane perpendicular to the lateral surfaces of the muscles and parallel to their end surfaces or rather coinciding with the end surfaces sited within the flesh. The uninterrupted lines represent the position of the part when the adductor muscle contracts. The dotted lines show the position which the same part takes, when the abductor muscle contracts.

B A C K is the mobile part of the claw, A K is the length of this part, B A C is its basis, A is the center of movement, C is the extremity into which the abductor muscle is inserted, B is the extremity in which the adductor muscle is inserted, C E is the length of the tendon edge in the abductor muscle, D B is the length of the tendon edge in the abductor muscle, F G is the width

adductoris, H I latitudo abductoris. Cum itaque adductor abductore, & latior ſit, & latera tendi-



dinoſa longiora habeat, etiam maiorem carnium habebit numerum, quo ſolo fortior reliquo eſſet, ſed & inſertio adductoris a centro motus remotior eſt, quàm inſertio abductoris, cum A B ſit longior, quàm A C, erit adeoque gmeino nomine fortior, tum ob maiorem carnium numerum, tum ob commodiorem inſertionis locum.

of the adductor muscle, and H I is the width of the abductor muscle. Since the adductor muscle both is wider and has longer tendon edges than

the abductor muscle, it has more flesh parts. For that reason alone it would be stronger than the abductor muscle. Moreover, the insertion of the adductor muscle is more remote from the center of the movement than that of the abductor muscle, since A B is longer than A C. The adductor thus is stronger for two reasons: more flesh parts and a more efficient insertion.

Sed necdum omnia, ad virium proportionem in hiſce muſculis determinandam neceſſaria examinata ſunt, reſtat in ſingulis examinanda illa pars carnium, quæ longitudini earum decedit, conſiderata tum reſpectu longitudinis totius carnis, tum reſpectu ſpatij, quod extremitas carnis in contractione percurrit. Id verò ſi hìc fuſiùs exponendum eſſet, alia præmittenda fuiſſent, quæ & plus temporis requirerent, & a præſenti inſtituto diuerſa eſſent.

Vt tamen pateat omnibus, non eſſe rem facilem adeò, ac hactenus creditum eſt, vires muſculorum rectè examinare; nec poſſe eaſdem ex alijs principijs, quam quæ hìc propoſui, naturæ conuenienter exprimi; oſtendam quid in ipſis muſculis conſiderandum eſt ad virium proportionem inueniendam, præter eorum inſertionem, circa quàm ferè ſolam hactenus fuere occupati.

Quid in muſculis conſiderãdum ad virium proportionem in illis explicandã.

In muſculis ſimplicibus.

Si duo muſculi ſimplices qualeſcunque inter ſe inæquales fuerint, reducendi ſunt ad duos muſculos rectilineos eiuſdem latitudinis, efficiendo, vt latera tranſuerſa in vtriuſque planis extremis eadem ſint. Inde in hiſce muſculis eiuſdem latitudinis, conferenda ſunt primò latera tendinoſa cum lateribus tendinoſis, quandoquidem ea carnium numerum exprimant; hinc latera carnoſa cum lateribus carnoſis, tum reſpectu partis, quæ longitudini eorum in contractione decedit, tum reſpectu ſpatij, quod extremitas eorum in contractione percurrit.

In muſculis compoſitis.

Si duo muſculi diuerſo modo compoſiti inter ſe comparentur, reducendi ſunt ad duos muſculos ſimplices eiuſdem latitudinis;

But all the necessary examinations have not yet been carried out to determine the ratio of the forces in these muscles, and it remains to be determined in each how much the flesh parts decrease in length, considering both the whole length of the flesh and the distance traveled by the extremity of the flesh during a contraction. Should this indeed be explained more extensively, other premises would be given, which would require more time and would be different from the present description.

What to take into consideration to explain the relative forces of the muscles.

To make it clear to everybody that it is not so easy, as it has been believed so far to examine properly the forces of muscles, and that they cannot be wrung out in agreement with Nature from principles different from those which I proposed here, let me show what must be considered in the muscles to find out their relative forces, beyond their insertion,[26] which was so far about the only subject of interest.

In simple muscles.

If any two simple muscles are unequal, they must be reduced to two rectilinear muscles of the same width, by obtaining that the transverse edges are the same in the end surfaces of both. Thence, in these muscles of the same width, the tendon edges of one muscle must first be compared with the tendon edges of the other muscle since these reveal the number of flesh parts. Then the flesh edges must be compared with the flesh edges, to ascertain how much they shorten their length in contraction, and to ascertain the distance traveled by their extremity during contraction.

In compound muscles.

If two different compound muscles are compared, they must be reduced into two simple muscles of the same width.

latitudinis; *id quod fit*, *carnes diuerſæ longitudinis in eodem muſculo* (*ſi qua fuerit in longitudine diuerſitas*) *ad mediam vnam longitudinem*, *& diuerſa plana extrema in vnum planum datæ latitudinis reducendo*; *quo facto*, *horum duorum inſtituenda eſt comparatio*, *prout modo inſtitui*.

Iam verò, vt carnium in compoſitione diuerſitas, vt planorum extremorum differentia inueniatur, patet neceſſarium eſſe, noſtra methodo muſculorum analyſin inſtituere, eorumque latera carnoſa, latera tendinoſa, latera tranſuerſa, & quæ alia hìc propoſita ſunt, in ipſo corpore menſurare.

De muſculis hactenus quaſi incognitis.

Vt de muſculis noſtri corporis hactenus confusè tantùm notis, ne dicam planè incognitis, quædam hic afferantur, vertebrales muſculos in certum ordinem reductos hìc exponam.

Qui de vertebrarum muſculis Anatomicorum ſcripta inter ſe contulerit, eorumque eoſdem adminiſtrandi modum imitari voluerit, agnoſcet facilè, æquè inter ſe diſcrepare ſingulos, ac a veritate omnes ſunt remoti. Poſſem id plurium Anatomicorum propria teſtari confeſſione, ſed vnus mihi omnium inſtar erit Fallopius, dum ait. Muſculi ita varij „
& complicati ſunt, vt non ſit mirum, ſi Anato- „
tomici Scriptores inter ſe concordes non erunt. „
Nam vt quid ſententiam ingenuè profitear, in- „
digeſta moles, atque confuſum chaos muſculorum „
mihi videtur, in quo Præceptorem deſidero, qui „
diſtinctè ante oculos hos mihi diſſecet, iplorum- „

This is done by averaging the length of the flesh parts of different lengths in each one of the muscles (if there are differences in length) and by reducing the different end surfaces into one surface of a given width. When this has been done, the two muscles can be compared as I described.

It should then be obvious that since differences are found either in the structure of the flesh or in the end surfaces, it is necessary to analyze the muscles by our method and to measure in the body itself the flesh edges, the tendon edges, the transverse edges, and the other elements which were proposed here.

On muscles almost unknown hitherto.

In order to introduce here something concerning muscles of our body only confusedly known hitherto, not to say completely unknown, let me present the spine muscles reduced to a certain order.

Anyone who compared the writings of anatomists on the muscles of the back, and wished to imitate their methods of handling these muscles, will easily recognize that the different anatomists are as much in disagreement with each other as they are all far-off from the truth. I could confirm this by the acknowledgment of several anatomists, but I shall use only one who stands out particularly to me to count for all, and that one is *Fallopius*, when he says:[27] "The muscles are so diverse and complicated that it is no wonder, if the anatomical authors do not agree. To be honest, [the muscles of the back] look to me like an undigested mess, or a confusing chaos of muscles, for which I need a teacher who clearly dissects them before my eyes

„ que partes ad certum numerum, ac ordinem re-
„ ducat.

Vertebralis muſculus. *VERTEBRALIS MVSCVLVS* mihi dicitur, *cuius vtraque extremitas vertebris continua eſt*, eſtque vel rectus, vel obliquus.

Vertebralis rectus. *VERTEBRALIS RECTVS eſt, cuius vtraq; extremitas eſt in eadem linea ſpinali medullæ parallela*, adeoq; ipſius muſculi ſitus ſpinali medullæ parallelus; eſtq; vel *MEDIVS, cuius vtraq: extremitas continuatur medijs proceſsibus, ſeu ſpinis vertebrarum*; vel *LATERALIS, cuius vtraq: extremitas continuatur lateralibus, ſeu tranſuerſis proceſsibus vertebrarum*: ad medios ſpectant ſpinati, ad laterales tranſuerſi: ſed ſunt præter hactenus deſcriptos alij, & medij, & laterales. Poſſent hæc eadem nomina illis imponi, ſed cum τὸ tranſuerſus potiùs ſitum muſculi tranſuerſum exprimat, quàm cum tranſuerſis proceſſibus connexionem; mihi viſum minùs confuſioni obnoxium lateralium nomen, quandoquidem tranſuerſi proceſſus laterales ſint.

Medius. *Lateralis.*

Vertebralis obliquus. *VERTEBRALIS OBLIQVVS eſt, cuius extremitates ſunt in duabus lineis ſpinali medullæ parallelis*: adeoque ipſius muſculi ſitus ad ſpinalem medullam obliquus; eſtque vel *A MEDIO RECEDENS, cuius extremitas ſuperior in proceſsibus lateralibus eſt*, huius generis eſt pars ſplenij inferior, itidem pars longi in collo inferior: vel *AD MEDIVM VERGENS, cuius extremitas inferior in proceſsibus lateralibus eſt*. Hùc ſpectat longi in collo ſecunda pars, & omnes illi, qui a ſpina colli ſecunda ad os ſacrum vſq; im-

A medio recedens. *Ad mediũ vergens.*

mediatè

and reduces their parts to a certain number and order."

Vertebral muscle.

I CALL VERTEBRAL MUSCLE a muscle continuing at both extremities into vertebræ. It is either straight or oblique.

Straight, median, lateral vertebral muscles.

A STRAIGHT VERTEBRAL MUSCLE is a muscle both extremities of which are on the same line parallel to the spinal cord. Therefore, the position of the muscle itself is parallel to the cord. Either the muscle is *MEDIAN, and its both extremities continue into the spinous processes or spines of the vertebræ*; or the muscle is *LATERAL and its extremities continue into the lateral or transverse processes of the vertebræ.* The spinal ones face medially whereas the transverse ones face laterally. But besides the muscles described so far there are others both median and lateral muscles. These same names could be given to them, but since the word transverse describes a transverse position of the muscle rather than a connection with the transverse processes, it seemed to me less confusing to call them lateral, since the transverse processes are lateral.

Oblique vertebral muscle.

AN OBLIQUE VERTEBRAL MUSCLE is a muscle the extremities of which are on two lines parallel to the spinal cord. Therefore, the position of the muscle itself is oblique to the spinal cord, either *RECEDING FROM THE MIDDLE, in which case its upper extremity is in the transverse processes*: the lower part of the splenius muscle and also the lower part of the longus muscle in the neck belong to this kind,

Receding from the middle.

Verging towards the middle.

or *the vertebral muscle is VERGING TOWARDS THE MIDDLE, in which case its lower extremity is in the transverse processes.* The second part of the longus muscle in the neck and all the muscles which lie directly over the vertebræ on both sides, from the second spinous process in the neck down to the os sacrum, belong to these.

mediatè vertebris vtrinq; incumbunt; quibus ſemiſpinati nomen non incongruè imponitur, licet præter ſemiſpinatos aliorum, etiam ſacri, ãlijque hùc ſpectent.

Ex dictis liquet, terminis paucis, ijſque perſpicuis, nec vlli æquiuocationi obnoxijs exprimi poſſe vertebrales muſculos, dum quatuor eorum genera conſtituuntur, quales ſunt *MEDII*, *LATERALES*, *ADMEDIVM VERGENTES*, *A MEDIO RECEDENTES*.

Ferè omnibus hiſce commune eſt, vt vna vertebra ſuperior a pluribus vertebris inferioribus muſculos accipiat, & vna vertebra inferior in plures ſuperiores vertebras muſculos mittat: quale muſculorum artificium etiam in coſtis alibi demonſtraui, cum ſacrolumbum deſcriberem. *Muſculorũ vertebraliũ fabrica*

Sed quò euidẽtiora forẽt, quę de vertebralibus muſculis hìc propoſui, duabus proximis figuris ea illuſtranda iudicaui.

