

Notes on the Fertilisation of Orchids

Mr Darwin - in the introduction to his admirable work on the Fertilisation of Orchids, - states that his chief reason for writing the work, was, "to show that the contrivances by which orchids are fertilised, have for their main object the fertilisation of each flower by the pollen of another flower", and to show that in his "^{very} Origin of Species" he had good grounds for advancing his (expressing his) belief in the apparently universal law "that hermaphrodite fertilises itself for

a perpetuity of generations, an occasional cross with another individual being required."

He moreover expresses the hope that his researches will stimulate others to enquire into the habits of our native species.

During the past Summer (1862) I spent some time in the examination of a considerable number of orchids with a view to ascertain whether or not Mr Darwin's observations were accurate, and the conclusions at which he had arrived correct.

The points which I especially wished to test were
 1st Is insect agency essential for their fertilisation? 2^d Is a flower fertilised by its own pollinia or by those of other flowers - for with regard to the first of these Mr Darwin says that in every orchid with the exception of the

Bee Orchis and Cephalanthus grandiflorum - insects are required to remove the pollinia: and with regard to the second, that although in some cases the pollinia may be applied to the stigma of the same flower from which they are taken, yet in all they may may be - and most generally are applied to the stigma of other flowers; - nay! in some flowers for example - the marsh Epipactis the pollinia are removed only by the insects leaving the flowers.

Sprengel in 1795 and R. Brown in 1833, - though he was not without some doubt on the subject - both expressed their belief that in some instances - insects are necessary - and many others have given support to the belief, - but Darwin has been

11

the first to show that the necessity - for insects - which was previously considered to be confined to a few, - is almost universal.

My observations so far as they have gone - have most thoroughly convinced me of the truth of Mr Darwin's statement, - I must however say - to prevent myself from being misunderstood - that I have only examined 4 species - on account of my not being able to procure any more, but these have been examined pretty thoroughly. - I was staying in a part of Kent where *Orchis maculata* and *Cephalanthus grandiflorus* were especially abundant, - and *Gymnadenis conopsea* and *Orchis pyramidalis* to a lesser degree. I examined 1175 flowers of *Cephalanthus*, 1,000 of *Orchis mac*,

-ulatio, and 244 of *Hyemodorum*
Conopsea and 60 of *Orchis Pyra-*
midalis in all 2,479 flowers, this
 number may seem very large

but then it must be remembered
 that they were most abundant
 in the locality, in which I was stay-
 ing - and I had no difficulty in
 procuring them.

All the plants of the 4 species
 given on the following page, grew
 here or in woods, so that they were
 most favourably situated for
 insect visitation. I have seen
Lepidopterous insects visiting
 them frequently, and on one
 occasion I saw an insect
 remove the pollinia from a
 flower of *Orchis maculata* - (I found
 that a warm cloudy day was
 the day on which they were busiest)

This fact is certain regarding
 the fertilisation of 3 of the 4 species
Self fertilisation is impossible, the
 pollinia must be removed from 73

Name	Number of Flowers examined	Both Pollinia Remaining		Both Pollinia Removed		One Pollinium The Right		One Pollinium The Left	
		Fertile	Infertile	Fertile	Infertile	Fertile	Infertile	Fertile	Infertile
<i>Orchis</i>									
<i>maculata</i>	1,000	50 2 of these young	28 12 of these young	765 15 of these young	47	53	3	44	10
<i>Gymnadenia</i>									
<i>conopsea</i>	244	54	24	96	4	30	4	15	4
<i>Orchis</i>									
<i>pyramidalis</i>	60	15	34	34	2	Pollinia attached by their bases			
Total	1,304	119	96	895	58	83	10	54	14
		215		953		93		73	
<i>Cephaelis</i>									
<i>pyramidalis</i>	1,175	35	128	8		Pollinia attached by their bases both must necessarily be removed			

1/4

6

Either the same flower or another flower, and applied to the stigma. In by far the greater majority of the flowers the pollinia were both removed - and in only a few of these were the ovaries non fertilised.

Sometimes I found the heads of Pollinia sticking to the stigma - this was rare however. I often found in new flowers bundles broken off from the pollinia adhering to the viscid disc, although the pollinia remained in the same flower untouched; showing conclusively that these flowers had been fertilised by the pollinia of other flowers.

The flowers I examined were generally old with the viscid discs and stigmas quite dry, so that no further change

could take place in the
fertilisation of such flowers,
Of 1304 flowers, 953
had both pollinia removed
of which 895 were fertile

58 - non fertile

From this it appears that
although the pollinia may have
been removed from their flowers
the flowers are sometimes non fertile

This is because the insect has
carried away the pollinia without
pushing them against the stigma,
and because the flowers have
been visited by insects
with pollinia on their probosces.

Of such flowers could ever have
become fertilised (not was old)
it must almost necessarily have
been by the pollinia of other
flowers.

In 212 both pollinia were
still remaining
of these 119 were Fertile
96 - non fertile

So that although these species are incapable of self fertilisation the flowers are oftener fertilised than not, showing that insects have visited the flowers and fertilised them although they have not removed the pollen.

Had the flowers grown in a less wooded district where insects are more scarce - many more would have had both pollen remaining and fewer of them would have been fertilised.

Observe how different is the case of *Cephalanthus franchetii* which is capable of self fertilisation 35 out of 1175 had both pollen remaining, and these were all fertile - while out of the 1128 which had both pollen removed 8 were non fertile.

In the 2 species which had their pollen se-
-parated

very

The right pollinium was removed rather often than the left, - a fact which would be difficult to explain.

Of the 166 which had ~~both~~ pollinia removed

142 were fertile

24 were non-fertile

Showing that where only one pollinium is removed the flowers are not so certainly fertilised - in short the insects have not visited them so frequently.

It is unnecessary for me to comment further upon the preceding table, - but I may shortly say that it fully bears out Mr Darwin's conclusions, it establishes nothing new, but merely places beyond doubt very important opinions advanced by Darwin, among which the following are the two most important.

