A Study of the Calvaria of those Dying Insane, with Special Reference to their Histology & Chemistry.

Thesis for the Degree of Doctor of Medicine

by Charles Hubert Bond, B.Sc., M.B., C.M., 1892.
London County Lunatic Asylum,
Banstead, Sutton,
Surrey.

May 14, 1895

Dear Sir,

When packing my thesis last night, I found that the frame, fixing the several parts together, was by no means dry. For its safe dispatch, I am therefore taking the liberty of entrusting it another day; it will however, with this, be posted to-night.

Thanking you again for your kind indulgence as to time, I am very faithfully,

J.R. Fraser (Hubert Kreid)
A Study of the Calvaria of those Dying insane, with Special Reference to their Histology and Chemistry.

From the Pathological Laboratory of the London County Asylum, at Banstead.

Introduction On attempting to review the observations that have been made upon the morbid appearances found in the calvarium of those dying mentally deranged, one cannot help being struck with the paucity of literature, concerning this fourth or outermost covering of the brain, as compared to that relating to the other three subjacent-
subjacent ones. The dura mater, the arachnoid membrane and the pia mater have each had their fair share of attention: witness the voluminous writings upon the much vexed question as to the origin of the so-called sub-dural false membranes; and the minute observations that have been recorded and figured, upon the chronic inflammatory adherences between the pia mater and cortical cerebi. But an inquiry into the facts that have been noted with regard to the bony covering of the brain, apparently
apparently indicates a marked absence of any corresponding minute ness of detail, at least as regards morbid changes found in conjunction with mental disease. It is true that its gross naked-eye changes have been, by various observers, pretty fully described, upon the evidence, too, of large numbers of cases; and that a large amount of microscopical work has been done in certain special diseases, e.g., where the bones, including those of the cranium, are affected, e.g., Osteomalacia. Yet, and the minute appearances of certain curious...
curious bony outgrowths, within the cranium, have been described by Virchow, Cleland and Ramonier. But I have failed to find an account of any systematic, microscopical or chemical, investigation of the calvaria of those dying insane.

Original of Recent Investigation

At every autopsy, I have been in the habit of regularly noting any morbid characters of the skull-cap, as seen to the naked-eye; and have always endeavoured to make the description as complete and detailed as possible.
possible. With such records I was at first content. However, I had occasion several times, for accidental reasons, to cut sections of the cranial bones for the microscope; and, when afterwards examining them, found that my original descriptions, based upon naked-eye observation, had not always been accurate: for example, -- in two cases the bone had been described as of normal thickness, but no trace that no diploe was visible; yet, under the microscope, I found that there was a very fair amount
amount of cancellated tissue, 
the meshes of which, however, were
unduly fine. Thus it would
seem, that a mere inspection of the
seven edge of the bone is not very
trustworthy; and that, if only
for the sake of accuracy of
description, a further examination
with the aid of the microscope,
would be of value. But further, as
I hope to shortly show, one is re-
warded for such an investigation,
when systematically carried out,
(even when limited to a compara-
tively few cases, as mine at present}
is) by the coming to light of various incidental facts, possessing in themselves, I think, no small interest.

Outline of Current Literature.