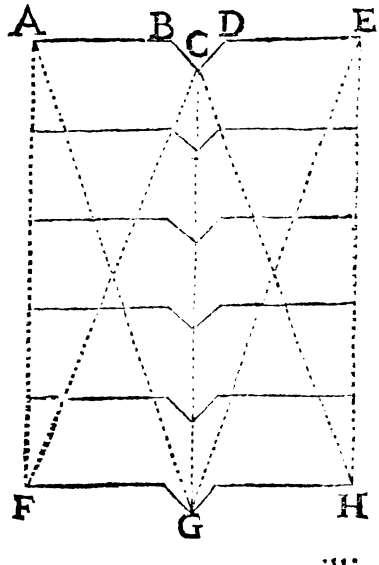


Figura I. vertebralium muſculorum varios ſitus exhibet. A B, D E, & illis ſimiliter ſitæ lineæ reliquæ, proceſſus vertebrarum tranſuerſos exhibent.

Angulus B C D, & illi

The name semispinatus is given to these muscles not incongruously, although, besides the semispinati of others, that of the os sacrum and others also belong to this kind.[28]

From what has been said, it is clear that the vertebral muscles can be described in a few exact terms without any ambiguity. Thus their four kinds are the *MEDIAN, THE LATERAL, THOSE VERGING TOWARDS THE MIDDLE, AND THOSE RECEDING FROM THE MIDDLE.*

Structure of the vertebral muscles.

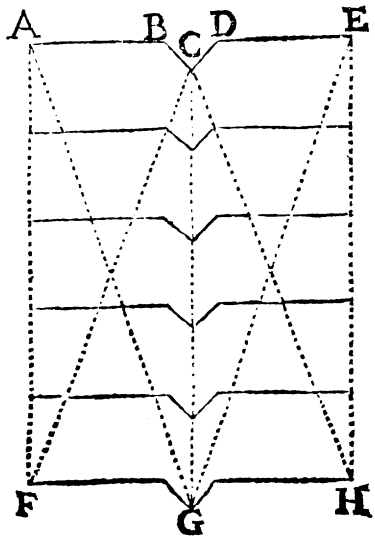
It is common to almost all these muscles that one upper vertebra receives muscles from several lower vertebræ, and that one lower vertebra sends muscles to several upper vertebræ. I demonstrated elsewhere such an arrangement of the muscles even in the ribs when I described the lumbo-sacro region.

But in order to show even more clearly, what I proposed here about the vertebral muscles, I decided to illustrate this with the two figures herewith.

Figure I shows the various positions of the vertebral muscles. A B, D E and the other lines similarly positioned represent the transverse processes.

The angle B C D, and

illi ſimiles reliqui, tum corpora, tum ſpinas vertebrarum exhibent.



Cum angulus B C D, ſpinam vertebræ exhibet, B C, C D, latera ſpinæ repræſentant, C, ipſum ſpinæ apicem.

A F, C G, E H, ſunt lineę ſpinali medullę parallelæ, in quibus lineis ſitos muſculos, muſculos vertebrales rectos appello, & quidem in linea C G, ſitos, vertebrales medios in lineis A F, E H, vertebrales laterales, G A, G E, F C, H C, ſunt lineæ, quarum extremitates ſunt in duabus lineis ſpinali medullæ parallelis nempe F C, & G A, in lineis A F, C G; G E, & H C, in lineis C G, E H. Hoc modo ſitos muſculos obliquos appello, & quidem F C, H C, ad medium vergentes, G A, G E, a medio recedentes.

Figura II. In vertebralibus muſculis ad medium vergentibus demonſtrat, qua ratione vnius vertebræ ſpinæ B C D continuati muſculi habeant extremitates oppoſitas continuatas tranſuerſis proceſſibus plurimis vertebrarum inferiorum, pari modo, quo vnius vertebræ tranſuerſis proceſſibus E F, G H, continuati muſculi habent extremitates oppoſitas

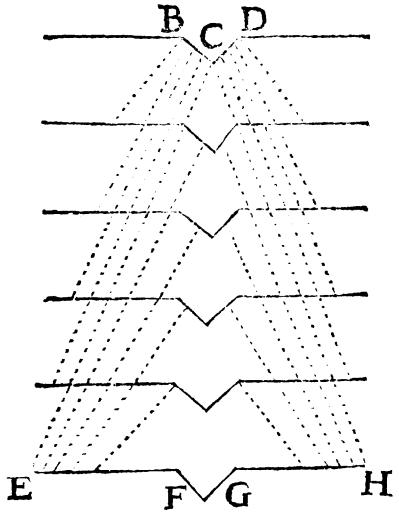
the other similar angles represent the vertebral bodies and the spinous processes.

Since the angle B C D represent a spinous process, B C and C D are the sides and C is the tip of the spinous process.

A F, C G, and E H are lines parallel to the spinal cord, I call the muscles situated along these lines the straight vertebral muscles. Those on the line C G are median vertebral muscles, and those on the lines A F and E H are lateral vertebral muscles. G A, G E, F C, and H C are lines the extremities of which are on two different lines parallel to the spinal cord, i.e., the extremities of F C and G A are on the lines A F and C G, whereas those of G E and H C are on the lines C G and E H. I call the muscles in this position oblique. Among them F C and H C are those verging towards the middle, and G A and G E are those receding from the middle.

Fig. II. It is seen in those vertebral muscles verging towards the middle, why those coming from one spinous process B C D have opposite extremities inserting into several transverse processes of lower vertebræ and, conversely muscles originating from the transverse processes of one vertebra E F and G H

tas continuatas plurium vertebrarum ſuperiorum ſpinis.



Qui hanc figuram intellexerit, omnium ſemiſpinatorum a ſecunda colli vertebra ad os ſacrum vſque vertebras exteriùs immediatè occupantium ſitum facilè intellexerit: ſola hæc eſt differentia, quod quibuſdam in locis plures intermediæ vertebræ reperiuntur, in alijs pauciores. Nec artificij multum præparatio requirit, modo quis a ſpatijs inter ſpinas deorſum, & a ſpatijs inter tranſuerſos proceſſus ſurſum leui manu cultrum dirigendo ſeparationem eorum peragat. Poſſet pari ratione reliquorum vertebralium muſculorum verus ſitus exhibèri, ſed hæc ipſi Myologiæ reſeruabo. Mihi tantùm in præſens animus fuit, publici iudicio elementorum Myologiæ Specimen exponere, dumque earum certitudinem figuris e natura depromptis aſſero, eadem opera indicare, qua ratione, & ſinguli iam tum ſuperficietenus noti muſculi, qua intrinſecam fabricam cognoſci, & alij hactenus confuſè tantùm noti, ne dicam planè incogniti, & præparari dextrè, & diſtinctè deſcribi poſſint. Cùm

have their opposite extremities inserting into spinous processes of several upper vertebræ.

Those who have understood this figure will easily understand the position of all the semispinatus muscles which occupy the grooves directly on the exterior sides of the vertebræ from the second cervical vertebra down to the os sacrum. There is only one difference: in some places the muscles span several vertebræ whereas in other places they span fewer vertebræ. Such a preparation does not require much cunning. One has only to separate the muscles by introducing the knife with a light hand in the spaces between the spinous processes downwards, and in the spaces between the transverse processes upwards. The true position of the other vertebral muscles could be displayed in the same way, but I shall reserve that for the Myology itself. Presently it has only been my purpose to bring to the public's judgment an example of elements of Myology, while providing certainty on these matters through figures taken from Nature. The same works indicate how some muscles known superficially only, for which I discovered the intrinsic structure, and others known confusedly only so far, not to say completely unknown, can be prepared properly and described clearly.

Cùm verò non dubitem, quin parum æqui laborum meorum Cenſores etiam hiſce gingiuam promore ſuo admoturi ſint, placuit ad Nobiliſſimum Amicum Theuenot perſcriptam epiſtolam hìc ſubiungere, qua non ſolum obiectionibus eorum reſpondetur, verum etiam muſculorum cognitioni inſeruientia nonnulla ſimul afferuntur.

Nobiliſsime Vir.

Qui probè noras, magnam felicitatis noſtræ partem in eo conſiſtere, vt quàm optimè de nobis optimus quiſque ſentiat, pariùm duxeras, amicitiæ ſimul, & hoſpitalitatis fœdere me tibi vincire, niſi Amicorum, quos multos magnoſque vbique habes, fauorem mihi, amoremque vna procuraſſes.

Fuit ea in re felix tua ſollicitudo; cùm non modo in varijs illis Galliæ Prouincijs, quas Autumno præterito, illumque excipiente hyeme peragraui, ſed in ipſa etiam Italia multos mihi tùm Patronos, tùm Amicos tua, tuorumque conciliarit recommendatio.

Vnum me ſollicitum habet, quod maiora meritis præconia mihi dederis ſæpius, ſequutus in eo potiùs, quæ dictauit amor, quàm quæ ſuaſiſſet ratio, ſi ab omni alias affectu libera in conſilium adhibita fuiſſet. Sed vt vt de his fuerit, quò maiori ſtudio Amicis tuis me commendatum voluiſti, eò maiori conatu in id mihi incumbendum, ne, quod alterius

Since, however, I have no doubt that the prejudiced critics of my works will champ their gums as they usually do, I have decided to append here a letter to my noble friend *Thévenot* in which not only their objections are refuted, but also some data are presented for a better understanding of the muscles.

Most Noble Man.

You who so well know that a great part of our good fortune resides in the fact that the very best gentleman has the very best opinion of us, you would have considered it too little to attach me by the bond of friendship and hospitality, if you had not procured for me the favor and affection of your friends of whom you have so many and great ones everywhere.

In this case your concern has been fortunate, since your own recommendations as well as those of your friends have provided me with a number of friends and patrons in several places in France, through which I traveled last autumn and the following winter, but also many here in Italy itself.

One thing bothers me though, the fact that you so often have proclaimed my merits as greater than they truly are, pursuing in this matter what love dictated rather than what reason would have persuaded, if reason had been adhered to free from all kind feelings. But whatever happens, the greater the zeal with which you desired to praise me to your friends, so much the greater is the obligation placed on me, lest what

alterius merito obtinui, mea culpa deperdam.

Cum itaque aliorum de meis ſcriptis iudicia velint, quædam ibi a me afferri ab alijs iam tum propoſita, alia in ijs occurrere parùm certa, multa ibidem dari ſuperuacua, nec niſi otioſo homine digna; ex re fore iudicaui, quæ ad mei defenſionem factura, maturè & placidè hìc in medium adducere. Ne verò quis credat, me litigioſas hìc ordiri velle controuerſias, ſciat hæc non tam Aduerſariorum obiectionibus, quam Amicorum dubijs, eſſe accommodata; vt hi certiores fiant, me nullis, niſi bonis artibus vſum, ad eorum obtinendum fauorem; illi verò, agnita cauſæ meæ iuſtitia, mitiùs mecum agere cum tempore aſſueſcant. *Præcipua capita huius epiſtolæ*

Duo, præ cæteris, nouitatis gratiam iam tum exuiſſe, nonnullis videntur, ea nempe, quæ de corde propoſui, vnà cum illis, quæ circa vitelli in inteſtina, pulli tranſitum adduxi. Silentio vtrumq; præterijſſem lubens, ſi de ſola inuentione quæſtio fuiſſet: iam verò, cum ſubdoli animi, & malitioſi ſit, alterius labores pro ſuis venditare, quò quis maiori honeſtatis amore ducitur, eò magis ipſi elaborandum, ne in aliorum animis vel leuiſſimam tanti criminis ſuſpicionem de ſe relinquat.

Volkerum Coiterum apophijſeos ab inteſtinis ad vitellum meminiſſe, eamque, modò canalem, modò meatum nominaſſe ex ſcriptis eius liquet. Sed quàm obſcurè hæc ab illo propoſita fuerint, vel inde patet, quod nec Harueius, nec Anatomicorum *Reſpõdetur his, quæ vitelli in inteſtina trãſitum ab aliis detecti dicunt.*

G alij

I have gained through the merit of another, I should lose through my own fault.

Major headings of this letter.

And so, since others judging my writings assert that some things which I have presented have already been proposed by others, and that other points are uncertain and that many are superfluous, not worthy of anyone except an idle man, for this reason I have decided calmly and quietly to bring into focus some remarks which speak in my defense. Lest anyone should think that I want to engage in litigious controversies, let him know that these remarks are aimed not so much at the objections of adversaries as at the doubts of friends; so that my friends should be assured that I have used nothing but good skills in order to attain their favor, and that my adversaries, acknowledging duly the justice of my case, will, in time, deal with me more gently.