1 Insect Agency is necessary in the ³ ~~instances~~

2 Crossing of the individuals of a species is not only permitted, but all the arrangements seem so specially adapted to bring about such a result,

Mr Darwin has however omitted one important observation. One would suppose that, from the freedom and ease with which insects carry off the pollinia and fertilise - even to the same polliniferous many flowers - Hybrids should be common; which we know that they are very rare. I have always observed that the same insects visit only one species. - I have never seen the insects which visit *O. maculata* visit *Cephalanthus frondiflorus*, although they grow quite near. In my limited sphere of observation I always found this to be the case; - possibly had it been more extended - I might have found that there are exceptions - but the fact does not seem to have been noticed by Darwin. My inquiry into this might bring out some interesting facts

William Rutterford

The Structure of the Oesophagus of the Ruminantia

The Muscular Structure of the
Oesophagus of the Ruminants
seems to have been a subject
which, - nearly two Centuries
ago - attracted a very consider-
able share of attention - for the
opinions of no fewer than twelve
Anatomists are quoted by Peyer
in his work on the Ruminantia.

In recent times it has not, -
- so far as I have been able to ascertain
- been re-examined; except perhaps
by Mr. Spencer Co. Wood (Todd's
Cyclopaedia of Anatomy & Physiology)

whose account of its structure although it certainly differs from those of Peyer and his predecessors, is like all the descriptions which I have been able to lay hold of not only erroneous, but very far wide of the truth.

I will briefly allude to the opinions of these authors before giving the results of my own investigations.

The first writers on this subject appear to have been, P. Cepernus and A. Mylianus, who said that the muscular fibres of the gut are arranged in two layers the outer consisting of longitudinal, the inner of transverse fibres. Agaprondeus and Ruilandius agreed to this description and Galea added to it, his opinion that while the food was swallowed by all the fibres it was

Returned to the mouth through
the action of the transverse. alone.

Fabriceus and Fallopius
went so far as to say that the
oesophagus did not contain any
muscular fibres at all but that
it consisted of a substance quite
peculiar - *Sui generis*. -

Nicol Stenson said that the
muscular fibres formed double
spirals: the bundles running
spirally from the one end of
the gut to the other, forming
two layers, which interlaced
at two angles, so that the same
bundle while running from
the one end to the other lies
alternately in the inner and
outer layers.

Baetholme and Boerhaave account
resembled this, - but they thought that
there was an internal series, and
an external series - of double spirals.
To this account by Stenson

Ducurus Delphinus and Willis
 agreed and Peyer's account
 though evidently meant to be or-
 iginal, does not differ from
 Stenon's, excepting that it is
 a more lively and intellig-
 ible narration of false facts

Mr. Spencer Coward's de-
 scription is the latest but
 it does not differ from those of
 his predecessors in superficiality
 and inaccuracy - He says

The gullet consists of two layers
 the outer "transversely circular"
 the inner "obliquely longitudinal"

These accounts are
 all incorrect, certainly
 Stenon's is nearer the truth than
 any of the others, but it is
 nevertheless wide of the mark

The following I consider to
 be the true description

The muscular structure of
 the oesophagus consists of two layers of
 fibres

Running in an oblique direction
(See Plate I Preparation 3, 4, 2.) The fibres of
both layers do not however run
in the same direction, but cross
each other like the letter X



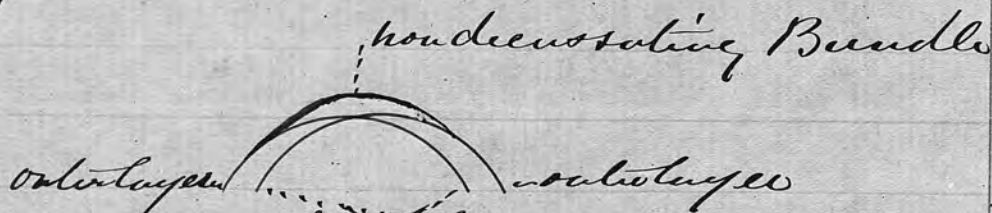
The two layers are everywhere separable
except at two lines which are exactly
opposite each other and which run
from the one end of the pullet to the
other dividing it into two sym-
metrical halves. (vide Plate II Preparation 4.)

These lines I shall call the Decussations, - for there the two layers inter-
mingle, the inner layer of either
side passing out to become the
outer layer of either side, - that is
the inner layer of one side passes
outwards to become the outer layer
of the opposite side. and in
so doing, crosses the inner layer
of the other side as it runs outward

Also (vide Preparation 3, Plate I)



On examining a line of decussation more minutely on both its outer and inner aspects (vide Plate I, Preparation 3) it will be observed that whereas internally the crossing is clean and distinct, externally it is more obscure. This is caused by a bundle of fibres of the outer layer - which instead of dipping down to become internal, continues over the decussation to the outer layer of the other side (vide Plate I, Preparation 3, b, 4)



These fibres will form the nondecussating bundles. An incorrect term, however, for if these bundles be traced round to the other line of decussation there they will always be found to

27

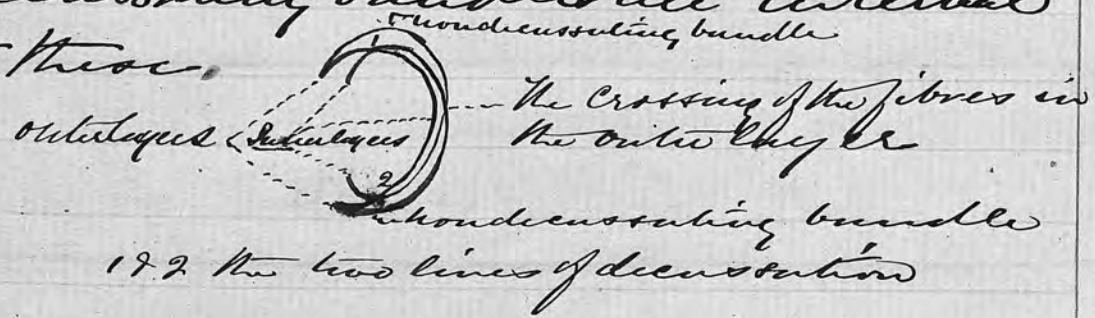
decussate - passing into the
inner layers  a bundle of fibres ~~was~~ ^{not}
decussating at the one ~~decussation~~
~~line~~ running round to
the other (decussation) and
then decussating

Further, the concavity of this how
decussating bundle - for they all
run obliquely - (vide model I)
looks at the one decussation up-
wards, at the other downwards.