Before proceeding any further, it would probably be advisable to give an outline of what is already known as to this subject. On turning to Duke's dictionary of Psychological Medicine, that right hand of all those, who are engaged in the investigation of mental disease, and who wish to ascertain what has already been done in any individual direction—one is again
again impressed with the small amount of attention that has apparently been bestowed upon the calvarium, viewed from the special aspect, which it is my desire to take up. Very full and detailed accounts are recorded of the shape and size of the skull; and numerous tables of measurements are given—the result, evidently, of immense labour. Not only brief and scattered references are made to any alterations in the actual structure of the cranial bones; excepting under the heading of
of hereditary syphilitic disease of the nervous system, which, however, is quite foreign to the present aim of this paper; for in none of the 130 cases, to which I am about to refer, were there any marked evidences of either hereditary or acquired syphilis. And the only account of any chemical examination of the bones of those dying insane, appears to be one based upon a paper by Dr. Rogers and Campbell Brown. These observers found, as the result of a chemical analysis of the ribs in three cases...
Three cases of General Paralysis, that the proportion of organic to earthy
matter was much increased, and that the ratio of lime to phosphoric acid
was decidedly less, than in those of healthy adults. Under the heading
of \textit{Morbid Anatomy of General Paralysis},
the dictionary states, \textit{that the calvar-
ium is sometimes increased in thickness, or in density, or is
osteophytic or of worm-eaten appearance.} It also states, in an
article by Dr. Fletcher Peach upon the Pathology of Idiocy, \textit{that the
cranium in such cases is often thinner}
thinner than normal and in part diaphanous, especially near the anterior fontanelle. Or instead of this, however, it may be thickened & burned; and, where there is unilateral atrophy of the brain, the skull may be thickened on that side to compensate for the wasting. Further on in the same work, when the subject of the whole Pathology of Insanity is being treated, special reference is made to the part inflammation plays, in causing thickening of the skull, and increased density and rareflection of its diploë.
diaphragm. And it is there pointed out, that
the frequent coincidence of a thickened
vibrissae lamina and a rarefied
diaphragm are very suggestive of the
change being a compensatory one.

Huxley and Luke* would ascribe
the thick and heavy skull, occurring
in cases of chronic insanity, to
repeated temporary attacks of
cerebral hyperaemia. The thin
diaphanous skull they observed
to be most common in cases of
very chronic Mania and of Demen-
tia, where there had been no such
engulphing

* A Manual of Psychopathological Medicine, Bucknill
cerebral attacks. Exostoses and bony excrescences they found to be very rare, their frequency being 0.75 percent. Sevan Lewis goes into the subject with considerably more detail. He classifies the abnormalities into 4 groups:—First, skulls which are thick yet light in weight from the presence of much rarefied diploe; due, he thinks, to subacute irritation, and often associated with a thickened and adherent dura mater. Second, thick and heavy skulls, from simultaneous deformation.

* A Text-Book of Mental Diseases, Sevan Lewis, 1889, p. 432.
deposition of bone beneath the periosteum and condensation within. The condition, he says, is due in some cases to very chronic inflammation of the meninges; in others, to repeated vascular engorgements, such as occur at times in states of violent cerebral excitement, in cases of chronic mania. Such a calvarium, he states, is common in epileptics and in the dementia of chronic insanity. The hyperostosis is generally widely distributed, but occurs chiefly in the frontal and occipital regions, especially in the former.
He alludes to an occasional and curious localized condition of localized thickening of the left frontal, along with the same in the right occipital region, also to the occasional occurrence of bosses upon the inner table, and states, that these frequently coincide with atrophy of the brain-substance beneath. Third, a thick skull, which, while they are very dense, are yet not thickened, but may in fact be thinned. Fourth, skull reduced in both thickness and density—a condition most frequent in cases of senile atrophy. The

vitreous
vibr speedy table, he states, is most affected in these cases, and the process is one of eccentric atrophy, "the compact being gradually replaced by cancellated tissue." Here again osteophytes, bony spicules, and small exostoses may sometimes be seen; these, according to Griesinger, point to an extinct localised inflammatory process, the products of which here remain in an osified form.

More recently, further facts of a similar nature have been published from Morningside Asylum, partly agreeing with

with and partly differing from
the above; but to these I shall probably
have occasion to again refer.

The Writer's Observations

I will now pass on to an
account of my own observations,
gathered from 130 autopsies, per-
formed by myself, during the sixteen
months between November 1893 and
April 1895. And here I would at
once like to state, that in no sense
do I consider my investigations
complete; and that I therefore do
not aim at drawing any far-reaching
conclusions from them. My aim
will be only to indicate the facts as
I have come to know them, and to
indicate the probabilities of the cause
of death that have come to my notice.
at present is rather to prove the worth of
a more minute examination of the
skull-cap in our Asylum autopsies; and
to record a few interesting points and
problems, which have impressed them-

selves upon me during my investigations.

Numbers of Cases in each Sex.

On dividing these 130 cases according to
sex, it transpires that they consist of an
equal number of each.

Ages of the Cases.