More than anything else, two things which I have proposed seem to some gentlemen to lack the grace of originality. One is my proposal about the heart,[29] the other is my presentation of the passage of the yolk into the intestines of the chicken.[30] On both issues I should have preferred to remain silent, had it only been the question of their discovery. But now since it belongs to a crafty and malicious soul to offer for sale as his own the work of somebody else, the more one is led by love of honesty, the more should he labor on his own behalf, not to leave in the minds of others even the slightest suspicion of being guilty of such a crime.

Answer to those claiming that the transfer of yolk into the intestines was discovered by others.

It will be remembered from the writings that *Volcher Coiter*[31] mentioned an extension from the intestines towards the yolk sac calling it both a canal and a passage which is evident from his writings. But just how obscurely his propositions were made appears from the fact that neither *Harvey*, nor any other anatomist

alij hoc ſeculo, licet eum ſedulò euoluerint, vel in eius rei ſuſpicionem potuerint venire.

Iniquus eſſem, ſi tanti Viri gloriam imminuere conarer; mihi ſuffecerit, rem ſaltem hodie publico fuiſſe incognitam. Poſt edita mea ex Amicorum literis didici, Clariſſimos Viros D. Huibertum, & D. Meibomium eundem canalem iam ante obſeruaſſe. Quod vt Amicis credo lubens, ſic mihi gratulor, me, non ab illis monitum, eadem, quæ illi, obſeruaſſe: nec me mouet, poſt alios, me hæc vidiſſe, modò ab alijs eadem habuiſſe non accuſer.

Reſpõdetur iis, qui me in corde nihil detexiſſe aiunt, quòd ab aliis nõ ante obſeruatum fuit.

De corde paulò diuerſa res eſt. Qui Antiquos iam tum muſculorum numero cor inſeruiſſe norunt, audiuntque Modernos ſpiralem fibrarum ductum in eo detexiſſe, me actum agere proclamant, & poſt Homerum Iliada ſcribere. Sed quod pace illorum dixerim, non cognita cauſa ſententiam pronuntiant; id quod vt eò pateat euidentiùs, dicam quid mihi cum alijs commune ſit, quid ſingulis noſtrum peculiare. Verum quidem illud, in eo nos conuenire, quod cor muſculum dicamus, quod carnem cordis muſculoſam aſſeramus, in eo verò diuerſitas ſic ſatis magna eſt, quod eorum quidam ſui generis muſculum cor velint, alij varios muſculos, fibras peculiares, & parenchyma ſimul concurrere ad componendum cor aſſerant, nemo autem veram fibræ motricis fabricam cognitam habuerit, adeoq; nec in corde eam potuerit demonſtrare. Hinc factum, vt per tot ſæcula indeciſa manſerit, quæ Galeno

in this century, although they studied this work diligently, have suspected the presence of such a passage.

It would be unfair to attempt to diminish the glory of such a gentleman. For me it shall suffice that until today this matter was unknown to the public. After the publication of my writings, I have been told in letters from my friends that the famous Gentlemen *Huibert* and *Meibom* had already observed the same canal earlier. Yet in the same way as I willingly believe my friends, I am glad to have made the same observation independently. And it does not at all disturb me that I have made these observations after others, as long as I am not accused of having stolen them from them.

Answer to those who say that I have not discovered anything else in the heart than what had been previously observed by others.

As far as the heart is concerned, the matter is a little different. Those who know that the ancient writers had already counted the heart among the muscles and hear that the moderns have discovered in it a spiral arrangement of the fibers claim that I do what has already been done and, so to speak, that I write the Iliad after *Homer.* But, with all respect to them, they deliver a judgment without knowing the case. To make things clearer let me say what I hold in common with others and what each of us holds in particular. Truly we agree when we say that the heart is a muscle, and when we claim that the flesh of the heart is muscular. But in this there is actually a fairly great difference: some maintain that the heart is a unique muscle. Others assert that various muscles, peculiar fibers, and parenchyma contribute in forming the heart. But nobody has recognized the true structure of the motor fiber, and, therefore, nobody has been able to demonstrate it in the heart. This is in fact the reason why the controversy between *Galen*

leno cum Hippocrate de corde fuit controuerſia. Vniformes in corde fibras, & obedientem voluntati motum vrgebant Galenici, tanquam requiſitas omni muſculo neceſſaria: Hippocratis verò Aſſeclæ carnem cordis carni muſculorum ſimilem afferebant, cætera, nec medium fibrarum, nec extrema determinantes. Si liberè fari auderem, Andabatarum pugnæ hanc ego controuerſiam aſſimilarem, vbi ſuam quiſque ſequutus eſt opinionem, quid oppugnaret, quid defenderet, neſciùs. Quis enim certò nobis affirmarit, oblatum minerale quoddam aurum eſſe, quamdiu nec auri naturam, ſaltem ſecundum noſtrum cognoſcendi modum, perſpectam habeat, nec ipſum, de quo agitur, minerale ritè nouerit examinare? Sic nec cor muſculum euincere potuere, quamdiu, nec vera muſculi requiſita cognita habuerint, nec cordis ſectionem veram potuerint adminiſtrare. Longum eſſet, ſingulas hìc de corde propoſitiones ab nemine hactenus tactas afferre velle; ſuffecerit paucis innuiſſe, non id meum eſſe, quod cor muſculus dicatur, nec quod ſpirales in eo demonſtrentur fibræ; ſed quod demonſtrentur fibræ mediò carneæ, extremis tendinoſæ, paucis, quod cordis cum muſculis, ſecundum ſubſtantiæ conformationem, omnimoda conformitas ipſis ſenſibus reddatur manifeſta, adeoque plurimis controuerſijs hucuſque indeciſis imponatur finis.

Ad ſecundum pergo, vbi quædam, quæ à me propoſita ſunt, parùm certa eſſe dicuntur. Sic parùm

Reſpõdetur iis, qui non de muſculis parũ certa eſſe dicũt.

and *Hippocrates* on the heart has remained unresolved throughout so many centuries. The disciples of *Galen* stuck to uniform fibers in the heart and to a movement obedient to the will, in so far as these properties are prerequisites in every muscle. The supporters of *Hippocrates* asserted that the flesh of the heart is similar to the flesh of muscles, without determining anything else, neither the middle nor the extremities of the fibers. If I dared speak freely, I would compare this controversy with a fight of blindfolded gladiators[32] in which everyone follows his own opinion, not knowing what he would attack nor what he would defend. For who could affirm for certain that an offered metal is gold as long as he does not know the nature of gold, at least according to our way of recognizing it, or if he is not able to examine the metal in a proper manner? Likewise they are not able to prove that the heart is a muscle as long as they neither know the true properties of a muscle, nor how to perform an accurate dissection of a heart. It would take too long to mention here all the propositions on the heart which had not been dealt with so far by anybody. It will suffice to state briefly that it is not my idea that the heart should be called a muscle, nor that spiral fibers are demonstrated in it. What I have demonstrated is that its fibers are fleshy in the middle and tendinous at their extremities. I have also demonstrated that a complete conformity of substance between the heart and the muscles appears to the senses. Therefore, an end should be made to the numerous unresolved controversies of the past.

Answer to those who say that what I have said on muscles is too weakly proven.

I pass to the second objection according to which some of the propositions which I have made are said to lack sufficient evidence.

rùm certam credunt nonnulli fibræ motricis fabricam, vnde & omnimodam cordis cum muſculis conformitatem vacillare certo argumento ſequeretur. Ineptus eſſem, ſi qui aliorum placita in dubium voco, mea pro oraculis habenda vrgerem. Multa olim pro veriſſimis habita noſtrum ſæculum falſa agnouit, multa etiam noſtro tempore, tanquam e tripode prolata plurimorum obtinuere aſſenſum, quæ ſedula inquirentium induſtria breui inde ſomnijs vidit annumeranda. Cum itaque, & priori ætate, & noſtra ſub veri ſpecie plurima falſa apparuerint, auditorum credulitate pronuntiatuum audaciam confirmante, meritò, & ego non modò de meis dubitantes alios æquo animo ferre debeo, ſed & ipſe primus eorundem veritatem ſuſpectam habere. Placet itaque hac occaſione alijs examinandas proponere rationes, quibus perſuaſus ea, quæ de fibra motrice propoſui, vera eſſe exiſtimem. Sunt autem ſequentes.

Mea de muſculis certa eſſe credo, 1. Quod ſẽſibus obuia ſint.

I. Quæ de fibra motrice, muſculiſque propono, ſenſibus ipſis obuia ſunt, quibus fidem denegare velle, eſſet hominem exuere. Debile fateor, hoc argumentum eſt, cum multa nobis Anatome exhibeat exempla eorum, qui grauiſſimos errores ſenſuum teſtimonio confirmatos defenderunt, rati rem ſua natura talem eſſe, qualem eam illorum præparandi methodus exhibebat: ne itaque & nobis ſimile quid contigiſſe videatur, demonſtranda mihi eſt hæc ſecunda propoſitio.

II. Fibræ

Thus, some believe that the structure of the motor fiber is uncertain, lacks proof and, consequently, therefore complete conformity between the heart and muscles would be questioned with a sure argument.

I should be inept indeed if, as one who questions proposals acceptable to others, I insisted that my own be considered as oracular. Much of what in the past was considered as the very truth has been recognized in our century to be false. But even in our own time so many matters, which had been accepted by many as if they were the words of an oracle, shortly thereafter, as a result of thorough investigation, have been found instead to be dreams. And so, since both in the past and at present, many false statements have appeared under the guise of truth, the presumption of those who enunciated them being confirmed by the credulity of those hearing them, I ought not only to accept with equanimity the doubts of others about my proposals, but I myself must be the first to question their truth. Therefore, I wish on this occasion to present some arguments for others to examine. I am myself convinced by these arguments that what I have proposed on the muscle fiber is true. This is as follows.

I believe that what I have said on the muscle is true, firstly because it is obvious to our senses.

I. What I propose on the motor fiber and the muscles is obvious to the senses themselves, and to deny them would mean to set aside the human being. I admit this argument is weak since Anatomy displays numerous examples of people who have defended the gravest errors established on the testimony of their senses, reasoning that a thing is, in its nature, such as it is revealed by their method of preparation. And so, lest the same would occur to us, I must demonstrate this second proposition.

II. Fibræ motricis, muſculique fabrica præparationi nulla ratione poterit adſcribi. Poſſem afferre, quod in varijs appareat corporis locis, ipſo muſculo tantùm non intacto, remotis duntaxat partibus conſpectum ipſius impedientibus. Sic in manu remotis alijs muſculis, ſolo flexore pollicis intacto, fibræ motricis in eo verus ſitus euidentiſſimè conſpicitur. Quid quod in femore, remotis tantùm integumentis, rectus cum vtroque vaſto idem quam diſtinctiſſimè demonſtret. Huic addere poſſem, quod in muſculis, quorum ſimplex eſt fabrica, vt in gaſterocnemio, idem exteriùs conſpicitur, vna eorum extremitate ab oſſe reſecta, ſine vlla alia ipſius muſculi præparatione. 2. *Quod præparationi non poſſint adſcribi.*

Prædictis ſubiungere liceret, quod, ſiue crudi præparentur, ſiue cocti, ſemper eodem modo conſpiciantur formati: vt adeoque varietas præparationis nullam in re demonſtranda afferat varietatem.

Sed validiſſimum meum argumentum hoc eſt, quod, quà vtor, muſculorum adminiſtratio nullam fabricæ muſculi afferre poſſit mutationem, cum nulla ibi fiat fibrarum ſectio, ſed ſola contiguarum ſeparatio, ſiue per longum ſectio inſtituatur ad fibrarum ordines demonſtrandos, ſiue per rranſuerſum ad earundem verſus exhibendos. Sic ſiue ſimplicis, ſiue compoſitæ fabricæ muſculum præparo, fibrarum in alterutro tendine ductum ſequendo, ita cultrum ſenſim adigo, vt a mutuo contactu tendinoſas fibras ſeparem, ijſque continuas carnoſas nullo pacto

II. The structure of the motor fiber and of the muscle can in no way be ascribed to the method of preparation. I could bring forward what appears in different places of the body, in which the muscle itself is hardly touched and where only those parts preventing from seeing have been removed. Thus in the arm[33] when the other muscles have been removed and only the flexor pollicis remains intact, the true position of the motor fiber in this muscle appears extremely clearly. So too in the thigh, as demonstrated most distinctly by the rectus and both the vastus muscles, when only the teguments have been removed. Further I could add that in muscles with a simple structure, like the gastrocnemius, the structure is conspicuous from the outside when one extremity of the muscle is cut from the bone without further dissection.