At both decussations all the
fibres of the inner layers run
~~inwards~~ ^{out} into the outer layers; but
all the fibres of the outer layers do not
run inwards to the inner, but
the half of these outer fibres run
over the decussation into the outer
layer of the other side; and whether
you trace these how decussating
bundles upwards from the
one decussation or downwards
from the other, they will always
be found to decussate at the
decussation of the opposite side
so that they are not circular fibres 86

P

The great difficulty in ascertaining the structure is in tracing those non-decrossing bundles from the one decussation to the other - for an intertwining of the fibres of the outer layer takes place, between the decussations: the non-decrossing bundle which is external to every thing at the one decussation - when traced (say downwards) gets below the non-decrossing bundle coming up from the other decussation (vide model I) while it in turn gets below the other just before it is about to decussate. So that at both decussations the non-decrossing bundles are necessarily external while the decussating bundles are internal to them.



py

* This intermingling occurs just below
F in Plate II (slide preparation 5)

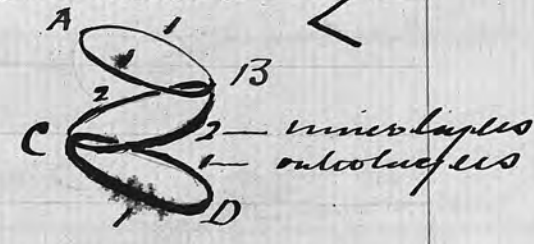
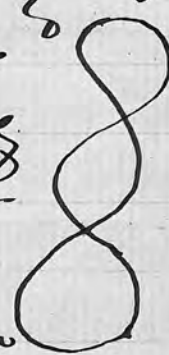
It would be an easy task to trace these bundles, did the individual fibres keep together - but the bundles break up into their finest fibrils rendering the interdigitations* and intermixture of the ^{two} bundles very minute - and difficult to follow out; I have often failed in doing so, but I have succeeded a sufficient number of times to warrant me in giving the above description as correct;

Now ^{all} the fibres of the inner layers whether you trace them upwards or downwards (vide plate - preparation 4) always decussate (except at the lower end of the pulpit) and if they be traced onwards in the outer layers they will be found to form the new decussating bundles at the next decussation; (vide plate III (B) - preparation 5). This being true the structure is this. Each bundle of fibres forms a perfect loop

pp

(vide Model I) which crosses the
fallet obliquely 3 times Z

That is to say a
non decussating
bundle of the one
decussation A



if traced round on both sides to
the next decussation B, would be found
to decussate and pass into the inner
layers, (2). in which it crosses the
fallet a second time and again
decussates at C - passing into
the outer layers in which it crosses
the fallet for the 3^d time and forms
at D the non decussating bundle.

So that the beginning of the loop
is above (q. q) on the one side of
the fallet and its termination
below on the other side and
the same bundle is twice
external but only once in the
internal layers; hence it is that
the outer layer contains twice
as many fibres as the inner

11
it certainly is not twice as thick
because it contains much
less Cellular tissue and is
altogether more compact than
the internal layer.

The fact which it is especially ne-
cessary to bear in mind is that
the bundles of the inner layers
when traced either upwards or
downwards always decussate
and when traced on in the outer
layers form at the next decus-
sation the transverse
bundles. If this be thought over
for a moment - it will be
seen how impossible it is
to draw from it - any but the
above conclusion - as to the
structure - viz a perfect loop cross-
ing the full 3 times.

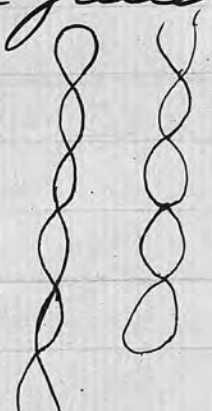
Just before the full 3 joins
the structure the inner layer
becomes very much thicker
than the outer owing to the presence
90

of circular fibres which may
act as a sphincter.

Two other theories suggested
themselves to me in the course
of my investigations. 1st That
although a perfect loop the bundle
might be longer than I now suppose,
that is, instead of crossing the full
- it only 3 times ^(the bundle) they might do so
often say 5 or 6 times. Σ This - I
soon abandoned for Σ I found
that all the fibres of the inner layers
after passing into the outer - become
redensating at the next decuss-
-ation, which would not be the case
if the loop crossed the full thor
than 3 times, and moreover
that, at a decussation, the new
-decussating bundle was as great
as the decussating bundle - which
could not be true if this long
loop view were correct.

The same facts overthrew the
2^d false theory which I termed

the "Hair Pin Theory" (vide Model II)
for I supposed that bundles of
fibres beginning with a loop below
at one decussation run spirally
up to the upper extremity. While
in the same way loops began
above at the other decussation
and run spirally downwards
to the lower extremity of the pullet
- According to this
view the pullet would
certainly have been
of equal thickness
throughout, - but it is
negatived by the same
facts which negatived
the long loop view viz the non-
decussating bundles at the
decussations are as large as the
decussating bundles, and
all the fibres of the inner layer
when traced round in the outer
layer become non decussating
at the first decussation after they



2) A spiral running from the one end
of the full set to the other would cross
it 6 or 10 times

have entered the outer layer*

I have calculated that according to this hair pin theory the deers-ating bundle at a deersation would be 10 times⁽²⁾ as large as the nondeersating. They are equal in size.