Next, as to age, they range from 22 to
85 years old, the average of the total
number being 52. The average age of the
males is 48 — the highest and lowest
recorded ages being respectively 83 and 22
—; while that of the females was 56.
the highest and lowest ages here being respectively 85 and 24. I have gone
thus into detail as regards the various ages, in order to more accurately dis-
cuss the next point to which I wish to refer, namely the actual weight
of the Calvarium.

Weights of the Calvaria.

On reading over previous accounts of the
various morbid characteristics of the
skull-cap,—such as those to which I
have above alluded in pages 7 to 17,—it
would seem, that, though it has been
frequently spoken of as being heavy
or light (as the case may be), no system-
atized report has been published, in
This country at least, of its actual weight, as tested by the balance. This has very probably been the case, because in removing the calvarium, we frequently found it convenient to vary the direction of the saw according to circumstances, and thus the weight of the skull-cap becomes an uncertain factor. This fallacy, however, can be easily obviated. And since I took up the question in the latter part of 1893, I have, with no great difficulty, invariably carried the saw round at a fixed level, viz.: 3 centims. above the root of the nose; and then

* As recommended in a scheme, drawn up by Mr. E. Goodall and myself, suggesting a uniform method in the examination of the Brain and Coverings, for our Asylum autopsies.—vide, Journal of Mental Science, Vol. XXXIX. p. 487.
Then weighed the bone, when so removed. The weights so obtained, when grouped together, bring out some facts worthy of attention. I am acquainted with only two references to some similar observations. *Fraenkel* found that cases of General Paralysis gave the greatest weights. *Peto* also observed the same thing, but associated Epilepsy with General Paralysis; and further states that the calvaria of females are relatively heavier than those of males.

I find that the average weight of the Calverium for the whole of my 130 cases.

*Rev. Sper. di Fren., Vol. i.*

*Arch. Ital. f. l. malat. nerv., 1887, p. 130.*
Cases was 11.315 g.: (320.7 grammes).
For the males it was 12.46 g., while
for the females it was 10.17 g. Thus,
from these figures, the male averages
2.29 g. more than the female skull-cap,
which is surely a greater difference
than can be explained by the fact
that the bones of the male, throughout
the body generally, are heavier than those
of the female. My results on this point, then,
differ from those of Pets. I append a table

<table>
<thead>
<tr>
<th>No.</th>
<th>Class</th>
<th>Average Circum.</th>
<th>Average Arch.</th>
<th>Average Diameter.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Whole</td>
<td>Limb</td>
<td>Ant-post</td>
</tr>
<tr>
<td>1761</td>
<td>Insane (male)</td>
<td>22.17</td>
<td>11.59</td>
<td>14.08</td>
</tr>
<tr>
<td>1900</td>
<td>(female)</td>
<td>21.36</td>
<td>11.00</td>
<td>13.28</td>
</tr>
<tr>
<td>183</td>
<td>Insane (male)</td>
<td>22.37</td>
<td>11.66</td>
<td>14.25</td>
</tr>
<tr>
<td>39</td>
<td>(female)</td>
<td>21.67</td>
<td>10.28</td>
<td>13.59</td>
</tr>
</tbody>
</table>

of head measurements in the two sexes. Figures obtained from the same source show that the "insane head" varies, too, in size according to age. In females the value of the cranial index rises up to 60 years of age and then decreases. In males, such a regularity of variation is wanting; its highest value is reached in the sixth decade, but after several fluctuations. Table II shows a classification of my 120 cases into certain age-periods; in each period is a statement of the highest, lowest, and average weights of the skull-cap.

The cranial index is obtained by adding together the measurements of the whole circumference, of the antero-posterior, and of the transverse arches.
skull-cap. The first age-period is
fallacious, owing to the few cases happening
to fall in it. In it and for the only
occasion, the weight of the male was
less than that of the female skull-cap.

Table II:— Showing the highest, lowest and average weights
(in ounces) of the Colomus of those dying insane,
within certain age-periods.