Second, because it cannot be ascribed to the preparation.

To what has been said it could be added that, whether prepared raw or boiled, the muscles always appear to be formed in the same way. How the muscles have been prepared, therefore, makes no difference for the matter to demonstrate.

But my most valid argument is that, with the method I use, the handling of the muscles cannot bring any change in their structure, since no sections in the muscle fibers are made, but only a separation of contiguous fibers, either through a longitudinal section to show the Orders of fibers, or through a cross section to show their Ranks. Whether I prepare a muscle of simple or of compound structure, I insert the knife gradually, following the direction of the fibers in one of the two tendons in order to separate their fibers without doing any damage to their flesh

cto lædam, donec ad oppoſitum tendinem peruentum fuerit, quem ſæpius relinquo integrum. Cum hucuſque continuata præparatio, ſimplicem muſculorum fabricam ſatis euidenter declaret, vt compoſitam fabricam oſtendam, vtrinq; in tendine externo ſecundum prædictam methodum procedo, medio tendine intacto: quandoquidem ſæpiùs ſe mutuò ſcandentes in intermedio tendine fibræ, niſi patienti adhibita attentione, ſine laceratione vix ſeparentur.

Et hæc quidem mihi videntur abundè demonſtrare fibræ muſculoſæ fabricam præparationi non poſſe adſcribi. Sed licet ſenſibus obuia ſit ea fabrica, licet præparationi non poſſit adſcribi, dubitari poterit, an omnibus ea muſculis competat. Reſtaret itaque demonſtrandum.

III. Quod in omnibus non hominis tantùm, ſed & cuiuslibet alterius animalis muſculis eadem fibræ motricis fabrica conſpiciatur. Sed necdum iſtam inductionem afferre poſſum, id tamen poſſum aſſerere, me nec in homine, nec in vllo eorum animalium, quæ & alibi, & præcipuè Florentiæ ſic ſatis magno numero aperui contrarium exemplum offendiſſe. Licet itaque credam in omnibus omnium animalium muſculis eandem fibræ motricis fabricam reperiendam eſſe, tamen donec vlteriori examine idem confirmavero, vt opinionem vero maximè ſimilem eam proponam. In nonnullis muſculis breuiſſimo, & quaſi nullo intermedio tendine adhærens oſſi caro videtur primo intuitu nobis aduerſari, quæ fibræ motri-

3. Quod nec dum cõtrarium exẽplum viderim.

cis

until I reach the opposite tendon, which I often leave intact. This preparation continued to this point reveals the simple structure of muscles so clearly that I show the compound structure on both sides. I proceed in the external tendon following the method thus described, leaving intact the middle tendon. Since the fibers often arise together in the intermediate tendon, unless given cautious attention, they would hardly be separated without laceration.

And to me this seems to be ample demonstration that the structure of the muscle fibre cannot be ascribed to the preparation. But, even though this structure is obvious to the senses and even though it cannot be ascribed to the preparation, one may still question whether it is found in all muscles. It would thus remain to demonstrate:

III. That the same structure of the motor fiber is observed in every muscle, not only of man, but also of any other animal. But I still cannot make such an induction. I can, however, assert that neither in a human body, nor in any of the rather large number of animals that I have dissected mainly at Florence and elsewhere, have I met any example showing the contrary. Since I, therefore, believe that the same motor fiber structure is to be found in all muscles of all animals, until I confirm this through further examination, let me propose it as an opinion very close to the truth. In many muscles the flesh seems to be attached to the bone by a very short, or by almost no intermediate tendon. At first glance this might seem adverse to my idea that both extremities of the motor fiber

Third, that I have not yet seen examples to the contrary.

cis vtramque extremitatem tendinoſam pronuntiamus; cum hìc tantùm in vna extremirate tendo conſpiciatur, in altera os occurrat. Sed facile eſt hoc dubium ſoluere, cum omnia fere oſſa in embryone tendines fuerint, & ipſæ fibræ oſſeæ maximam partem tendines ſint, vel in os indurati, vel oſſeis particulis circumſepti, id quod demonſtrare liceret, tum ex fibrarum motricium per oſſa continuatione, tum ex proportionato tendinum oſſiumque incremento, alijſque: ſed hæc diſcurſui de oſſibus reſeruanda, vbi ſpero poſſe de ijs certò pronuntiari ea, quæ formationi fœtus lucem non obſcuram allatura, & ſic ſatis iucunda lectori videnda ſunt; cum, præter alia ibi afferenda, tendinoſarum fibrarum in oſſibus chiaſmus pulchri quid in ſe continere videatur, quem æquè hactenus incognitum crediderim, ac neruoſarum fibrarum in cerebro circa ventriculos chiaſmum, de quo memini me ante quadriennium in quadam ad Amicum epiſtola ſcripſiſſe. Non diſputabo an in os indurati tendines tendinum nomen mereantur, cum de nomine tantùm lis futura eſſet. Videmus res, quas petrefactas credunt, non ideo primum ſuum nomen amittere, quod priſtinam mutarint conſiſtentiam, cum ligna petrefacta, oſſa petrefacta, petrefactum panem dicamus. Hæc illa ſunt, quibus perſuaſus, quæ de muſculorum fabrica propoſui, certò vera eſſe credo, nec alijs rationibus opus ad eorundem certitudinem in cordis fabrica demonſtrandam. Cum verò non paucos

are tendinous, since a tendon is seen at one of the extremities only and at the other there is bone. But this doubt is easily removed, since almost all bones in embryo have been tendons, and the bony fibers themselves are for their most part tendons, either hardened into bone or surrounded by bony particles. This could be demonstrated by the continuation of motor fibers through bones by the proportional increase of tendons and bones, and by other means. But this has to be reserved for a discussion on the bones, in which I hope to make clear about these something which will shed light on the formation of the fetus and thus satisfy the reader. Besides other subjects to be taken up there, there is a great beauty to be found in the crossing of the tendon fibers within the bones which I should think is as unknown hitherto as the crossing of the nerve fibers about the ventricles of the brain, which I remember having described four years ago in a letter[34] to a friend. I will not argue here whether those tendons hardened into bone deserve to be named tendons, since this would be a quarrel about the name. We see things that people think are petrified. For this reason they do not lose their original name, although they have lost their original consistency: for instance, we say petrified wood, petrified bones, and petrified bread. These are the facts by which I have been persuaded that what I have proposed on the muscle structure is true, and that there is no more need for further explanations to demonstrate the certainty of the structure of the heart.

cos nouerim, qui licet viderint fibrarum in corde, & ſubſtantiam, & conformationem fibris muſculorum ſimilem eſſe, necdum tamen id a ſe impetrare poſſunt, vt cor muſculum pronuntient, Galeni, Carteſij, aliorumque autoritatem non auſi deſerere, in illorum gratiam ſequentem demonſtrabo propoſitionem, *vt fibræ motricis fabrica in corde, & in muſculis eadem eſt: ſic quæ in eadem fibra motrice ſenſibus manifeſta ſunt motus phænomena, in corde eadem quæ in muſculo conſpiciuntur*: id quod ſingulorum phænomenon inductione patebit.

Demõſtratur motum in corde & in muſculis eodem modo quoad apparẽtiam ſerari.

Quæ pars muſculi cõtrahitur.

1. Cum muſculus contrahitur, ſingulæ in eo fibræ motrices fiunt breuiores.

Diſſecta muſculi membrana, fibriſque a ſe inuicem ſeparatis, id euadit manifeſtum. Fibræ namque a mutuo contactu liberatæ eadem ratione breuiores euadunt, ac ante cum ſibi iunctæ intra membranam muſculi, tanquam intra communem thecam, continebantur. Quid quod maxima fibrarum parte reſecta reliquas motum ſuum ad aliquod tempus continuaſſe ſæpius obſeruauerim. In muſculis integris æquè euidenter idem conſpicitur, vt in panniculo carnoſo, in diaphragmate, in abdominis muſculis, imo in alijs quibuslibet, qui, dum cutis detegitur, abdomen aperitur, ſcapulare ſecatur, aliæ preparationes adminiſtrantur, ſe ſe videndos exhibent: namque in his omnibus perſæpè non omnes fibræ ſimul, ſed diuerſo tempore ſingulæ ſeorſim moueri conſpiciuntur. Nec alius eſt mirus ille motus,

Since I have met several people who, although having seen that both the substance and the composition of the fibers in the heart are like those of the fibers of the muscles, nevertheless cannot bring themselves to acknowledge that the heart is a muscle, because they do not dare to depart from the authority of *Galen*, *Descartes*, and others. For their benefit, I will demonstrate the following proposition: *The structure of the motor fiber in the heart and in the muscle is the same: thus the phenomena of movement in the motor fiber which are manifest to our senses and are seen in the muscle are the same in the heart.* The phenomenon in each of them will be made clear by induction.

It is demonstrated that movement in the heart and in the muscles takes place the way it appears.

Which part of the muscle does contract.

I. When a muscle contracts, its different motor fibers shorten.

This becomes evident when the aponeurosis of a muscle is divided and the fibers are separated from each other. Thus, fibers liberated from mutual contact become shorter for the same reason as before, when they were closely joined together inside the aponeurosis of the muscle as if they were inside a common envelope. For, as I observed very often, even when most of the fibers are resected, the others continue to move for some time. The same is obviously observed in intact muscles such as in the panniculus carnosus,[35] in the diaphragm, in abdominal muscles, and, in fact, in whichever muscle is made visible after the skin has been peeled off, the abdomen opened, the shoulder resected, or after other dissections have been carried out, they are revealed to the light. Very often in such circumstances not all the fibers are seen to move at the same time, but individual fibers move separately at different times. The amazing movement so often seen in the dying heart is not different,

motus, quem in corde moribundo ſæpiùs intuemur, namque & hìc, quæ prius ſimul mouebantur fibræ, modò diuerſo tempore motæ id phænomenon producunt.

II. Cum fibra motrix breuior fit, ſola eius caro breuior fit. *Qua parte in fibra motrice contrahatur.*

Poſſem id varijs alijs experimentis confirmare, ſed vnum in præſens adduxiſſe ſuffecerit, quod multis alijs propoſitionibus poterit inſeruire.

Vbi muſculum, cuius fabrica ſimplex eſt, ab vno eſttremo ad alterum ſecundùm fibrarum ductum in duas partes diuiſeris, alteriuſq; partis carnem tranſuerſam diſſecueris, tendinibus intactis, videbis ilico carnes diſſectas carnibus integris longè breuiores euaſiſſe, tendines verò tendinibus manſiſſe æquales.

Sic, & diſſectis in viuo corde ventriculis, ſtaminum carnoſorum manifeſtus motus eſt, valuularum verò tricuſpidum nullus.

III. Cum caro fibræ motricis breuior fit, etiam durior fit, ſuperficieſque eius ante contractionem læuis, in contractione aſpera euadit. Qui in eodem animali digitis, oculiſque diaphragma contractum, & contractum cor examinauerit, huius propoſitionis veritatem manifeſtò deprehendet. *Quid in carne obſeruetur dũ cõtrahitur.*

IV. Caro fibræ motricis poſt contractionem iterum ad certam longitudinem relaxatur. De muſculis iam olim id demonſtrarunt alij. In corde nihil eo euidentius, quandoquidem exhauſto ſanguine, & reſectis auriculis non deſinat ad tempus ſic ſatis longum, mo- *Quid carni accidat poſt cõtractionem.*

for here also the fibers that previously moved simultaneously move at different times, thereby causing this phenomenon.

Which part of the motor fiber contracts.

II. When a motor fiber shortens, the flesh part alone shortens.

I could confirm this by other different experiments, but at present it should be sufficient to present one which can serve for many other propositions.

After having divided in two a muscle with a simple structure from one extremity to the other along the length of the fibers, without touching the tendons, you divide the transverse flesh in one of the parts. You will observe that the divided fleshy part will become much shorter than the intact fleshy part, while the length of the tendons actually remains the same.

Similarly, when dividing the ventricles of a living heart, the movement of the fleshy threads is obvious, while there is no movement of the tricuspid valves.

What can be observed in the flesh when it contracts.

III. When the flesh of a motor fiber shortens, it also hardens, and its surface which, before contraction was smooth, becomes rough.

Whoever will test with his own fingers and eyes the contracted diaphragm and the contracted heart of the same animal, will obviously find out the truth of this proposition.

What happens to the flesh after contraction.