What then is the use of this remarkable and beautiful structure? is it to enable the animal to ruminate? it would be difficult to conceive why so elaborate and ingenious a structure should be required to bring the food back from the stomach. for the simplest human gullet ought to be able to carry the food up from the stomach - as well as to carry it down, - and this idea is shown to be wrong by the

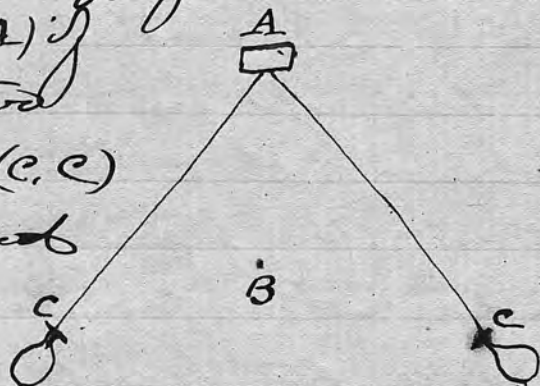
* I have frequently used the term layers both in the plural and singular, e.g.

inner layer - or inner layers, the terms are synonymous - because the whole gullet might be split into symmetrical halves at the deersations, where the term is paired it means - the inner layers of both halves

fact which I discovered (if I be not mistaken) that the Dog's vesophagus is structurally identical with that of the Ruminant.

The advantage gained by a structure such as this seems to be 1st Rapidity of transmission

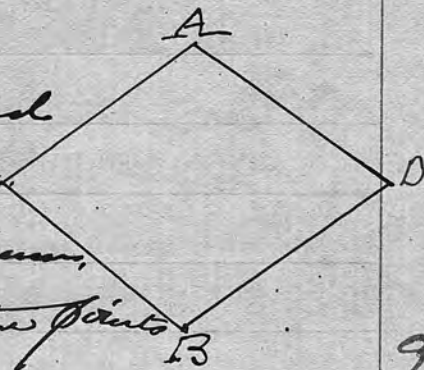
A body at (A) if pulled by two oblique strings (C, C) will be advanced to B more rapidly



than if these strings were pulled directly before the body - supposing the same force to be used in both cases: - When the strings are oblique however, although rapidity of transmission is gained, there is a loss of force

A bundle of fibres of the inner and outer layers of the gullet when taken together form a parallelogram.

During contraction the points



But C and D are also approximated
by which, Constriction of the tube ~~seems~~
is effected and it may be argued that
as the upper and lower extremities of the
gullet are more fixed than its sides
so the points A and B will be more
fixed than C and D and so Constriction
of the gullet will be the chief thing which
occurs - but the extremities of the gullet
cannot so very fixed for the Lingua
descends just before deglutition and
moreover the points C and D are
fixed on account of the resistance of
the passing bolus - The same
object is gained as that which is ef-
fected by Longitudinal and Circular
fibres viz some shortening and constriction
- but on account of the obliquity of
the action - it is attained with greater
speed than in the case of Longitudinal
and Circular fibres.

A and B are approximated - and from the obliquity of the fibres a body is carried along the gullet more rapidly than it could be along the human gullet or that of ~~the~~ Bird (Circular fibres) and this is a great advantage to the Ruminant, for the slow passage of so much food backwards and forwards would very seriously interfere with respiration by pressing upon the trachea, so that it is necessary that it should pass along as swiftly as possible.

But then, Why should the Carnivorous animal have such a gullet? (Are the oesophagi of all the Carnivora similar to that of the dog?)

This fact renders necessary an additional explanation by that by this structure great strength is gained. The same number of fibres as are present in the human gullet would make a much longer and more compact tube if

interwoven in a manner similar to that in the Ruminants' gullet; for the fibres are so closely interlaced that separation of them is extremely difficult; while in the Human gullet consisting simply of longitudinal and circular fibres the fibres would be more apt to separate if pressing upon a not very compressible bolus. And as the muscular tunics of even the sheep and dogs gullet are thicker than in the human subject - Strength in addition to rapidity of transmission is certainly gained - I have often been astonished (before I knew the structure of its gullet) at the large masses of unchewed food which a dog can readily swallow.

I have examined especially the Sheep's gullet. for that of the Ot though possessing the same structure is much more difficult to dissect on account of

of the greater brittleness of the fibres when boiled - I have not examined the fullest of any other Mammal - on account of not being able to procure one.

The Method I have pursued in dissection has been to boil the oesophagi for 4 or 5 hours then macerate them in 2 parts of Rectified Spirit to 3 of water for a week or 10 days. This converts the cellular tissue into a gelatinous matter, so that the fibres may be separated by needles with considerable ease. Rectified Spirit should be dropped upon them from time to time in the course of the dissection, to keep them from becoming soft.

William Reetherford

Plate I (from Preparation 3)
Portion of a Sheep's gutlet 2nd the
natural size - seen from the
interior

The fibres of the inner layer c, c,
are seen decussating, and running
into the outer layer B, B, while
at a is seen a nondecussating
bundle passing outside the
decussation from the outer layer
of one side to that of the other side of
the decussation

