

A STUDY OF THE SATELLITE CELLS IN FIFTY SELECTED CASES OF MENTAL DISEASE.

BY SAMUEL T. ORTON, M.D.

(From the Laboratory of the Worcester State Hospital, Massachusetts.)

IN the normal cerebral cortex, both human and animal, there are found at the base of many of the large pyramidal cells one or two small cells lying between the basal processes and, as a rule, in close association with the point of origin of the axis-cylinder.

There has been some question as to whether these cells should be regarded as neuroglial in origin, or cells of the lymphocytic series. By the ordinary staining methods their morphology is very similar to that of the lymphocyte, except that the nucleus is often less deeply stained and bears a more loosely woven chromatin mesh, while some even appear vesicular. On the other hand it is rare, even among the vesicular forms, to find a nucleus which is oval, or as large as the ordinary glia cell. The lymphocyte is not as a rule an active phagocyte, while the satellite seems prone to take on neurophagocytic activity. In conditions associated with marked perivascular extravasation, such as general paralysis and chronic meningitis, the lymphocytes are closely packed in the perivascular spaces, but do not apparently tend to penetrate the surrounding nervous tissues. Many such cases show, it is true, a more or less active satellitosis, but this reaction is almost without exception in the deeper cell laminæ, while the perivascular accumulations are diffuse, or even more intense in the superficial layers.

Cajal accepts the neuroglial origin of these cells and speaks of them as basal neuroglia cells. He calls attention to the fact that they are in relation with that part of the cone of origin and early course of the neuraxon which is not covered with myelin, and suggests that they may serve to insulate these structures from surrounding non-medullated fibres. In the cerebellum of the rabbit, he has described a cell which he classes as a displaced stellate cell of Golgi. In the cerebellum of the majority of animals those cells are found in the granule layer and give off non-medullated axons which arborize in the granule layer. The

displaced cells in the rabbit lie in the plexiform zone and their axons would thus be exposed to contact with other bare fibres of this layer. Cajal states that these cells may be recognized not only by their morphology but by the mass of accompanying nuclei of the neuroglia type which surround the axon and base of the cell, and here again suggests an insulating capacity for the satellite.

In pathological conditions the satellite becomes of greater interest. Especially is this true of the acute degenerative conditions which have been studied by Alzheimer in great detail by the aid of special staining methods. These include the toxic and infective deliriums and the experimental toxic states, as well as the severe acute manifestations of such diseases as katatonia, status epilepticus and the acute delirious type of general paralysis. In these conditions the cells at the bases of the pyramids are increased in number and show, with appropriate staining methods, a large protoplasmic body which may take on amoeboid forms, may contain lipoid, or fuchsinophile, or other granules, and may be actively neurophagic. Alzheimer's work leaves little doubt that these reactive cells are of glial origin, but of a type not active in the production of fibres.

Another change in the normal relation of these cells is that of increase of number without the variety of alterations observable in the acute processes. This is the condition spoken of as satellitosis, and its occurrence has been noted in a number of diseases. As a rule the increase is most noticeable in the deeper cell laminae of the cortex, and it is rather the exception to see any considerable number of them above the stellate layer.

The fifty cases forming the basis of the present study were selected to form five groups of ten each. These are: Maniacal depressive insanity, dementia præcox, senile dementia, general paralysis and alcoholic insanity. All three types are included among the dementia præcox cases, while the cases of the senile dementia group have been selected to exclude those showing gross brain disease, but not those showing moderate cerebral atrophy or arteriosclerosis.

With few exceptions the counts have been made from material fixed in alcohol, embedded in paraffin, cut at 10 μ and stained with Nissl's soapy methylene blue. The exceptions are from cases in which the brain was fixed in toto in formalin. This material was also cut into sections by the paraffin method at 10 μ and stained in thionin, so that the results should be comparable within reasonable limits of error. In all cases five areas from the neopallium were examined. The sites of the sections were as follows:—

Precentral or motor cortex (PCL): Block taken from about the mid-portion of the ascending frontal or precentral gyrus in approximately the arm area.

Postcentral cortex (PoCl): Block taken from the ascending parietal or postcentral gyrus opposite the precentral block.