IV. The flesh of a motor fiber again relaxes to a certain length after contraction. Others have shown this about the muscles long ago. In the heart, nothing is more evident than this since, after the blood has been drained and the auricles resected, the heart does not stop beating for quite a long time,

dò baſi vnum adducendo breuior euadere, modò eodem iterum relapſo longior fieri.

An contractio ſit totius carnis an verò ſingularũ eius partium.

V. Quælibet pars carnis tranſuerſim diſſectæ pari ratione, & breuior fit, & ſolidior, iterumque ad longitudinem certam relaxatur ac ipſa caro integra.

In ſcapulæ, collique muſculis id demonſtraui ſæpiùs, cum in ſemimortuis canibus Thoracici vaſculi cum vaſculis lymphaticis concurſum circa iugularis ſcapulariſque confinium rimarer. Facilis autem huius experimenti faciendi ratio eſt in muſculis, qui carnem longiuſculam habent: forfice namque vnius eiuſdemque muſculi carnes ter quaterue tranſuerſim diuidendo, interceptæ ſingulis ſectionibus carnium partes contractionem ſuam multis vicibus repetunt, tactuique duritiem, & aſperitatem viſui exhibent. Idem in pectorali auium non infrequenter mihi ſucceſſit, ſic mucro cordis a baſi reſectus digitoque impoſitus, ea ſe vi repetitis vicibùs contrahit, vt a digito exſiliat, quod facultati cordis (vt appellant) pulſificæ attribuunt, qui idem alijs muſculis commune eſſe non obſeruarunt. Dum ſic a digito exſilit, manifeſtam digitus duritiem percipit, nec ſolitam læuitatem oculi obſeruant.

An ad cõtractionem fibræ motricis vaſa quicquam immediatè contribuãt.

VI. Fibra motrix, reſectis arterijs, venis, neruis æq; ac ijſdem non reſectis contrahitur. Tremulus parnniculi carnoſi motus in mactatis recens animalibus, quibus, & cor, & caput ablatum eſt, nemini non notatus eſt. Reſectum cum cartilaginoſa coſtarum parte ſternum per interualla ſubſultaſſe quibuſdam caſu

now growing shorter by drawing into a cone at the base, then becoming longer by relaxing again.

Whether it is all the flesh or single parts of it which contract.

V. Whichever part of the flesh is divided transversely, becomes both shorter and harder to an equal degree, and relaxes again to a certain length as does intact flesh.

I have often demonstrated this in the muscles of the shoulder and of the neck when I explored the junction of the thoracic duct and lymphatic vessels in the region of the throat and shoulder in half dead dogs. An easy way to carry out this experiment is by cutting across the flesh with a scissor at three or four places in a muscle with fairly long flesh. The flesh parts between the divisions repeat their contraction several times and become hard to the touch and rough to the sight. Not infrequently I have succeeded in seeing the same in the chest cavity of birds. The apex of the heart, cut off the base and set on a finger contracts repeatedly so vigorously that it leaps from the fingertip. Those who have not observed that the same phenomenon is shared by the other muscles, attribute it to a heart's pulsatile faculty[36] (as they call it). When it thus jumps off the finger one feels its manifest hardness and does not see the usual smoothness.

Whether the vessels contribute immediately to the contraction of the motor fiber.

VI. A motor fiber contracts as well when the arteries, veins and nerves are resected as when they are not resected. There is no one who has not noticed the trembling of the panniculus carnosus in recently slaughtered animals, from which both heart and head have been removed. The sternum after being divided with the cartilaginous part of the ribs has been casually observed by some people

caſu obſeruatum, quorum nonnulli communicatam illi a corde vim pulſificam credidere, non attendentes muſculorum intercoſtalium eam actionem fuiſſe. Ranam reſecto corde diù nataſſe, Amicus meus Svvmmerdammius ſæpiùs nobis monſtrauit. In teſtudine, reſecto capite, 24. ab eo tempore hora etiamnum in pedibus, & cauda notatus motus eſt, qui ablato corde ad aliquod inde tempus continuabat. Leidæ experimentis Bilſianis examinandis intentus cum in moribundis canibus eleuata ſcapula diſſecarem neruorum plexum ad pedem ſiniſtrum anteriorem ramos exporrigentem, vidi muſculos conuelli, non modò cum neruos illorum integros etiamnum diſſecarem, verùm etiam cum adherentes muſculis reſectorum neruorum portiones, vel premerem fortiùs, vel diſſecarem, idem modò nominatus Amicus meus Svvammerdammius in ranis iam ante obſeruauerat.

Quid itaque mirum eſt e corpore extractum cor repetitis ictibus moueri, licet nec nouus in vaſa eius influat ſanguis, nec per neruos a cerebro noui influant ſpiritus.

Cum itaque fibræ motricis non fabrica modò, vt iam ante triennium obſeruaui, ſed motus, quantùm ſenſibus manifeſtum, eodem modo in corde, quo in muſculis ita vulgò dictis, obſeruetur, ſpero ſatis euidenter demonſtratum eſſe, quod Antiqui dixere, cor muſculum eſſe.

Quæ hìc de motu muſculorum propoſui, reſpi-

to jolt at intervals.[37] Some believe that this pulsatile force is transmitted from the heart, without noticing that this action comes from the intercostal muscles themselves. My friend Swammerdam has often demonstrated to us that a frog swims quite a long time with its heart cut out. In a tortoise, movement has been noticed even in the feet and tail twenty four hours after the head had been cut off. This movement continued some time after the heart had been excised.[38] At Leiden, while intent on testing the experiments of Bils when, after the scapula had been raised in moribund dogs, I divided the plexus of nerves spreading out to the left front limb, I saw muscles convulse, not only when I divided their intact nerves, but also when I pressed strongly, or divided the parts of the divided nerves adhering to muscles, the same reaction that my friend Swammerdam had previously observed in frogs.

What is surprising, therefore, is that the heart, extracted from the body, moves with repeated beats, although neither new blood flows into its vessels, nor does new spirit enter it through the nerves from the brain.

Since, therefore, not only the structure of the motor fiber is as I observed it to be three years ago, but a movement obvious to the sense is observed in the same way in the heart as in what are commonly called muscles, I hope to have demonstrated clearly what the ancients said, namely, that the heart is a muscle.

What I have proposed here concerning the movement of muscles,

ciunt mutationem, quæ in ipſis muſculis contingit, dum contrahuntur, nulla habita ratione cauſæ, vnde motus ille procedit: hinc de voluntatis imperio nihil addo, cum euidens eſſe credam omnem motum voluntarium muſculis peragi, non verò omnem motum qui muſculis peragitur eſſe voluntarium, vt adeoque ſoli quidem muſculo, ſed nec omni, nec ſemper competat, eſſe motus voluntarij organum.

Tandem, & illis aliquid reponendum eſt, qui myologiam numeris ſuis omnibus, quantùm per Anatomen licuit, iam dudum abſolutam rati, hoſce meos labores otioſi hominis occupationes clamitant.

Reſpõdetur iis, qui nouos Anatomicorum labores circa muſculos irridẽt tanquã ſuperuacuos.

Quod ſi meis tantùm laboribus extenuandis deſtinata eſſet hæc illorum cenſura, parui ponderis res eſſet, nec in opera mea laudanda operam perderem, ſed maioris momenti res agitur, & ne ipſi quicquam ignoraſſe videantur, alijs vlteriora inueſtigandi viam præcludere laborant, adeoque quantùm in ipſis eſt, ſuam ignorantiam ſcientiæ velo indutam æternitati conſecrant, cum maximo & veritatis, & ſanitatis detrimento. Non itaque hìc mei defenſionem adorno, quo me vtilia operatum demonſtrem, ſed ne alij maiori cum fructu hæc eadem molituri ab incœpto ſe abſterrere patiantur.

Fateor equidem multùm hìc, & priſcos egiſſe, & recentiores, tantaque ſolertia Galenum, Veſalium, Falloppium, Spigelium, Placentinum, Aquapendentem, Riolanum, alios magnos Viros in eo ſtudio

refers to the change which occurs in these muscles when they contract, without suggesting any cause from which that movement proceeds. Hence, I add nothing concerning the power of the will, since I believe that it is evident that every voluntary movement is carried out by muscles, but that not every movement executed by a muscle is voluntary, so that it fits to a muscle alone, but not all, nor at all times, to be an organ of voluntary movement.

Finally I must also answer to those who claim that all myology in all details has been established completely by anatomy long ago as much as it is possible, and that therefore my work is but that of an idle man.

Answer to those who consider the new work of Anatomists concerning the muscles as ridiculous and superfluous.

Now if the opinion of these people was destined to diminish my own endeavors only, it would be a matter of little consequence, and I would not waste any effort in commending my own work. A more important issue is at stake. Thus, not to appear themselves as being ignorant, they try to obstruct the path of the ones who investigate further. Thus, as much as they can, they validate forever their ignorance wrapped in a veil of science, at the greatest detriment to both truth and health. I am not here elaborating my own defense to demonstrate the usefulness of my work, but so that others about to tackle the same subjects successfully do not let themselves be deterred from beginning.

For my part, I acknowledge that both ancient and modern authors have accomplished much in this field. *Galen*, *Vesalius*, *Fallopius*, *Spigelius*, *Placentinus*, *Aquapendente*, *Riolan*, and other great men

ſtudio fuiſſe occupatos, vt facilè ſibi quis perſuaderet ad Herculis columnas rem deductam eſſe, quas vltra pergere velle temerarium credidit Antiquitas. Sed nec Antiquitati opprobrio eſt, quod vltra Herculis columnas penetrarunt Poſteri, nec magnos Anatomicæ Antitiſtes iure quis reprehenderit, quod non omnia naturæ penetralia potuerint perſcrutari. Scio quam Præceptoribus debeo reuerentiam, & certus ſum, ſi in lucem reduces præſentium Anatomicorum labores intuerentur, longè mitioria de ijs pronuntiaturos eſſe, quam quæ Cenſores noſtri pronuntiant.

Demõſtratur de muſculis multa ignorari.

Vt verò pateat multa de muſculis reſtare incognita, tum ea, quæ omni muſculo communia ſunt, tum illa, quæ ſingulis peculiaria, breuibus, & quaſi biter percurram.

Omni muſculo communia, vel ad ſolidum eius, vel ad eius fluidum reducuntur, quorum vtrumque ſi priſcis, tantùm non, omnino incognitum dixero, ignoſcant mihi magnorum Virorum manes.

Nolo, quæ alibi a me de muſculis propoſita hìc repetere, ad demonſtrandum, ne illa quidem ipſis nota fuiſſe, quæ, quoties caro menſis infertur, omnium oculis obuia ſunt. Probè noui ſæpiùs quę maximè patent, minimè videri, nec dubito, quin in his ipſis, quæ detexi, alia me lateant, obſeruatis forſitan, & faciliora, & magis obuia, adeoque ſi illis, hoc obijciendo, ſciolum agerem, ab alio Talionis iura iurè expectarem.

Ad

have dealt with this problem with such skill that one could easily deduce that the whole issue had already reached the Pillars of Hercules, which the ancients believed highly imprudent to pass. But it is not disgraceful to the ancients that their posterity did penetrate beyond these pillars, and one will not rightfully reproach the great high priests of anatomy not to have investigated all the arcanes of Nature. I know the reverence I owe to my teachers, and I am sure that, if brought back to life, they gazed upon the works of present day anatomists, their verdict would be far kinder than that pronounced by our censors.

Demonstration that much is still unknown about the muscles.

As it is evident that much about the muscles still remains unknown, let me review briefly as in a quick survey what is common to all muscles and then what is peculiar to some.

What is common to all muscles may be reduced either to their solid or to their fluid part. If I say that both were completely unknown to the ancients, and not only to them, may the shades of the great men of the past forgive me.

It is not my wish to repeat what I have said elsewhere about the muscles to show that the ancients did not know what is obvious to the eye of anyone any time meat is brought on the table. I honestly knew that quite often what is most evident receives the least attention; nor do I have any doubt that, hidden among what I myself have discovered, there are things which, perhaps, are simpler and more obvious than what I have seen. Therefore, if I were to act like a charlatan in making these remarks, I should rightly expect retaliation.