Plate I

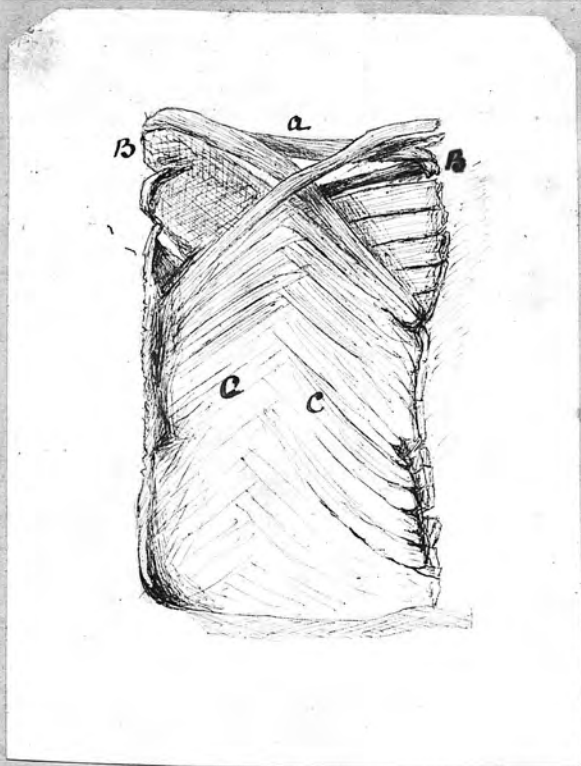


Plate II (From Preparation 5)

Portion of Sheep's Gullet seen from within - $\frac{1}{2}$ larger than natural size

The gullet has been merely slit up and dissected - The 2 lines of decussation a. a.

The inner layer has been partially removed in the middle showing the external layer.

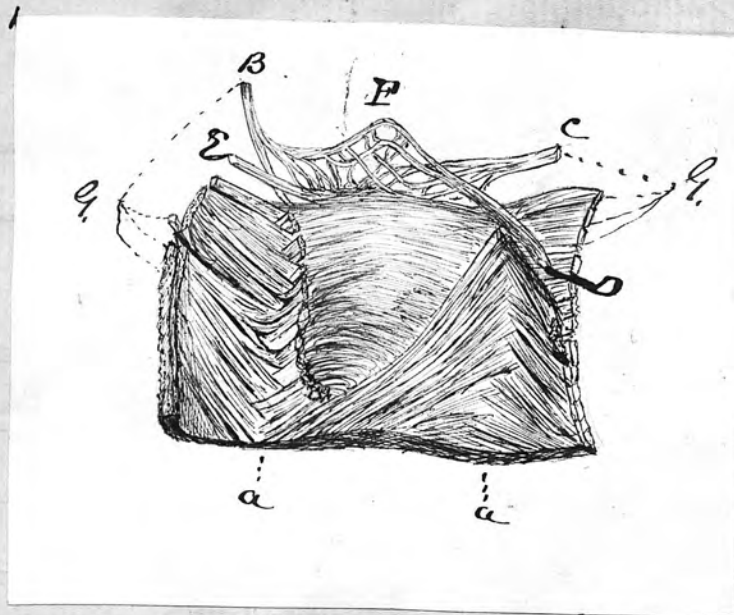
At B, a nondecussating bundle of one decussation, At C, another decussating bundle of the other decussation

At D a bundle of fibres is seen running up from the inner layer of the right side into the outer layer and forming the nondecussating bundle B at the other decussation,

E, a bundle of fibres of the inner layer in like manner runs on to the outer layer to form the nondecussating bundle C at the other decussation,

E. e. outer layer

Plate II



It is just below F where the intertwining of the fibres of the outer layer occurs. D and E crossing each other, do no bother to be concerned to anything with their respective decussations.

Plate III

From Preparation 3

Portion of Sheep Jellet
natural size

- A The Line of decussation seen from within - the crossing is clear distinct and unobscured
- B The same decussation seen externally - it is rendered obscure by the nondecussating bundles running over it, instead of dipping down into the inner layer

Plate III



A



B

Description of Preparations

(1) nearly the whole length of the
 Thrips fullit-boiled - The fibres run
 obliquely - the inner layer may be
 seen between some of the bundles of
 the outer layer - The lines of
 denervation are faintly visible

2

Portion of the blastophagus of the ox
 turned inside out. The lines
 of denervation are distinct - A
 portion of the inner layer has
 been removed to show the outer
 layer

3

Portion of a Thrips fullit

The concave side is the inner as-
 pect, Two denervating bundles
 are raised upon a black thread -
 are running up from the inner
 layer to the outer - while outside
 there a non-denervating bundle
 - / by which the preparation is

Suspended - runs from the outer layer of the one side to that of the other - observe the difference between the decussation as viewed from the outer and from the inner side

4

Portion of an O.S. full of slit open - Concave side is internal +
- Both decussations are seen - dissected - bundles of fibres are running from the inner layer - decussating and passing into the outer layer - while a - non?
non - decussating bundles is ~~seen~~ at right angles decussation lies in plane instead

5

Portion of a Sheep's full of seen from the inner side
side Plate II Page 99 for an explanation

Preparation
lost
+

6

24

Portion of a Sheep's pallet seen from the inside - both decussations are dissected - the nondecussating bundle of roots is held aside by white thread while the decussating bundles passing from the inner layer are supported on black threads

7

Portion of a dog's pallet - seen from the outside - a portion of the outer layer has been removed to show the inner

The structure is the same as that of the Sheep's pallet

103

Appendix to Cellular Pathology
accompanied by XX Preparations

i

Transverse Section of Fibro Cartilage 4/5/63

In one - the thinner - of the two sections the nuclei and processes are clearly seen.

ii

Transverse Section of Fibro Cartilage 1/1/63

The "processes" have now become so faint from the action of the glycerine - that they can only in some places be recognised. The nuclei appear to remain unaltered. The intercellular substance - fibres - is more transparent

iii

Longitudinal Section of Fibro Cartilage 1/1/63

nuclei are seen in abundance, and also fibres running in the longitudinal direction. On altering the focus you may see indistinct transverse striations which are probably the transverse processes of the corpuscles

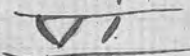
iv

Transverse Section of Tendo Achillis of Adult 26/4/63. (vide drawing i)

The nuclei and anastomosing Processes of the corpuscles are distinctly seen - Septa are also seen crossing the section in various directions



Transverse Section of Tendo Achillis 1/1/63
(vide Drawing ii) Has been put up in Elycerine for 4 months. The changes which have occurred in it took place before the end of the third week. Nuclei remain unaltered. Processes how faint and indistinct in some a chain of molecules is all that remains of the original process. The little black dots with which the section is so numerously studded are not the cut ends of fibres as Dr Hartog (Beales archives May 1961) supposes.