Frontal cortex (F.): Block from the first frontal gyrus along the margin of the great longitudinal fissure about midway between the frontal pole and the Rolandic fissure. In some of the cases this block yields sections showing a stellate layer and hence belongs in the true frontal type of cortex (Campbell's classification). Some showed no definite stellate layer (indicated in the tables by an absence of figure in lamina 4) and hence probably belong in the intermediate precentral field.

Temporal cortex (T.): Block from the first temporal gyrus, lateral surface along the lip of the fissure of Sylvius about midway between the line of projection of the anterior sylvian trunk and the point of division of the posterior or main sylvian fissure and hence representing audito-psychic cortex.

Occipital cortex (Occ.): This material is not constant in origin. Some sections are of calcarine or visuosensory cortex and some are of the common occipital or visuopsychic field. The sections from the calcarine area may be identified in the charts by the absence of a figure in the lamina ganglionaris, as no attempt was made to count the satellites in this layer as will be explained below.

The count has been made to include the two major points of interest, viz.: The number of satellites and their distribution by laminae. Brodmann's division of the neopallial cortex into six layers—i.e., (1) zonalis, (2) granularis externa, (3) pyramidalis, (4) granularis interna, (5) ganglionaris, and (6) multiformis—has been adopted for this purpose, and an attempt has been made to count only cells which conform to the type of each layer. Thus in the lamina pyramidalis only large pyramidal cells have been counted, &c. This leads to some difficulty in some cortices, such as the precentral and agranular frontal which are without a well-developed lamina granularis interna and in the calcarine where the granule layer is reduplicated and the lamina pyramidalis is not well supplied with characteristic cells homologous to those in other regions. It has seemed advisable, however, for the present purpose to use one classification for all cortices, and hence the counts are made with the omission of a figure in lamina 4 of the precentral and agranular frontal, and in lamina 5 of the calcarine, while

the reduplicated lamina granularis interna of the visual cortex has been considered as one layer. No effort was made to estimate the numbers of neuroglia nuclei in the zonal layer.

In each lamina the count has been made by recording the number of satellites found in association with 20 representative cells and record is made in increments of 10. Thus the association of 20 or less satellites with 20 nerve-cells has been considered negative; from 21 to 30 satellites with 20 nerve-cells is considered as a ratio of 1·5 to 1; 31 to 40 satellites, to 20 nerve-cells, as of 2 to 1, &c. Only those cells in immediate relation with a nerve-cell have been counted, and no cognizance is taken of the clusters of neuroglia nuclei about vessels, nor in spaces in the fibre layers which may have originally contained nerve-cells.

RECORD OF COUNTS.

I.—MANIACAL DEPRESSIVE GROUP.

Case 1.—Maniacal depressive insanity; maniacal form. Third attack; eleven years' duration.¹ Age at death, 65 years. Autopsy number, xv-15.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	1—1	0	0
(4)	—	1—1	1—1	0	1—1
(5)	1·5—1	1—1	1·5—1	1·5—1	—
(6)	1·5—1	1·5—1	2—1	2—1	1·5—1

Case 2.—Maniacal depressive insanity; depressed form. Third attack; duration twenty-seven years. Age at death, 68 years. Autopsy number, xvi-34.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	1—1	0	0
(4)	—	1—1	—	0	0
(5)	1—1	1·5—1	1—1	1—1	—
(6)	1·5—1	1·5—1	1·5—1	1·5—1	1—1

Case 3.—Maniacal depressive insanity; depressed form. Three years' duration. Age at death, 61 years. Autopsy number, xvi-42.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	1—1	1—1	0
(4)	—	1—1	1—1	1—1	1—1
(5)	1—1	1·5—1	1—1	1—1	1—1
(6)	1—1	2—1	2—1	1·5—1	1—1

¹ In the maniacal depressive series the duration is given as from the time of onset of the first attack.