Muſculi reſolutio Chymicæ. Ad alia itaq; pergam. Necdum quiſquam, quod ſciam, ita Chimiam Anatomicæ ſociauit, vt non artis præcepta exſequendo, ſed naturæ veſtigia indagando, in quibus caro, tendo, os, conueniant, in quibus differant, clarè, & diſtinctè expoſuerit. In humoribus noſtri corporis feliciter id molitus eſt Celeberrimus Præceptor meus Syluius, & ſi rectè memini, etiam de tendinum, oſſiumque ſubſtantia illum ſecundùm eadem hæc principia diſſerentem audiui. Sed licet multa in hoc ſtudio præſtiterit celeberrimus Vir, ne ſuam gloriam publicæ ſaluti anteferre videatur, diſcipulis ſuis in dies inculcat, ſe non omnia potuiſſe præſtare, in eumque finem, quæ necdum certò ſibi perſpecta credit, opinionum, ſuſpicionumque nomine proponit, quo alijs ad inueſtigandum, & animos addat, & materiam ſimul porrigat.

Muſculi reſolutio Anatomica. Sed vt fibræ motricis vera reſolutio Chimica necdum ab vllo inſtituta, ſic neque vera ſectio muſculi, quæ per varia plana ad mechanicæ leges inſtituitur, ab alio tentata eſt.

Muſculi a muſculo ſeparatio. Quid quod ne quidem muſculi a muſculo vera ſeparatio legitimè vbique inſtituta, quo factum, vt in multis muſculis, & vera illorum extremitas incognita manſerit, & ſæpiùs plures muſculi per vno habiti fuerint, licet vel diuerſis partibus mouendis, vel eiuſdem partis diuerſis motibus peragendis inſeruiant.

Termini Myologiæ. Faceo confuſionem, quam peperere, principium finis,

Chemical analysis of the muscle.

Therefore, I pass on to other matters. As far as I know nobody has associated chemistry and anatomy in such a way as to show clearly and distinctly—not by following the precepts of an art, but by tracking the footprints of Nature—in what flesh, tendon, and bone are the same or in what they differ. My very famous teacher *Sylvius* has successfully studied the humors of our body, and if I remember well, I have even heard him lecture on the substance of tendons and bones according to these same principles. But even though this very famous gentleman achieved much in this field of study, he daily impressed on his students the fact that he had not been able to achieve everything, lest he seem to prefer his own glory to the public interest. To this end, what he thought he himself did not yet truly understand, he proposed as hypotheses and suggestions, by which he stimulated others to investigate and at the same time offered material for further research.

Anatomical analysis of the muscle.

But just as no one has yet set up a true chemical analysis of the motor fiber, so nobody has attempted a true dissection of the muscle, which is conducted through the various planes according to the laws of mechanics.

Separation of one muscle from another.

What about the fact that rules for true separation of one muscle from another have not even been established anywhere? Thus, the actual extremity of many muscles remains unknown. Frequently several muscles have been considered as[39] one muscle even though they are either used in moving different parts, or in performing different movements of the same part.

The terms of Myology.

I face the confusion generated by words like beginning,

finis, ligamentum, tendo, alijque termini muſculorum partibus exprimendis deſtinati, quæ ſola, rei non benè cognitæ euidens argumentum eſt.

De fluido muſculi, quàm incerta, quàm nulla eſt noſtra cognitio.

Certum eſt eſſe fluidum in fibrillis, vnde componitur fibra motrix, inter fibrillas eius, inter ipſas fibras motrices, in fibris membranoſis muſculi, inter eiuſdem fibras membranoſas; at verò vnius ne generis ſint fluida hæc, an, vt locorum interuallis diſtincta, ſic & materiæ proprietatibus diuerſa non æque certum. *Fluidum muſculi quotuplex?*

Nec ſcitur, cui nam eorum fluidorum, quæ nobis cognita exiſtimamus, vllum ex hiſce fluidis ſimile ſit. Spiritus animales, ſubtiliorem ſanguinis partem, vaporem eius, & neruorum ſuccum multi nominant, ſed verba hæc ſunt, nihil exprimentia. *Cui fluido nobis noto fluidũ muſculi reſpõdeat?*

Qui vlteriùs pergunt, ſalinas, ſulphereaſque partes, vel ſpiritui vini analogum quid adferunt, quæ vera forſan, ſed nec certa, nec ſatis diſtincta. Ab aſſumpto vini ſpiritu reſtitui exhauſtas vires experientia docet, ſed ipſi hoc humori, quem ſpiritum vocamus, an alij materiæ adſcribendum, quæ ſpiritum fluidum reddit, aut aliam fortè ob cauſam illi iuncta eſt, quis determinauerit?

Vt ſubſtantia fluidi huius nobis ignota eſt, ſic incertus eiuſdem motus, quandoquidem vnde veniat, quà pergat, quò ſe abiens recipiat, necdum certis vel rationibus, vel experimentis ſtabilitum ſit. *Quis fluidi huius motus?*

Arterias,

end, connecting link, stretching part,[40] and other terms aimed at describing parts of the muscles. This confusion is an obvious indication that the matter itself is not well known.

Concerning the fluid part of muscle our knowledge is so uncertain as to be non-existent.

How manifold is the fluid of muscle.

It is certain that there is fluid in the fibrils of which the motor fiber is made, between these fibrils, between the motor fibers themselves, in the membranous fibers of the muscle, and between these same membranous fibers. It is also certain that these fluids are not all of the same kind.[41] Whether they are distinct in their separate locations and whether they are also different in their material properties is not so certain.

Which known fluid does the muscle fluid correspond to?

It is not known to which of those fluids, which we consider known to us, any of these [muscle] fluids is similar. Many call them animal spirits, the more subtle part of the blood, its vapor, juice of the nerves. But these are mere words, nothing proved by experiment.

Those who proceed further introduce salty and sulphurous parts, or something analogous to spirit of wine, which may be true perhaps, but are neither certain, nor sufficiently distinct. Experience teaches us that exhausted strength may be restored by drinking spirit of wine, but whether to ascribe this to the humor which we call spirit itself or to another substance which makes the spirit fluid, or perhaps to another cause closely linked to spirit, who will determine?

What is the movement of this fluid?

Just as the substance of this fluid is unknown to us, its movement is uncertain, since it has not yet been established, either through reasoning or through experiments, whence it comes, by what means it proceeds, or where, on departing, it escapes.

Vnde veniat? Quo abeat? Arterias, neruos, oppoſitos muſculos, ambiens fluidum pro fontibus agnoſcere poteſt. Exitui oſtium aperire poſſunt, venæ, pori corporis, oſſa forſan, & nerui. In ipſo muſculo ferri poterit motu ſimplici a medio verſus extrema, ab extremis verſus medium, ab vno extremo ad alterum, ſed & motu minus ſimplici ibidem poterit moueri.

Quò motu in muſculo moueatur?

In quo differat fluidū muſculi contracti a fluido muſculi non contracti. Reſtat haud minoris momenti difficultas alia nec dum deciſa: nempe in quo differat motus fluidi in muſculo, dum contrahitur, a motu fluidi in eodem muſculo, dum quieſcit non contractus; an quantitas eius mutetur, an maneat eadem, an ſuperueniens fluidum, ſi quod ſuperuenit, eiuſdem naturæ ſit, an a priori diuerſum; moueatur ne fluidum, quod ſolidum ſe contrahat, an vero ſolidi contractio a fluidi motu procedat.

Quæ alia in muſculorum ſcrutinio examinanda? Sed vt eorum inueſtigatio feliciter procedat, quæ in muſculorum cognitione deſiderantur ſimul neruoſarum fibrarum, & ſolidum, & fluidum indagandum eſt, imo ipſius ſanguinis partes vnà cognoſcendæ, quorum examen ritè inſtitui nequit, niſi in fluidi naturam, & in modum, quo obiecta ſenſus noſtros afficiunt, vnà inquiratur.

Nemini ampliùs ignotum eſſe poterit, quàm imperfecta fuerit, ſitque eorum, quæ omni muſculo communia ſunt, cognitio, & quanta inueſtigandi materia laborem non fugientibus ſuperſit. Nec minus amplum inueſtigandi campum aperirem, ſi quę ſingulis

From where does it come?

Where does it go?

How does it move in the moving muscle?

One can recognize the fluid surrounding the arteries, the nerves, and opposite muscles as its source. The veins, the pores of the body,[42] the bones perhaps, and the nerves may offer an exit. In the muscle itself it can be carried in a simple movement from the middle towards the extremities, from the extremities towards the middle, from one extremity towards the other; but it can also move in a less simple displacement.

In what way does the fluid of the contracted muscle differ from that of the non-contracted muscle?

There remains another problem no less momentous and not yet solved: namely, in what does the movement of the fluid in a muscle differ when this contracts, from the movement of the fluid in the same muscle when this is at rest, non-contracted? Is its quantity changed, or does it remain the same? If some new fluid arrives, is this incoming fluid of the same nature, or different from the one which was previously there? Does the fluid move because the solid part contracts, or does the contraction of the solid part proceed from the movement of the fluid?

What else in the muscle has to be examined with scrutiny.

But in order to investigate successfully what is lacking in the knowledge of the muscles, the solid and the fluid part of the nerves must be examined at the same time, and even the composition of the blood one must be known. Their examination cannot be carried out properly unless the nature of fluids and the way in which objects affect our senses are also studied.

It cannot any longer be ignored how incomplete our knowledge of what is common to all muscles has been and still is, and how great an area of investigation lies waiting for those who are not shy of work. Nor would I discover a less extensive field of investigation

ſingulis muſculis peculiaria hactenus intacta recenſerem. Sed verbulo hæc innuam potiùs, quàm exponam. Ferè quot diuerſa muſculorum paria, totidem diuerſæ fabricæ occurrunt, quas ab illis non obſeruatas, qui ſuperficiem muſculi non perruperunt, non vſq; adeo miror; miror tamen, qui muſculos delinearunt, ſæpiùs ijs, qui eoſdem deſcripſerunt, exactiores fuiſſe, nec potuiſſe naturæ facilitati accedentem pictoris induſtriam ad tanti artificij admirationem, inueſtigationis parentem, illos inuitare. *Diuerſa diuerſorum muſculorum fabrica*

Nolo errores recenſere, qui circa partes a ſingulis muſculis mouendas ſæpiùs committuntur. Cuilibet euidens eſt, quorum muſculorum veræ extremitates ignotæ ſunt, eorundem verum motum vel omnino incognitum eſſe, vel caſu tantùm ſciri. *Singulorum muſculorum motus*

Cum itaque ſolidi in fibra motrice ſubſtantia, & conformatio; fluidi & ſubſtantia, & motus tum in contractione, tum extra contractionem; omnium muſculorum analyſis & fabrica; multorum a ſe inuicem ſeparatio; nonnullorum motus; cum, inquam, hæc omnia hactenus ignota fuerint, pleraq; etiamnum incognita lateant, ſatis patet, quo iure Cenſores noſtri myologiam omnibus numeris abſolutam clamitent, quantumque laboris ſuperſit, ſi quis hiſtoriam muſculorum veris, & deſcriptionibus, & figuris illuſtrandam aggrederetur.

Sed dixerit quis, negaturum neminem, quin multa ipſos lateant, quòd verò hæc eadem ipſis ignota

if I enumerated those matters peculiar to individual muscles and hitherto unknown. But rather than explaining it, let me hint at it in a few words. There are almost as many structures as there are pairs of muscles. I am not surprised that they have not been observed by those who do not look beneath the muscle's surface. But it surprises me that those who have drawn the muscles often have been more exact than those who described them in words, and that the industry with which painters have approached Nature's skill had not the power to urge them to admire such a work of art, which is the first step to investigation.

Different structure of different muscles.

I am not going to review the errors which are frequently committed concerning the movement of parts by individual muscles. It is evident to everyone that the true extremities of these muscles are unknown, and their actual movement is either completely unknown or known only by chance.

Movement of individual muscles.

All of the following matters thus have been ignored hitherto and some still are: the substance of the solid part in the motor fiber and its shape; the substance of the fluid part and its movement both during and outside contraction; an analysis and the structure of all the muscles; the separation from each other of many of them and the movement of some of them. Since, I say, all these matters have been unknown hitherto and most of them remain unknown even now, it is clear enough that our censors have no right to proclaim that Myology is complete in all its aspects, however much labor remains if somebody undertook a description of the muscles illustrated by accurate figures.

But some will say: no one will deny that much still lies hidden, but most will deny that what they themselves do not know,

ſciri vel poſſint, vel mereantur, id verò pleroſque negaturos.

Oſtenditur multa ex illis ſciri poſſe, quæ de muſculis ignorãtur.