Longitudinal Section of Tendo Achillis 1/1/63
Fibres are seen running in the longitudinal direction elongated nuclei are here and there seen lying between the fibres. On altering the focus an appearance similar to that in Fibrocartilage may be seen viz. an obscure

transverse striation probably owing to the processes of the corpuscles. I have never been able to find the oval spaces between the fibres - with processes at either extremity described by Dr. Martyn.

VII

Longitudinal Section at base of adult Tendo Achillis. Showing the junction between Cartilage, Fibro Cartilage & Tendon 26/4/63
At one side of the Section Cartilage is seen and running into this Fibrocartilage. The junction between Fibro Cartilage & Tendon about the middle (in length) of the Section is rather indistinct.

These preparations of Fibro Cartilage and Tendon have been first macerated in dilute Acetic Acid for 24 hours, then dried, and the sections put up in Glycerine.

VIII

Connective Tissue from muscular sheath of a Cat showing Connective Tissue Corpuscles 2/5/63. (See Drawing III.) Spindle shaped bodies are seen

4

with 2 processes generally - one at either end
these processes correspond ^{in some instances} to the elastic
fibres. you may see them curled up
in many instances - the cells are
faintly granular - and a few large
granules generally supply the place
of distinct nucleus - Sometimes
however an oval nucleus may
be seen - The preparation is put up
in weak spirit and no reagent
has been added

IX

A Preparation similar to VIII * 1st sent

X

Connective Tissue from a muscular
sheath of a young Rabbit, 1/5/63

The Corporcles are numerous and
are similar to those in Prep VIII Darning III
no Reagent has been added - Preparation mounted
in Glycerine

XI

Connective Tissue from muscular
sheath of old Rabbit at some distance
from that of insertion 30/4/63 Put up in Glycerine

107

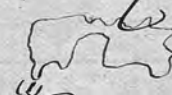
The Candidate Cells are enlarged and now contain large nuclei (vide Drawing iv) Some contain two nuclei while in others division of the nucleus is taking place

There are other Cells which are not Candidates and many of which have obviously never been so - that is - the fibres have not been torn off by manipulation - they contain large nuclei - Some one nucleus others - two nuclei - Coagulated Fibrin is also present

XII

Connective Tissue in which Pus is appearing from old Rabbit. taken from heavier the seat of imitation than Preparation

XI Pus Cells - very much smaller ^{3 or 4 times smaller} than the round Cells of the last preparation are now appearing while the Candidate and non Candidate Cells seen in the last preparations are disappearing - at one part of the preparation

(1)  ^{copy of Preparation} } The Candidate Cells are seen also in Preparation XI vide Drawings v & vi

I have not been able to find any

Caudate Corpuscles in which first of course multiplication was taking place as maintained by Virchow but the appearance of many of the cells as the in XI and XII favors the view advanced by Virchow Weber - viz Endogenous formation of pus cells - The nuclei of cells contained within the caudate and non-caudate cells. closely resembling pus corpuscles (vide preparation XVII)
XIII

Connective Tissue in which pus is appearing taken from old Cat, Caudate cells and pus corpuscles here a preparation similar to XII
XIV

Connective Tissue of young Rabbit in which pus cells were abundant, Caudate cells scarce. Taken from here the first of irritation, many caudate cells contain bodies which closely resemble pus cells
XV

Connective Tissue of young Rabbit

*
Are these contained bodies due to
coagulation by the acid - I don't
think so for when I add the acid
to the normal cells I find no such
bodies produced

47

taken from nearer the ~~start~~ of involution
than the last. This is fully formed
The Caudate Cells have almost
entirely disappeared

XVI

Connective Tissue of Old Cat
taken from close upon the ~~start~~ of involution
This fully formed, no Caudate
Corpuscles

XVII

Suppuration in ^{Connective Tissue} muscle - taken from
Gastrocnemius of Old Cat

Spindle shaped bodies are seen in the
Connective Tissue filled with bodies
closely resembling small pus corpus-
cles. vide Drawing VII. * Nitric acid has
been added & the Section put up in Glycerine

XVIII

Striped muscle of young Rabbit
showing nuclei within the Sarcotubules
Nitric acid has been added & the prep. mounted
in Glycerine. vide Drawing VIII
(The Rabbit was $\frac{1}{2}$ grown)

P

XIX

Striped muscle from Old Rabbit - showing nuclei - too transparent - nitric acid added - put up in glycerine - vide Drawing IX
The nuclei are not so distinct as in XVIII - they are more elongated - and narrower than those of the Young Rabbit.
XX

Striped muscle from Old Cat
showing nuclei - nitric acid added - put up in glycerine - vide Drawing X
The nuclei are more elongated than those of the old Rabbit.

XXI

Suppuration in muscle Striped muscle of Young Rabbit taken from close to the seat of irritation - nitric acid added - put up in glycerine - vide Drawing XI
In many of the fibres the nuclei are enlarged and a proliferation has taken place in Drawing XI fig 3 taken from this preparation the nuclei are seen when enlarged and greatly multiplied in numbers some are seen forming a projection



Have repeatedly seen rounded
bodies within the sarcoplasm of an
irritated fibre - which are really like
Pus Cells - it may be said, however that
they are nevertheless nuclei and thought
they should escape from the sarcoplasm
they would only be broken nuclei - un-
affected as other nuclei by Acetic
Acid - such is not the case for Acetic
Acid renders these bodies transparent,
while it does not affect the original oval
nucleus - so that a chemical change has
taken place during the multiplication
of the nuclei - and we have in those
rounded pyoid bodies bodies with structure
chemically differing from their parent
nuclei and presenting all the characters
of Pus Cells - In suppurating muscle
there is a multiplication of nuclei - do these
give origin to new muscular fibres -
I cannot see any such development.
What becomes of them then? - they rupture
the sarcoplasm & escape - Are they lost Pus
Cells?

from the fibre. Some of the cells at a are round and very like pus cells.