<table>
<thead>
<tr>
<th>Periods</th>
<th>25 years &amp; under</th>
<th>26 to 35</th>
<th>36 to 45</th>
<th>46 to 65</th>
<th>66 and upwards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M.</td>
<td>F.</td>
<td>T.</td>
<td>M.</td>
<td>F.</td>
</tr>
<tr>
<td>Cases several males</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>M. wt.</td>
<td>8.5</td>
<td>12.3</td>
<td>16.5</td>
<td>12</td>
<td>17.5</td>
</tr>
<tr>
<td>F. wt.</td>
<td>8.5</td>
<td>9</td>
<td>10.5</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Male males</td>
<td>2.25</td>
<td>1.208</td>
<td>1.625</td>
<td>2.262</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Leaving it out of account, we see that
the average weight for the males re-
mains almost a constant throughout
the other 4 periods; that for the female
fluctuates in an irregular manner.
But certainly neither shows a special decrease depending upon old age, as one might have expected from the previous observations of others, namely, that the thin diaphanous skull is especially frequent in senile atrophy.

Furthermore, on selecting the specially light skull-caps (ranging from 7½ to 9½ g. in the males, and 7 to 9 g. in the females), and on taking an average of their several ages, 41 and 54 are respectively the ages that came out—certainly not senile ones: and, if we go to the opposite extreme and

* Of which there were 9 cases.
† Of which there were 15 cases.
select the heaviest skull-caps (15½ to 20½ g. in the males, * and 13 to 16½ g. in the females), and treat them in the same fashion, the ages 50 and 60 respectively come out.

Considered according to the duration of mental disease.

In this relation, the duration of the mental affection is naturally an important factor to consider. The following table shows my cases arranged as

Table III: Showing Highest, Lowest and Average Weights (in ounces) of the Calvaria of those Dying Insane, arranged according to the Duration of Mental Affection.

<table>
<thead>
<tr>
<th></th>
<th>Up to 6 months</th>
<th>Over 6 months, not above 1 year</th>
<th>Over 1 year, not above 3 years</th>
<th>Over 3 years, not above 10 years</th>
<th>18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case numbers</td>
<td>M. F. T.</td>
<td>M. F. T.</td>
<td>M. F. T.</td>
<td>M. F. T.</td>
<td>M. F. T.</td>
</tr>
<tr>
<td>Average</td>
<td>17 12.5</td>
<td>22.5 - 11.5</td>
<td>14.5 - 15.5</td>
<td>17 - 16.5</td>
<td>13 - 13.5</td>
</tr>
<tr>
<td>Total</td>
<td>7 5 7</td>
<td>8.5 - 10.5</td>
<td>9.5 - 7.5</td>
<td>11 - 8.5</td>
<td>9 9</td>
</tr>
<tr>
<td>Male</td>
<td>12.16 10.21</td>
<td>11.408</td>
<td>11.6 - 11.16</td>
<td>13.45 - 11.35</td>
<td>10.625 - 10.625</td>
</tr>
<tr>
<td>Male mean</td>
<td>1.95</td>
<td>3</td>
<td>0.44</td>
<td>2.325</td>
<td>0</td>
</tr>
</tbody>
</table>

* Of which there were 9 cases.
+ Of which there were 9 cases.
as in table II., but classified according to the total length of time, as far as could be made out from the imperfect histories given to us, that each had been mentally deranged. In the first column—where there are the greatest number of cases, and therefore less likelihood of fallacy—it is interesting to note, that the average weight of the calvarium, in both sexes, approximate very closely to the total averages for both sexes (ex. p. 22). That is, of course, what we would expect, namely, that, for a case which had been of very short duration, there would be correspondingly little
little structural changes in the bone. However, the table contains, in both the
group two columns, some striking ex-
ceptions to such a generalization; and
to these I shall again advert, when
speaking of the microscopical and chemical
changes and clinical features of
individual cases. The averages in
the 2°, 3°, 4°, 5°, columns show very fair
uniformity, as regards the females;
but the figures for the male sex
fluctuate considerably; and in fact
the total number of cases is, in my
opinion, much too small to warrant
any dogmatic conclusions being
drawn.
drawn. The last column is interesting, in that the total average is lower than in any other, perhaps indicating that Insanity of very long duration does tend to produce lesser crania, providing that no other disturbing element comes in, which might produce a hyperostosis instead. This agrees with the opinion expressed by Bucknill and Tuke (see p. 12).