Non hìc operoſa reſponſione opus eſt, ad demonſtrandum, poſſe ex ijs multa ſciri. Ex obſeruationum mearum, & elementorum ſpeciminibus patet, non vſque adeo paruam eorum partem iam tum detectam eſſe, & ſi vel ea ſola continuarentur, poſſe muſculorum omnium veras extremitates, veras fabricas, veros motus non minùs certò exhiberi, quàm ſuas propoſitiones certò demonſtrare ſolet Geometria. An reliqua omnia pari facilitate detegenda ſint, meritò dubitatur. Sed vt vt dubium iſtud, illud tamen certò exploratum, poſſe quædam de iſtis ſciri, quæ necdum cognita ſunt, & poſſe ſi non verum contractionis modum determinari, ſaltem, quæ certa ibi ſunt, ab incertis diſtingui. Quod ſolum quanti æſtimandum, nemo ignorat.

Quod eadem illa, quæ magno labore reſtant inueſtiganda, ſciri mereantur, qui veritatem amat, nec ſanitatem ſpernit, vix vnquam negaturus eſt.

Oſtenditur quod eadẽ ſciri mereantur.

Non itaque opus a Rhetoribus argumenta mutuari, vt euincam, non eſſe hominis otio ſuo abutentis iſti labori inſudare, quod in illuſtrium Virorum præſentia ſæpiùs aſſerere non erubuerunt Cenſores noſtri. Sola artificij elegantia, dum euidentiſſimum intelligentis Naturæ argumentum exhibet, indaginis laborem, etiam millies maiorem mereretur. Adde, quod de fibra motrice agatur, de parte, quæ

either can be known or is worth knowing.

It is shown that many among the matters which are unknown on muscles can be made known.

There is no need of an elaborate answer to demonstrate that many of these problems can be solved. It is evident from the examples of my observations and of the elements that so far only a small number of them have yet been exposed, and, if these alone were pursued, the true extremities, the true structures, and the true movements of all muscles could be displayed as certainly as Geometry is accustomed to prove its propositions. Whether all remaining issues will be discovered so easily, however, is deservedly questionable. But even so, this doubt itself, explored with assurance, can make known for certain, matters which so far were unknown, and, if it cannot determine the true mode of contraction, it can at least distinguish what is certain in it from what is uncertain. Nobody should ignore how much this alone should be valued.

No one who loves truth and cherishes health will ever deny that the matters which remain to be investigated at the price of much work deserve to be known.

It is shown that these matters deserve to be known.

There is no need to borrow arguments from Orators, to prove that sweating on this work is not the fact of a man who spends his leisure time, as my critics were not ashamed to assert, often in the presence of famous men. The elegance of the artefact alone deserves an endeavor in research even a thousandfold greater, since it reveals such great evidence of Nature's intelligence. Add that it deals with the motor fiber:

quæ membra agitat, quæ aerem inſpirat, quæ ſanguinem mouet, paucis, vnde vitæ mortiſque ſigna dependent. At quis otioſi dixerit, velle iſtius partis naturam indagare, cum eam hactenus quaſi ignotam deprehendat, videatq; poſſe quid in eius indagine præſtari: ſed hæc Cenſores noſtros non tangunt.

Memineris facilè, non mihi tantùm, ſed ipſi tibi meas partes ſuſcipienti obiectum ſæpiùs, at cui bono, hæc ſcire velle? quid hæc ad praxin? quam ſuam interrogationem identidem repetendo, varijſque figuris exornando, apud omnes id agunt, vt nouis rebus inuigilantes ridiculos, ne dicam, inuiſos reddant.

Licebit alibi fuſiùs demonſtrare, quantùm huius ſæculi experimentis Anatomicis debeat praxis, vel eo ſolo, quod innumeros errores, qui in cauſarum explicatione occurrunt, detexerit, ſimulque rationes plurimas, quas in remedijs applicandis afferunt, erroneas demonſtrarit. Hìc reſponſi loco rogatos eos volo, ſuam ipſi excutiant conſcientiam, videantque quid ſolidi ſubſit omnibus ijs, quæ in apoplexia, paralyſi, contractione, conuulſionibus, virium proſtratione, ſyncope, alijſque motus animalis ſymptomatis explicandis audaci facundia pronuntiant; cui fundamento innitantur, quæ ijſdem malis tollendis applicant remedia, idque non paralyſin, nec conuulſionem, ſed hunc paralyticum, hunc conuulſum ſumendo.

Quod ſi videant in cognitione, præter verba, ni-

with the part that moves the limbs, that breathes in the air, that moves the blood, in short, on which the signs of life and death depend. But who will call idle the desire to explore the nature of a part which is so far almost unknown, and who sees what can be accomplished in this exploration? But such considerations escape our critics.

Since you have often personally taken my side, you as well as myself readily remember the objection: What's the use of wanting to know? or, What practical application does it have? So by repeating their questions again and again, adorned with various figures of speech, they try to make those who remain ceaselessly alert to new discoveries, appear ridiculous, I may even say troublesome.

How much medical practice owes to the experiments of anatomists of this century may be shown in greater detail elsewhere. One example alone will suffice. Anatomy has disclosed innumerable errors committed in the etiology and revealed errors in most of the reasons given for the application of medical remedies. Instead of responding here, I ask them to search their conscience to determine on what solid bases rest all what they in their brashness so glibly deliver to explain apoplexy, paralysis, spasms, convulsions, prostration, syncope and other symptoms of the movement of animal. On what foundation do they rely in deciding what remedies to apply to the cure of these same evils, not in applying them to the paralysis, nor to the convulsion, but to the paralytic, and to the convulsed person?

If they face the fact that their diagnosis is mere words,

hil afferri, in curatione, ſolam coniecturam principatum obtinere; vel inviti fatebuntur, eſſe alicui bono, velle veri, certique quid in hac Anatomes parte indagare. Nec eſt quod obijciant, tot ſæculorum decurſu in eodem ſtatu manſiſſe omnia. In promptu reſponſio eſt; remedia quæſiuerunt omnes, partem, cui remedia applicant, cognoſcere, pauci allaborarunt. At verò automati ab alio confecti conſtructio illi exactè inueſtiganda eſt, qui eiuſdem automati motum læſum reſtituere debet, & ſanguinis, fibræ neruoſæ, fibræ motricis natura, quantùm humana induſtria fieri poterit, illi indaganda eſt, qui motum naturalem lædentia ſymptomata non ſolo caſu curare deſiderat.

Cum itaque in Myologia multa nos lateant, quę ſciri poſſunt; cum non veritatis tantùm, ſed ſanitatis interſit, vt eadem ſciantur; cuilibet manifeſtum eſt, quo iure Cenſores noſtri, noua Anatomicorum experimenta ridendo; illorum labores otioſi hominis occupationes clamitant.

Et hæc illa ſunt, quæ in medium afferenda iudicaui, vt pateat Amicis, quid illis reſpondendum ſit, qui parùm amicè de meis laboribus loquuntur.

Vale Vir Nobiliſſime, & me amare perge.

CANIS

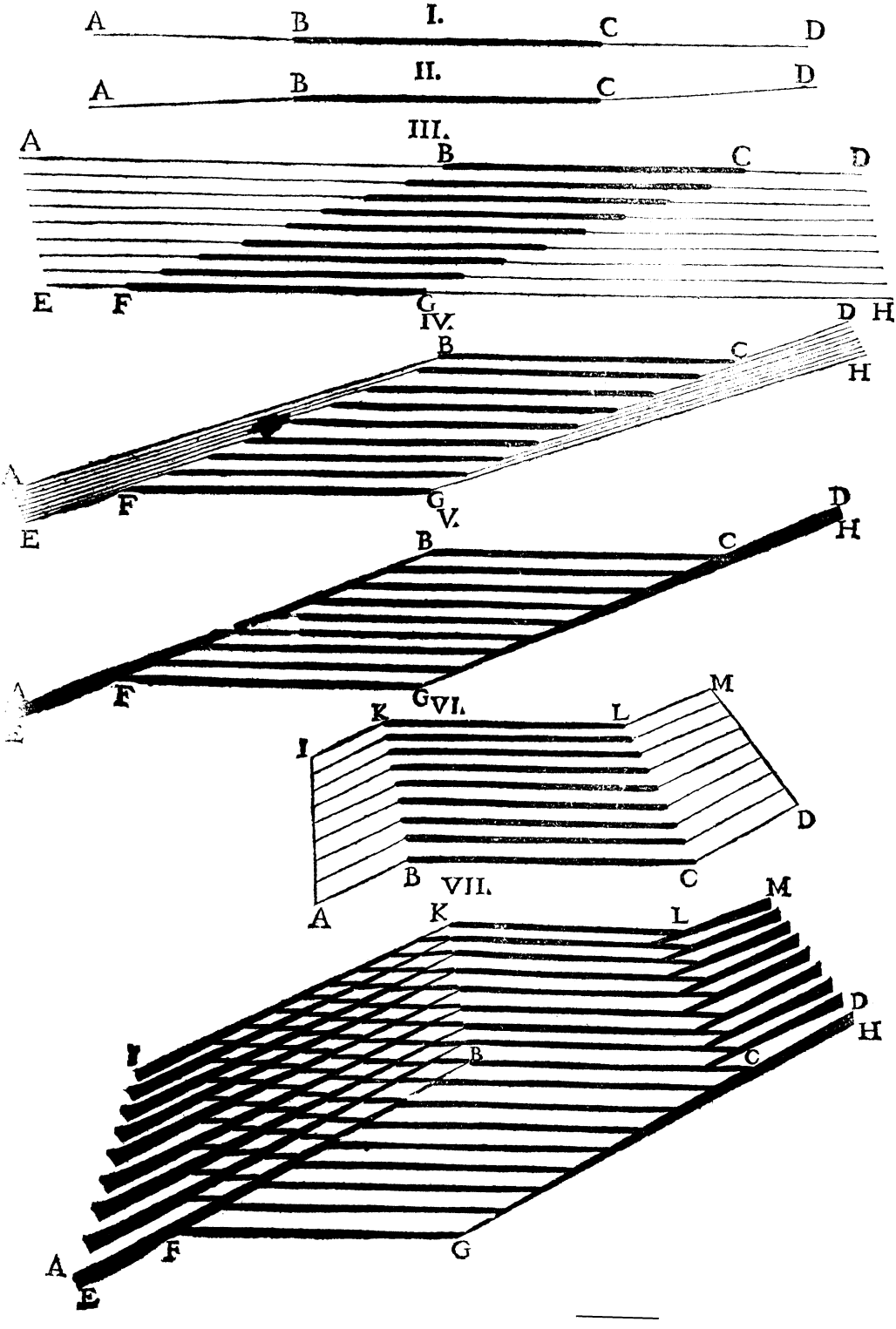
their cure but guess work, they will admit, even reluctantly, that it serves a purpose to discover what is true and certain in anatomy. Do they not object that every thing has remained the same down the centuries? The answer is in short: they all look for remedies and for that part to which the remedies apply, but few attempt to understand. But, just like the construction of a machine built by someone else must be precisely understood by the one who must restore the movement of this damaged machine, similarly the nature of the blood, of the nerve fiber, and of the motor fiber must be investigated as far as human zeal permits by the one who wishes to cure not only by luck the symptoms affecting the natural movement.

In Myology much that can be known remains hidden to us, and since it is not only in the interest of truth but also of good health that these points be known, it is clear to anyone how little justified our critics are in ridiculing the new experiments of the Anatomists and in claiming their labors to be the occupation of an idle man.

These are the matters that I decided to bring to light in order that my friends might know what answer to give to those who speak not too kindly about my work.