Case 4.—Maniacal depressive insanity ; circular form. Multiple attacks ; duration, forty-five years. Age at death, 74 years. Autopsy number, xvii-10.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1-1	...	0	...	1-1	...	1-1	...	0
(4)	—	...	1-1	...	1-1	...	1-1	...	1-1
(5)	1-1	...	1-1	...	1·5-1	...	1·5-1	...	—
(6)	1·5-1	...	1·5-1	...	1·5-1	...	2-1	...	1-1

Case 5.—Maniacal depressive insanity ; maniacal form. First attack ; duration, five and a half years. Age at death, 35 years. Autopsy number, xvii-17.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1-1	...	—	...	0	...	0
(5)	1-1	...	1-1	...	1-1	...	1-1	...	—
(6)	1·5-1	...	1·5-1	...	1·5-1	...	1-1	...	1·5-1

Case 6.—Maniacal depressive insanity ; maniacal form. First attack ; duration, two months. Age at death, 41 years. Autopsy number, xvii-32.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	1-1	...	1-1	...	1-1	...	0	...	0
(6)	1-1	...	1-1	...	1·5-1	...	1-1	...	1-1

Case 7.—Maniacal depressive insanity ; maniacal form. Sixth attack ; duration, thirty-one years. Age at death, 66 years. Autopsy number, xvii-48.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	1-1	...	0	...	0
(4)	—	...	1-1	...	1-1	...	0	...	1-1
(5)	1-1	...	1-1	...	1-1	...	1-1	...	—
(6)	1-1	...	1-1	...	1·5-1	...	1-1	...	1-1

Case 8.—Maniacal depressive insanity ; depressed form. First attack ; duration, five years. Age at death, 41 years. Autopsy number, xvii-49.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1-1	...	—	...	0	...	1-1
(5)	1-1	...	1-1	...	1-1	...	1-1	...	1-1
(6)	1-1	...	1-1	...	1·5-1	...	1-1	...	1·5-1

Case 9.—Maniacal depressive insanity; maniacal form. Third attack; duration, seventeen years. Age at death, 70 years. Autopsy number, xvii-59.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	0	0	1—1	0
(4)	—	0	—	0	0
(5)	1·5—1	1—1	1—1	1—1	—
(6)	1·5—1	1—1	1·5—1	1·5—1	1—1

Case 10.—Maniacal depressive insanity; maniacal form (some depressions). Eleventh attack; duration, thirty-one years. Age at death, 75 years. Autopsy number, xiii-12.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	0	0	0
(4)	—	1—1	—	1—1	1—1
(5)	1—1	1—1	1—1	1—1	1—1
(6)	1·5—1	1·5—1	1—1	1·5—1	1·5—1

II.—DEMENTIA PRÆCOX GROUP.

Case 1.—Hallucinatory type; slight deterioration. Duration, eight months. Age at death, 31 years. Autopsy number, xv-22.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	0	0	0	0	0
(4)	—	0	—	0	0
(5)	0	0	0	0	0
(6)	1·5—1	1·5—1	0	0	0

Case 2.—Dementia præcox; hebephrenic form. Duration, three years. Age at death, 45 years. Autopsy number, xv-58.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	0	0	0	0	0
(4)	—	0	0	0	0
(5)	0	0	0	0	—
(6)	0	0	0	0	0

Case 3.—Dementia præcox; paranoid form. Duration, seven years. Age at death, 52 years. Autopsy number, xv-58.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	0	0	0	0	0
(4)	—	0	0	0	0
(5)	0	0	0	0	—
(6)	0	0	0	0	0

Case 4.—Dementia præcox; paranoid form. Duration, thirty-one years.
Age at death, 69 years. Autopsy number xv-67.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	1—1	...	0	...	0
(5)	1—1	...	1—1	...	0	...	0	...	—
(6)	1—1	...	1—1	...	2—1	...	1—1	...	1—1

Case 5.—Dementia præcox; katatonic form. Duration, three years.
Age at death, 41 years. Autopsy number, xv-79.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	0	...	0	...	0	...	0	...	—
(6)	0	...	0	...	0	...	0	...	0

Case 6.—Dementia præcox; paranoid form. Duration, thirteen years.
Age at death, 43 years. Autopsy number, xv-84.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	0	...	0	...	0	...	0	...	—
(6)	0	...	0	...	0	...	0	...	0

Case 7.—Dementia præcox; hebephrenic form. Duration, seven years.
Age at death, 29 years. Autopsy number, xvi-37.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	0	...	0	...	0	...	0	...	—
(6)	0	...	1—1	...	1—1	...	1·5—1	...	0

Case 8.—Dementia præcox; paranoid form. Duration, forty-six years.
Age at death, 83 years. Autopsy number, xvii-4.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	1—1	...	1—1
(4)	—	...	0	...	0	...	1—1	...	1—1
(5)	1—1	...	1—1	...	1—1	...	1·5—1	...	—
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1·5—1	...	1·5—1

Case 9.—Dementia præcox; hebephrenic form. Duration, twenty-eight years. Age at death, 63 years. Autopsy number, xvii-14.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	0	...	0	...	0	...	0	...	0
(6)	1—1	...	1—1	...	1—1	...	1—1	...	1·5—1

Case 10.—Dementia præcox; katatonic form. Duration, twenty-five years. Age at death, 60 years. Autopsy number, xvii-16.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	0	...	0	...	0	...	0	...	0
(6)	0	...	0	...	1·5—1	...	1—1	...	1—1

III.—SENILE GROUP.