Considered in Relation to the Kind of Mental Disorder. Let us now see what facts may be deduced from an attempt to associate the kind of mental disease with

\[\text{\textdagger}\] The limit of durations in the last two columns may appear curious. But there happened to be no cases, whose duration had been between 13 and 18 years, and the Asylum has not been opened more than 18 years.
The weight of the calvarium. My cases, however, are too few at present to allow all varieties of insanity to be considered. In fact, after adding up the various diagnoses, it comes to this, that General Paralysis and Dementia are the only varieties occurring in sufficient numbers to permit of averages being taken. A consideration of the latter may be aptly made here, following upon my remarks, above, as to lighter skull-caps being associated with insanity of very long duration. Mark this difference, however: in the cases I am
Am now about to consider, the insanity was developed actually during senility, or at least not before the age of 60; while in the previous cases, though death occurred mostly during senility, yet the onset of the mental malady was usually in middle-age. And, in truth, as regards the male sex, quite a different average comes out. Of the 130 cases, 12 males and 23 females, were examples of senile insanity. The average age at death was for the males 68, and 72 for the females. In the former, though the average duration
duration of the attack was only 9 months, and the longest period before
death was 2 years, yet the average weight of the calvaria was 13½ oz., an
ounce more than that of the total 65 male cases, and nearly 3 oz. more than
that of those dying after being 18 years
viscera. It would not, perhaps, be
unreasonable to account for this by
the fact, that cases of Senile Dementia
frequently show maniacal exacerb-
ations; in fact, as pointed out by
Claubroin, only one third of them ex-
hibit Melancholia, while two thirds
have more or less maniacal symptoms.
And he, too, has frequently observed in them, thickening of the skull-cap.

Among the female cases, much longer periods elapsed before death supervened;

than there were 5 cases with a duration of over 7 years: the average duration was 3½ years. The average weight of the skull-caps was 11 oz., being very nearly again one ounce in excess of that of the total 65 female cases.

Turn now to the General Paralytics,

of which there were 20 men and 6 women; it would be admirable not to consider the latter alone, being too few. The average of the ages of the 26 men
was 4.4, that for the duration of the disease 1½ year. The calvaria averaged 1½ g.; I found the same figure when calculating for the male sex alone. Excluding the females, this would indicate that G.P. is associated with light skull-bones. This again is contrary to the conclusions arrived at by Tränkel and Selö (see p. 21).

The Relation of Brain-ablot by to Thickened Calvaria. As regards the question of their being any connection between brain-abloty and thick skulls (the condition of the latter has been sup-
posed by to be a compensatory one), I am of opinion, that no such relation
relative exists. Buckwill & Thwaites, and Lewis both are opposed to it. Recent asylum figures from Morrinpride, too, while they may possibly indicate some connection, certainly do not show, that Manic-depressive is invariably followed by thickening of the skull. Fletcher, in his book, as I mentioned on page 11, speaks that such a relation does exist, at least in Idiots; but here we have very few 'Idiots' of special asylum, exist for them. My cases, point quite in the opposite direction. Or pressing the heaviest male calvaria together, I find that...
atrophy of the brain existed in
less than a third of them, and, even
in these instances, was only very
trifling. One of the thickest calvarias
of my collection was associated
with one of the heaviest and largest
brains I have seen. The females
do not show such striking
results. On selecting examples
of the heaviest of their skull-caps,
I find none were associated with
a very heavy brain; and, in nearly
all, there was some amount of
atrophy, but very slight, however.
As far as I have been able to glean
from my cases, frequent recurrent
maniacal attacks, or continued
maniacal restlessness, or large
and grandiose delusions, and
Epilepsy, when there have continued
for long periods, have the most
intimate connection with the pro-
duction of thick, dense and
heavy crania, especially Epilepsy.