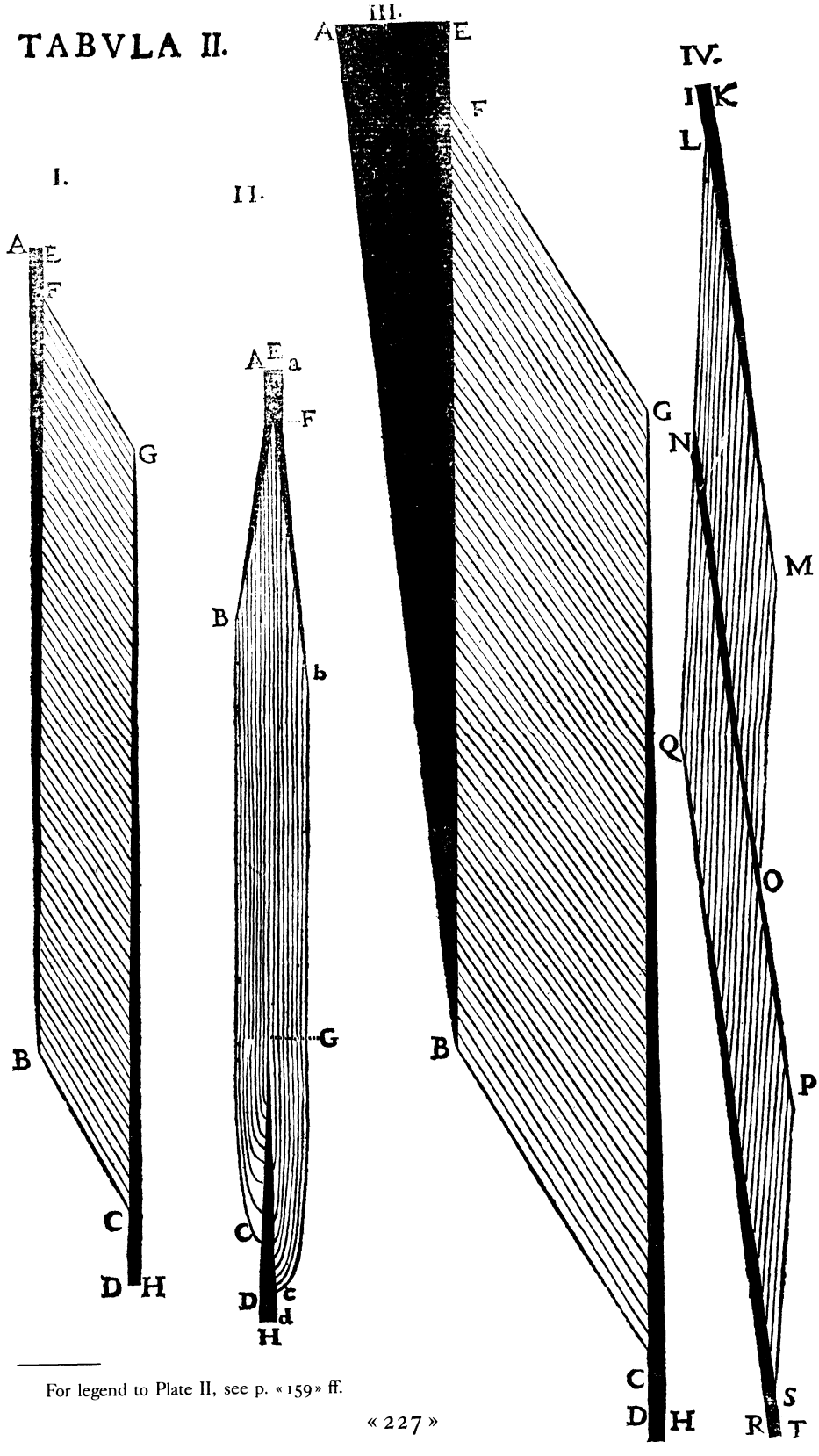
Farewell, most noble man, and do continue to appreciate me.

TABVLA I.



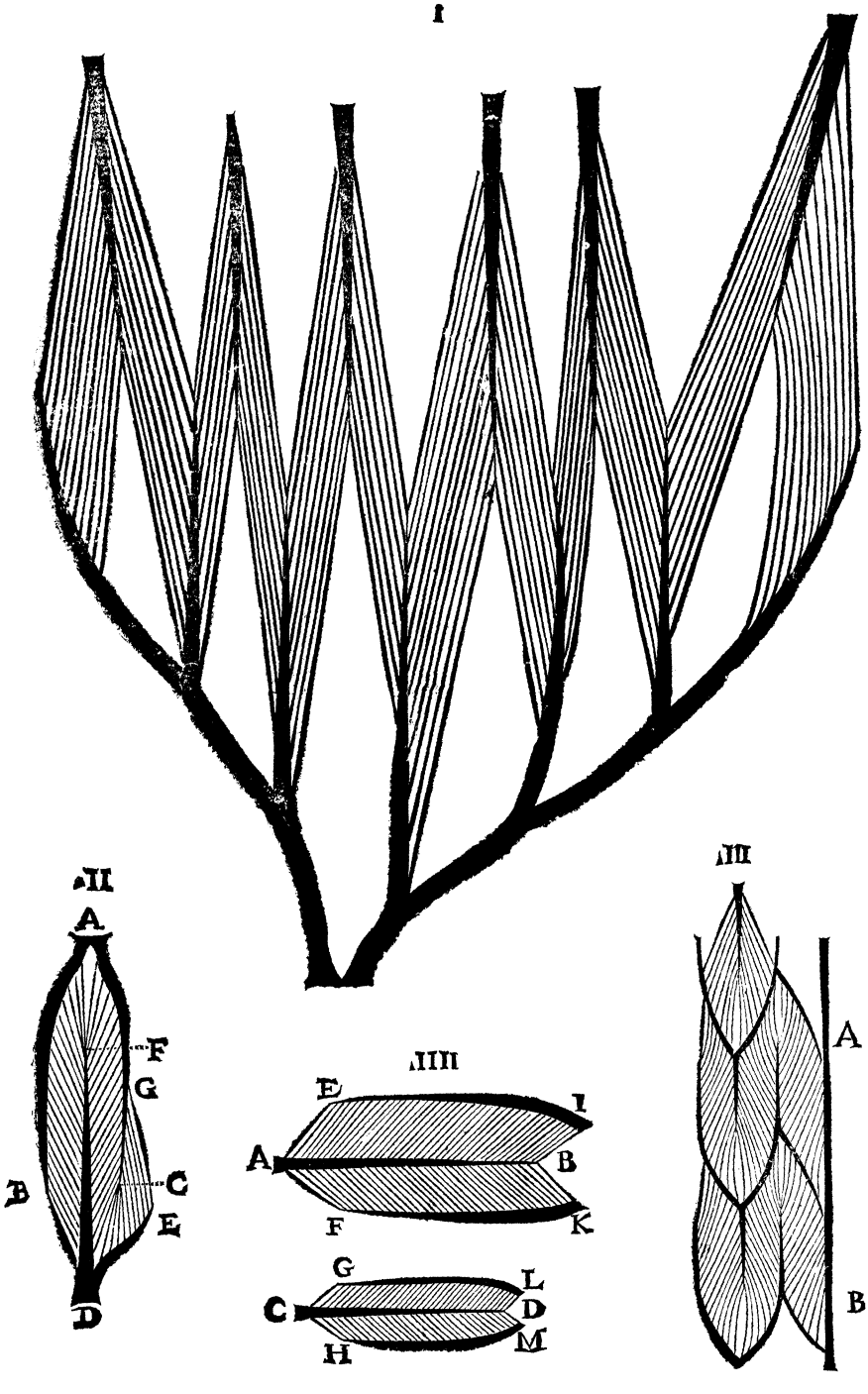
For legend to Plate I, see p. «159».

TABVLA II.



For legend to Plate II, see p. «159» ff.

TABVLA III.



For legend to Plate III, see p. « 163 » ff.

ENDNOTES TO ENGLISH TRANSLATION

1. *Faveant* in MS and 1667 ed., *flaveant* in OPH 2, p. 63.

2. *Aula*; the Pitti Palace which Ferdinand II was enlarging and decorating, continuing the work begun by his father, Cosimo II, and building the Palatine Gallery to house the Medici collection of over 500 paintings, redecorating the halls with frescoes; the young northerner must have been dazzled by the profusion of color and form.

3. This and the following sentence quoted directly in *Phil. Trans. R. Soc.* 2 (1667/68): 627.

4. That is: Mathematics.

5. Proclus (410–485 A.D.) defined *Element* as follows: "There are in the whole geometry certain leading theorems, bearing to those which follow the relation of a principle, all-pervading, and furnishing proofs of many properties. Such theorems are called by the name of *elements*; and their function may be compared to that of the letters of the alphabet in relation to language." Quoted from the introduction to Euclid, vol. 1, p. 114.

6. *De musculis et glandulis observationum specimen*, 1664.

7. This abnormality was also described in *De Musculis.* See the English translation of 1712, reprinted in Kardel *A specimen of observations on muscles*, p. 112.

8. It is incorrect when Stensen defines the microstructure identical with the macrostructure as here. But Stensen did not use the microstructure in the geometrical argumentation, which was based on only the macrostructure from def. 33.

9. *Equal* denotes equal in content.

10. *Equally equal* denotes equal in shape.

11. In *De musculis* Stensen compared the "unequally equal" arrangement of the tendons with the shape of a Pan-flute, *Syringa*, see Kardel, p. 110.

12. In the 1684 English translation of Thomas Willis, *De motu musculari*, reviewing Stensen, Samuel Pordage translated [*Ordo*] as ORDER and [*Versus*] as TURNINGS. In the English translation from 1712 of Stensen, *De Musculis* [*Ordo*] was translated as RANK, and [*Versus*] was translated as LINE or ROW. In the present context LINE may be misleading, and RANK and ROW may be difficult to keep apart. Therefore, ORDER and RANK were preferred for this translation.

13. Croone and Borelli.

14. This remark and the following sentence presumably refer to Charleton, *Natural History*, p. 208.

15. According to Proclus, *lemma*, is "a proposition which is assumed for the construction of something else: thus it is a common remark that a proof has been made out of such and such lemmas. But the special meaning of *lemma* in geometry is a proposition requiring confirmation." Quoted from the introduction to Euclid, vol. 1, p. 133.

16. [Def. 13] in 1667 edition is clearly an error, as pointed out also by Maar. MS has def. 33.

17. One postulate, two axiomas, and ten propositions from Euclid quoted by Stensen are listed on p. 243. Maar has questioned the correctness of this definition number, which is, however, in accordance with MS.

18. Reference in MS is to def. 41.

19. Maar: *latitudinem*. This error in Maar passed on to the Italian translation.

20. Same error in Maar and Italian translation as mentioned in previous note.

21. [= N I]

22. [= M N]

23. Here the text changes from the third person in the first sentence to the second person in the following sentence.

24. [*in bicipite manus*]. According to the following quotation, *manus* is translated as *arm*. "By the word hand (in the manner of Hippocrates and Galen) I mean what is commonly called the arm." Cf. G.B. Canano, *An illustrated dissection of the muscles of the human body* (1541?). Engl. translation in Lind, *Pre-Vesalian anatomy*.

25. [*Seminervosus*] is according to Maar the semitendinosus muscle.

26. The site of insertion in relation to the center of movement, i.e., the lever arm of force.

27. According to Maar a reference to G. Fallopii, *Observationes Anatomicæ*, Venice 1561. The passage is found in lib. II, c. XVIII.

28. The meaning of this sentence is not clear to the translators.

29. *De musculis et glandulis observationem specimen*, 1664.

30. *De vitelli in intestina pulla transitu*, 1664. OPH 17. English translation by M.T. May, *Journal of the History of Medicine and Allied Sciences* 1950, 5: 119–43.

31. V. Coiter, *Externarum et internarum principalium humani corporis partium tabulæ*. Pp. 35–36. Nuremberg 1573, cf. Maar I:263.

32. *The andabats*, in Greek mythology a kind of gladiator fighting blindfolded, cf. Maar.

33. See note 22.

34. This letter has not been identified.

35. The layer of muscles contained in the superficial fascia. It is well developed in some animals, but in man represented only by the platysma muscle.

36. Here, Stensen clearly overemphasized his idea of uniformity of skeletal muscle and heart muscle and underestimated what had been called the faculty of pulsation of the heart.

37. The same observation was reported later by Albrecht von Haller: "With regards to the sternocostals, I have often seen with pleasure, that upon cutting away the sternum, they still preserved a sufficient force to bend the cartilages of the ribs, and pull them inwards." Memoires sur la nature sensible et irritable, des partes du corps animal (1756). Quoted from Fulton, *Muscular contraction*, p. 30.

38. Stensen described the study of tortoises in a letter to Croone dated Rome, 26 May 1666 (not recovered), produced by Croone to the Royal Society on 21 July: "That he, Steno, had begun to dissect tortoises; the particulars of the observations upon which he would send at large another time; but that having cut off the head of one, it was found to keep motion and feeling for above twenty-four hours after, stirring several parts of the body, according as he touched several places in the joinings of its scales." T. Birch, *The History of the Royal Society*, vol. 2, pp. 102–103.

39. MS has *pro*. 1667 and later eds. *per*.

40. Stensen indicates the ancient meaning of the words, *ligament*, connecting link, and *tendon*, stretching part.

41. An early description of the compartmentalization of the water space.

42. The capillaries.