Case 1.—Senile dementia. Duration, six months. Age at death, 74 years. Autopsy number, xv-17.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	0	...	0	...	0
(5)	1·5—1	...	1—1	...	1—1	...	1—1	...	—
(6)	1·5—1	...	1·5—1	...	2—1	...	1·5—1	...	1—1

Case 2.—Senile dementia. Duration, nine years. Age at death, 73 years. Autopsy number, xv-18.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	1—1	...	0	...	1—1
(4)	—	...	0	...	1—1	...	0	...	1—1
(5)	1—1	...	1—1	...	1·5—1	...	1—1	...	—
(6)	1·5—1	...	1·5—1	...	2—1	...	1—1	...	1·5—1

Case 3.—Senile dementia. Duration, nine months. Age at death, 75 years. Autopsy number, xv-20.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	1—1	...	1—1	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	1—1
(6)	1—1	...	1·5—1	...	1·5—1	...	1·5—1	...	1—1

Case 4.—Senile dementia. Duration, one month. Age at death, 75 years.
Autopsy number, xv-25.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	1—1	...	1—1	...	1—1
(4)	—	...	1—1	...	1—1	...	1—1	...	1—1
(5)	1·5—1	...	1—1	...	1—1	...	1·5—1	...	1·5—1
(6)	2—1	...	1·5—1	...	2—1	...	2—1	...	2—1

Case 5.—Senile dementia. Duration, five months. Age at death, 76 years.
Autopsy number, xv-29.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	—
(5)	0	...	0	...	0	...	1—1	...	0
(6)	1—1	...	1—1	...	1—1	...	1—1	...	1—1

Case 6.—Senile paranoid condition. Duration, twenty-five years. Age at death, 83 years. Autopsy number, xv-40.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	0	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	0	...	0
(6)	1·5—1	...	1—1	...	1—1	...	1—1	...	1—1

Case 7.—Senile paranoid condition, with dementia. Duration, ten years.
Age at death, 78 years. Autopsy number, xv-42.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	1—1	...	0	...	0
(4)	—	...	1—1	...	1—1	...	0	...	1—1
(5)	1—1	...	1·5—1	...	1—1	...	1—1	...	—
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1·5—1	...	1—1

Case 8.—Senile paranoid condition. Duration, two years and a half.
Age at death, 67 years. Autopsy number, xv-43.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	0	...	—
(4)	—	...	1—1	...	1—1	...	0	...	0
(5)	1·5—1	...	1—1	...	1—1	...	1—1	...	—
(6)	2—1	...	1—1	...	1·5—1	...	1·5—1	...	1—1

Case 9.—Senile dementia. Duration, one month. Age at death, 62 years.
Autopsy number, xv-57.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	1—1	...	0	...	1—1	...	0	...	0
(6)	1—1	...	1—1	...	1—1	...	0	...	0

Case 10.—Senile dementia. Duration, nine years. Age at death, 84 years.
Autopsy number, xvi-2.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	0	...	0	...	0	...	0	...	0
(6)	1—1	...	1—1	...	0	...	1—1	...	0

IV.—GENERAL PARALYSIS GROUP.

Case 1.—General paralysis; demented. One year's duration (?). Age at death, 37 years. Autopsy number, xv-24.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	1—1	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	—
(6)	1·5—1	...	2—1	...	1·5—1	...	2—1	...	1—1

Case 2.—General paralysis; demented. Three years' duration. Age at death, 63 years. Autopsy number, xv-31.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	*	...	*	...	*	...	*	...	0
(3)	*	...	*	...	*	...	*	...	0
(4)	—	...	*	...	*	...	*	...	1—1
(5)	1·5—1	...	*	...	1—1	...	1—1	...	—
(6)	2—1	...	2—1	...	1·5—1	...	1·5—1	...	1—1

* Marked stratigraphic disturbance due to the lesions of general paralysis.