The Pathology of the Increase in
the Bony Tissues. There appear to be two
theories as to the pathology of these
thick skulls, an inflammatory
and a nutritional one. I cannot
keep inclining to the letter. It is
is true, that they often, in fact in the majority of cases, have the dura mater unduly adherent; but the membrane is but seldom thickened, and, as pointed out by Dr. Middlemiss and Roberton (see foot-note p. 16), there usually has been no headache during life. Nodes and bouses upon the inner table have, too, been especially instanced as the result of inflammatory processes; and have been said to be produced by layer upon layer of bone, formed by the dura mater. My own observations make me very sceptical upon
Microscopic appearances.

Forty of the preceding 120 cases I have subjected to a microscopic examination. Specimens for the microscope were always procured by sawing a V-shaped piece of bone from the calvarium, the base of which corresponded to the sawn edge. In each of these 40 cases, a piece was taken from the left side of the frontal bone, about 3/4 inch from the mid-line. If there were any specially noticeable features about the skull, several specimens were
were then taken from various paths. Each was placed in a decolorizing solution of chromic and nitric acids. I found that it required a certain amount of self-education to know when they were sufficiently softened for the microscope. On an average 36 days were required, distinctly more in the males than the females. They were then hardened in spirit, embedded flat in celloidin. The sections were subsequently stained in Ehrlich's triple stain and mounted in Canada balsam.

In all, rather more than 100 specimens.
Specimens of bone were cut. In 15 instances, I made similar preparations from the ribs. It has been recently shown, that Pagham patient frequently show most extensive structural alterations in the ribs. While the skull-bone shows many interesting microscopical changes, I have failed to find any parallelism with those in the ribs. That I mean is, that when the ribs have become small, thin and flat, trabecular deficiency of bone trabeculae, I have observed the skull, instead of being corresponding

altered, to be thickened, hard & dense; and, under the microscope, to be in a condition of what, from analogy, may be termed acelomia. It is difficult to fix a normal standard for the calvarium. In cases where, during life, there have been no symptoms of mental or other disease likely to cause abnormality of the cranium, I have yet seen distinct variation in thickness at the level. I have indicated: also the thickness of the table, and the relative amount of diploe varies in presumably healthy skulls. My own observations would
would lead me to say that 0.4 centim. is about the normal thickness of the frontal bone at 3 centim. above the level of the root of the nose. And I find that as one ascends, the frontal bone normally increases in thickness until it reaches about 0.6 centim. The parietal bone is usually rather thinner. The occipital is either the same as the frontal bone, or frequently slightly thicker, very seldom thinner. I am still speaking, of course, of the normal skull.
In the form of an appendix, I am adding 8 plates, being photo-micrographs that I have taken in order to illustrate some interesting appearances, as seen under the microscope. The magnification in each case is 35 diameters.

Plate I. is from a Senile Dementia, aged 76. She showed the first symptoms of mental breakdown when aged 75. At times she was very, violent and restless; she rapidly became very weak and died after a cerebral attack. The weight of...
the calvarium was g.g. the
photograph shows the inner table
tobe slightly thickened, and in a
condition of partial osteoporosis.
The cancellated tissue is in excess
and has encroached upon the outer
table. If illustrated, too, in an
exaggerated degree a fact, I have
observed to be normally constant, viz:
that the normal increase in the
thickness of the frontal bone is
brought about by increase in
the diploe, not by thickening of
the table, and that the wider the
diploe is the wider are its medullar.
Plate II. illustrates

Mewartenius's first class of skulls (see p. 13). The calvarium, at the occipital edge, was 11 centim.; its thickness in the frontal 1.3 centim.; in the occipital region, it weighed 10½ oz. It will seen that it consists practically entirely of cancellated bone. The inner table is thin, but relatively not nearly so much so as the outer.

It was taken from a woman aged 56 suffering from Organic Dementia. The total duration of the case was 9 months. She was melancholic at first, afterwards Maniacal Vexels.
Plate III. is exactly the converse of the last. The calvarium here weighed 22½ oz.; it was thick and uneven all round, ranging from 1½ to 1½ centim. It belonged to a man aged 63, suffering from Senile Dementia. He died after an attack of 7 months. Maniacal restlessness was the chief feature in his symptoms. According to Dr. Kikin, these shalls are brought about by deposition of new bone upon the old. Simultaneously, resorption.

In this section, there is no indication of stratification. The two latter can be easily distinguished.