I have figured a pus corpuscle from the same preparation to show how closely they resemble each other:— This fibre is to be found in the centre of the preparation covered like the letter f

 The portion of the fibre I have drawn at page 12nd is marked 1; unfortunately the portion of muscle was turned upside down when the preparation was permanently put up and in consequence the included cells - (or nuclei) happen not to be so numerous on the side which is next the covering glass - but the preparation upside down so that the thick glass is next the object glass and you will observe their greater number on that side - unfortunately it cannot in that case be examined by a sufficiently high power.

Moreover the drawing was taken when the tissue was first examined; it has now become so transparent that only the coarser - denser nuclei are visible

I have made Drawing XIV from the same Preparation since ~~it~~ was put up it shows a proliferation of nuclei and many fibres may be seen—especially well in one part of the Preparation (at 1) which contains quite a multitude of new nuclei some of them may like pus cells—in one fibre there is at one part quite a crowd of new small nuclei—The Rabbit was killed after ^{wooden} pin diffused in nitric acid  had been inserted in the Gastrocnemius for two days.

Remarks on the foregoing Preparations,

The Preparations from P 15 17 inclusive illustrate the growth of pus in Connective Tissue. P 15 and 16 show the structure of Connective Tissue in the Young Rabbit and Old Cat; the Connective Tissue corpuscles closely resemble those figured by Richardson at page 44 Cell. Pathology: they are more numerous in the

11
young tissue than in the old,
but their unmistakable presence
in the old tissue, precludes the
idea that they are cells splitting
up to form fibres. I have intentionally
selected a thin membrane - such as
that surrounding the muscles - to
show these in, as it does not require to be
torn up by needles - which quite destroys
them - but simply to be spread out and examined.

I have traced the various changes which
take place in supputation of this
membrane - from healthy tissue
up to the point where pus has
fully formed - and they are these
1st The mildest effect of the irrit-
-ation is an enlargement of the con-
-nective tissue corpuscles with the
appearance of distinct and
sometimes large nuclei within
them (they normally contain a few
large granules or an indistinct ^{nucleus}
-less). Large round non-caudate ^{simple} cells
now appear with distinct large nuclei.

Some contain one - some two or three, nuclei, and in some - the nucleus may be seen dividing into two - At this stage a very small quantity of Fibrin - if any is present. These round cells cannot be pus cells - they are 3 or 4 times larger - ~~than~~ ^{the} ~~than~~ pus cells which afterwards appear - Compare Prep. 11 with 14 -

Fibrin now appears in the part - in considerable quantity (See Prep ~~12~~ 12 & 13) and small pus cells begin to appear the nuclei of the Candidate Corporules are meanwhile undergoing proliferation - in some you may see them dividing - in others - the cells contain 2, 3, 4 or 5 nuclei (vide figures iv. v. vi. vii) which very closely resemble pus cells both in size and appearance.

In short when the pus corporules appear - and they usually do so in groups of 2 or 3 - the Candidate & large non-candidate cells contain bodies identical with pus corporules. Still further progressing (Prep 14)

the pus cells increase in size and number while the Connective Tissue corpuscles - and Large Round Cells - "Mother Cells" diminish in number till finally you arrive at a point where pus is fully formed (Prep 16, 15?) and where you can detect nothing but pus cells, no leucocyte or other large round cells - being present - we began with Connective tissue corpuscles and we end with pus cells which have taken their place - the intermediate stages pretty decidedly showing the former to be the parents of the latter.

When we remember, how that in other cells - (generally) irritation gives rise to a proliferation - and when we compare the nuclei of these connective tissue corpuscles with pus cells - and take into account the disappearance of the connective tissue corpuscles and the appearance - pari passu of pus cells - is the probability not very strong? yes it is

not so strong! that we may say: the
 Connective Tissue Corpuscles and
 the nonCaudate Cells are the parents of
 the pus cells. Irehon says that a
 Connective tissue corpuscle divides
 repeatedly when giving rise to pus Corp
 uscles - I have never seen this in the
 case of Caudate Corpuscles, but I have
 some times seen it in the case of the
 nonCaudate Corpuscles (vide Fig 5 Prep
 11). On the other hand - Weber supposes
 the pus cells to be developed from the
 nuclei inside the Connective tissue Cor-
 puscles; this is the view which I think
 is best supported by the facts: But
 where do the noncaudate Corpuscles
 come from? (vide Prep 4) As they
 are abundant and large in size - while
 the exudation if any is very scanty
 it could not - I think - be maintained that
 they are developed from an exudation
 - As it is these cells which I have
 sometimes seen dividing - it is not
 improbable that they are Connective

Tissue corpuscles whose processes have disappeared - and are proceeding to develop pus cells by division of the whole cell as Virchow says (P. 457 Cell Pathology) - Perhaps Weber and Virchow may be both correct.

Compare Prep 17 and Figure VII with figure 138 page 452 of Virchow's Cell. Path., and see how closely they resemble each other - for although Virchow's drawing is one of Cancer yet had the drawing of Suppuration in the preceding page been taken from a longitudinal section of the corpuscles instead of a transverse one - it would have closely resembled the one of Cancer.

In Aponeurosis however - whether of Cat or Rabbit - although I have occasionally found oval spaces between the fibres - more commonly the dark nuclei - so often figured are all that can be seen - and they seem to be unaccompanied by any cell wall in cepting that represented

by the fibres into which the original cell wall is said to have split up? how do these nuclei conduct themselves during inflammation? are they passive? Such would be contrary to all that we know of the conduct of nuclei on such occasions do they develope mother cells similar to the noncandidato coo nuclei perhaps, in short do they give birth to pus cells - I cannot tell for I have not yet had time to investigate this.

Lastly observe how easy it would be for one looking at such a preparation as XVI to come to the conclusion that pus cannot come from cells seeing that no other cells but pus cells can be seen - to understand the process - the proper method must be to begin with healthy tissue at a distance from the incitation and gradually approach the point where pus is fully formed.

Suppuration in muscle

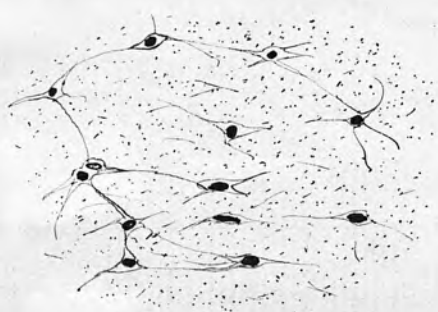
Prep 18-19. & 20, Show the normal

Structure of muscle with special reference to the nuclei within the Sarcotubum

Prep XXI Shows the muscle of a half grown rabbit which had been taken from heart seat of infection which had existed for 3 days - the preparation is much too transparent - for although figure XI was an accurate copy when the muscle was fresh - now - in the preparation faint outlines of many of the contained nuclei can only be seen while many are invisible - what I have observed is - that as a result of an infection the nuclei enlarge and divide again & again giving rise to a crop of corpuscles some oval some round resembling droplets pus corpuscles - where this proliferation occurs the Sarcotubum is distended - bulged out - sometimes it has an irregular roach appearance and looking as if it had burst and discharged its cells (Pus? Cells)

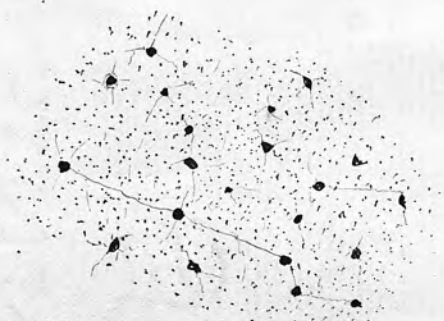
Have not a doubt as to these bodies being contained within the

I



Transverse Section of
Adult Tendo Achillis
after 2 days immersion in
Glycerine 450 diam.
Slide Preparation 4

II



Transverse Section of
Tendo Achillis of Adult
after 3 months immersion in
Glycerine 450 diam
Slide Preparation 5

III



Connective Tissue from
Muscular Sheath of Cat
Showing Connective Tissue
Corpuscles 250 Diam
Hale Preparation 8.

IV



Connective Tissue Corpuscles
from Muscular Sheath of Old Rabbit
Near a Seat of Inflammation 450 Diam
Hale Preparation 11

V



VI



The same from Preparation
12

Contractile Tissue Corpuscles from
Muscular Membr of Ad Rabbit Heart
Stained in Iodine - 500x magn
Preparation was unfortunately broken

VII



From Connective Tissue
in Muscle near sentry
initiation 450 micron
from Preparation 17

VIII



IX



X

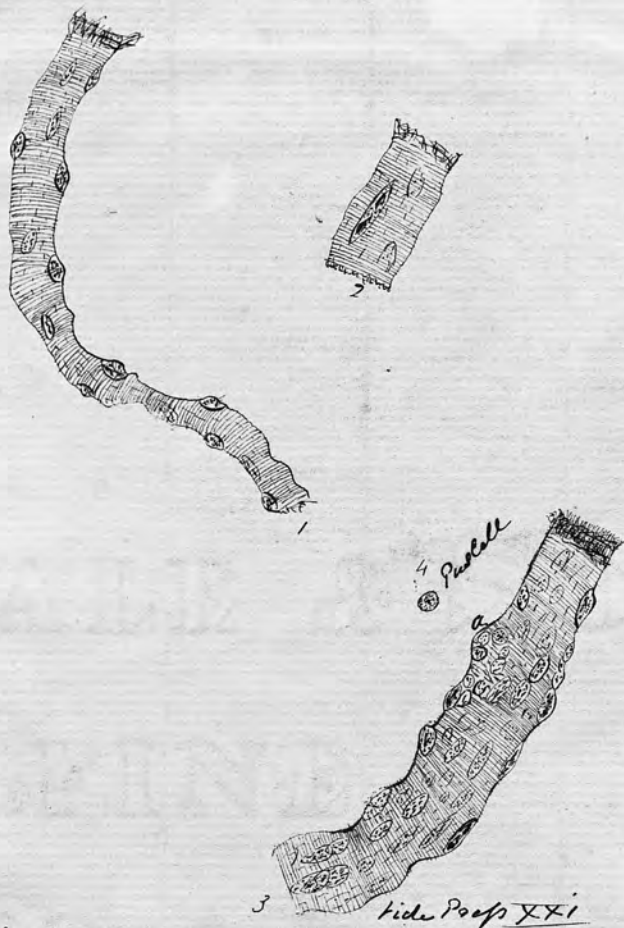


Tilusele from
Young Rabbit
450 Diam
Tide Prep XIX

Do
from Old Rabbit
450 Diam

Do
from Old Cat
450 Diam
Tide Prep XX

XI



Suppuration in Muscle of Young Rabbit
Preparation of 1 - not kept

- 1 - 250 Diameters from young rabbit near intestine
2 - 450 " " " " " "
3 - 500 " " " " " " " " " "
4 - 500 " " " " " " " " " "

XII

Pure from Connective
Tissue of Cat.
Acetic Acid has been
added, 500 Diam.
There is endogenous
multiplication of
nuclei

XIII

Muscle of Cat at a
little distance from
seat of irritation
Acetic Acid has
been added, 450 Diam

XIV



Striped Muscular fibre
from near Seat Irritation
in young Rabbit 500 diam.
from Preparation XVI
after 10 days maceration in
glycerine after addition of
nitric acid, —

Multiplication of nuclei is
seen here occurring