Plate IV. is taken from a very rapid facies case of General Paralysis. He was aged 45 and died in less than a year from the onset of the first symptoms. The skull-cap weighed 11 1/2 oz. It was 0.4 cm. at the inner edge, increasing upwards to 0.6 cm. It shows a condition, which I, in such a marked degree, have only seen within the instance. The inner white matter, as though it had been deformed in distinct layers; and, as a matter of fact, I noticed, before I cut the sections, that it could be stripped into layers with the finger.
It has encroached much on the
diploi, the meshes of which, in
many parts, appear to be breaking down,
in fact the outer 1 minor tables and
have been torn apart. The outer
table is thickened, if the size of its
an
Persianian spaces, much reduced.

Plate V. shows the same
undulation as plate III. But it
illustrates a point, to which I
demur especially refer, viz: the
microscopical appearance of the
small nodules stones, so frequently
found upon the inner table of the
fracture tree. In no instance have
I seem any indication of these being composed of layer upon layer of new bone. But rather that the inner table, when it can be distinguished, appears to bend round the nodule, as though the irregularity of its surface had been produced by an internal expansion; and further pointing to such a mode of production is the fact, that I always observe an exuding out of the matter, or a sort of air-space, opposite the site of the nodule. Is it possible, that a vasomotor disturbance
Could account for thin? The case was that of a woman aged 37. She died of Pthiois after an attack of Chronic Manie, lasting a year and two months. The calvarium weighed 1½ lb. It was 0.6 to 0.7 centim. in thickness.

Plate VI. is illustrative the same fact, as regards the cranium. The general thickness of the frontal bone, as seen to the right of the section was 0.5 centim. Both lateral were thick. The left two thirdly the section is through a flat sessile node, round which the dumerable is seen to wind. Nearly opposite to it
it is a large gap in the diploma.

This is not caused by bad mounting, causing any loss of time. It occurs
opposite every node in this case.

It came from a man aged 32, who
died of Phthisis, after a mental
illness of 2½ years. He became
very demented from very excessive
masturbation, but had had frequent
maniacal attacks.

Plate VII is merely to
illustrate a fact as regards
Peculiarian depressions. I have
invariable observed, that the time,
in the immediate proximity of these
pils, becomes much con-
densed. The section also shows
one of the many small excrescences,
usually seen at the bottom of these
depressions. The bone, forming it, is
seen to be of compact tissue having
dense.

Chemical Examination.

To further my case I
have applied a partial chemical
examination. For this purpose
specimens were taken similarly to
those for microscopical examination,
but from the right side of the fractured
bone. These were then suared into small
chips.
chips. About 2 grammes were usually taken at a time for incineration. Three such incinerations were made for each specimen taken, in order to guard against errors of manipulative creeping in. I say that only a partial chemical examination has been made in these cases, because, as yet, I can only give the percentage of organic and mineral matter in each instance. My detailed analysis of the resulting ash is not complete, but in reading an abstract of this I hoped before a future meeting of
The Medico-Psychological Association.

I trust to give a full account of it then. The whole process is so excessively tedious, it involves the expenditure of so much time, that as I say. My observations are limited to 12 cases; and then I do not intend to even attempt to draw any conclusions whatever, but simply to content myself with an enumeration, in a tabular form of the results I have so far obtained. The first 7 cases are males, the remainder females.
<table>
<thead>
<tr>
<th>Case</th>
<th>Prominent muir's matter</th>
<th>Age at death</th>
<th>Duration muir's disease</th>
<th>Weight</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64.15</td>
<td>53</td>
<td>16 yrs</td>
<td>9.7</td>
<td>Waxed but not thick</td>
</tr>
<tr>
<td>2</td>
<td>59.71</td>
<td>40</td>
<td>12 1/2 yrs</td>
<td>12.5</td>
<td>Rather thick from excess of diplot</td>
</tr>
<tr>
<td>3</td>
<td>58.3</td>
<td>41</td>
<td>2 yrs</td>
<td>12</td>
<td>Very dense and very thick.</td>
</tr>
<tr>
<td>4</td>
<td>57.0</td>
<td>67</td>
<td>1</td>
<td>22.5</td>
<td>Thick and very dense</td>
</tr>
<tr>
<td>5</td>
<td>56.9</td>
<td>68</td>
<td>13</td>
<td>15.2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>55.9</td>
<td>55</td>
<td>1/2</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>48.99</td>
<td>30</td>
<td>1/4</td>
<td>14</td>
<td>Thickened with excess of diplot</td>
</tr>
<tr>
<td>8</td>
<td>56.25</td>
<td>49</td>
<td>14</td>
<td>11.5</td>
<td>Dense but not thick</td>
</tr>
<tr>
<td>9</td>
<td>52.6</td>
<td>70</td>
<td>8</td>
<td>14</td>
<td>Thickened with excess of diplot</td>
</tr>
<tr>
<td>10</td>
<td>52.64</td>
<td>61</td>
<td>5</td>
<td>8.5</td>
<td>Thinner than usual</td>
</tr>
<tr>
<td>11</td>
<td>51.19</td>
<td>60</td>
<td>1</td>
<td>14.2</td>
<td>Slightly thicker.</td>
</tr>
<tr>
<td>12</td>
<td>50.56</td>
<td>84</td>
<td>1/2</td>
<td>10.5</td>
<td>Slightly thicker.</td>
</tr>
<tr>
<td>13</td>
<td>49.79</td>
<td>25</td>
<td>7 days</td>
<td>12.5</td>
<td>Slightly thicker.</td>
</tr>
<tr>
<td>14</td>
<td>35.5</td>
<td>30.0</td>
<td>94</td>
<td>4.4</td>
<td>A very curious skull-cap.</td>
</tr>
</tbody>
</table>

The bone scarcely resisted any decalcifying solution in order to cure the microtome. Internally a ridge could be felt corresponding to the Cortical nature. This was found to be due to the frontal bone being thickened, while the parietal had been reduced to less than 2 millimeters in parts. The frontal increases were greatly enlarged, and, where the parietal bone possessed any degree of thickness, there were also large air cavities in it. Plate VIII shows a section through the right parietal bone and shows part of one of the air-cavities. The microscope showed a marked absence of compact tissue. The character is very suggestive of Osteomalia. The other bones of the body appeared normal. The woman had borne children, but many years previously.
The earthy matters in bone are paid to be two thirds, to one third organic. Whether this applies to the skull-bone, I have yet to determine. If so, then my cases show a remarkable falling off in mineral matter, and increase in organic constituents. In this connection, case 13 is interesting. For it was from a strong, healthy girl, who died suddenly during the exhausting fever attack of Acute Mania of only 7 days duration. She would have pronounced her skull would be a healthy one.
Yet we see, that it is above the average weight, and that the mineral matter is far from amounting to two-thirds. This shows the need of further and collective investigation.

Though my investigation is obviously far from complete, I trust I have succeeded in bringing to light some interesting points; and shown the worth of not too necessarily, for much further inquiry in this direction.
Appendix of Illustrative Plates.
Sagittal section of Frontal Bone.

From a case of Venile Dementia. E.L. Admitted Novom. 12th 1834.
Magnification 3.5 diameters.
Horizontal section of Frontal Rense.

From a case of Organic Dementia. M.S., a female aged 56, admitted April 30th, 1874. Magnification 3.5 diameter.
Horizontal section of frontal bone.

From a case of Senile Dementia. J. W., a male aged 64, admitted 30th of April, 1894. Magnification 3.5 diam.
Sagittal section of Frontal Bulb.

From a case of General Paralysis. J.B., a male aged 65, admitted October 13th, 1894. Magnification 3.5 diam.
Horizontal section of frontal bone.

From a case of Chronic Mania. A.M. a female aged 57, admitted Feb. 21st, 1894. Magnification 3.5 diam.
Horizontal Section of Fluental Bone

From a case of Chronic Mania & Dementia. M.A.J. a male aged 32, admitted September 3rd 1892. Magnification 3.5 diam.
From a case of Chronic Mania, Dementia. J.F., male, aged 41.
Admitted June 29, 1842. Magnification 3-5 diam.
Cortical section of Right Parietal bone

Inner Table

Large air cavity