Case 3.—General paralysis. Four years' duration. Age at death, 43 years.
Autopsy number, xv-33.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	1—1	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	1—1
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1—1	...	1—1

Case 4.—General paralysis. Two years' duration. Age at death, 42 years. Autopsy number, xv-34.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	*	...	*	...	0	...	0
(4)	—	...	*	...	*	...	0	...	0
(5)	1—1	...	*	...	*	...	1—1	...	—
(6)	1·5—1	...	2—1	...	1·5—1	...	1—1	...	1—1

* Marked stratigraphic disturbance due to the lesions of general paralysis.

Case 5.—General paralysis. Two years' duration. Age at death, 54 years. Autopsy number, xv-41.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	1—1	...	0	...	0
(4)	—	...	1—1	...	1—1	...	0	...	0
(5)	1·5—1	...	1·5—1	...	1·5—1	...	1—1	...	1—1
(6)	2—1	...	1·5—1	...	1·5—1	...	1·5—1	...	1—1

Case 6.—General paralysis. One and a half years' duration. Age at death, 55 years. Autopsy number, xv-47.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	—	...	0	...	1—1
(5)	1—1	...	0	...	1—1	...	1—1	...	—
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1—1	...	1—1

Case 7.—General paralysis. Six months' duration (?). Age at death, 36 years. Autopsy number, xvi-9.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	0
(6)	1·5—1	...	1—1	...	1·5—1	...	1—1	...	1—1

Case 8.—General paralysis. One year's duration. Age at death, 60 years. Autopsy number, xvi-14.

	PCL.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	1—1	...	1—1	...	0	...	0	...	0
(6)	1·5—1	...	1—1	...	1—1	...	0	...	0

Case 9.—General paralysis. Seven years' duration. Age at death, 49 years. Autopsy number, xvi-15.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	1—1	...	0	...	0
(4)	—	...	1—1	...	1—1	...	0	...	0
(5)	1—1	...	1—1	...	1·5—1	...	1—1	...	0
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1·5—1	...	0

Case 10.—General paralysis. Two years' duration. Age at death, 40 years. Autopsy number, xvi-26.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	0	...	0	...	0
(4)	—	...	1—1	...	1—1	...	0	...	0
(5)	1·5—1	...	1·5—1	...	1—1	...	1—1	...	0
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1—1	...	0

V.—ALCOHOLIC INSANITY GROUP.

Case 1.—Alcoholic deterioration. Duration, three years.¹ Age at death, 46 years. Autopsy number, xv-44.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	0	...	0	...	0	...	0	...	—
(6)	1—1	...	1—1	...	1—1	...	0	...	0

Case 2.—Alcoholic deterioration. Duration, five years. Age at death, 61 years. Autopsy number, xv-45.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	1—1	...	1—1	...	0	...	0	...	0
(6)	1—1	...	1—1	...	1—1	...	0	...	0

Case 3.—Alcoholic paranoid condition. Duration, nine years. Age at death, 37 years. Autopsy number, xv-73.

	PCL.		PoCL.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	0	...	0	...	0	...	0
(4)	—	...	0	...	0	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	—
(6)	1·5—1	...	1·5—1	...	1·5—1	...	1·5—1	...	1—1

¹ In the alcoholic group duration refers to duration of the psychosis, not the habit.

Case 4.—Alcoholic deterioration. Duration, sixteen years. Age at death, 58 years. Autopsy number, xvi-16.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	0	0	0	0	0
(4)	—	0	0	0	0
(5)	0	0	0	0	1—1
(6)	0	0	1—1	0	1—1

Case 5.—Alcoholic paranoid condition. Duration, one month. Age at death, 61 years. Autopsy number, xvi-19.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	0	1—1	0	0
(4)	—	1—1	—	0	0
(5)	1·5—1	1—1	1·5—1	1—1	1—1
(6)	2—1	1—1	1·5—1	1·5—1	1—1

Case 6.—Alcoholic deterioration. Duration, one month. Age at death, 65 years. Autopsy number, xvi-32.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	1—1	1—1	0
(4)	—	1—1	—	1—1	1—1
(5)	1·5—1	1·5—1	1—1	1—1	—
(6)	2—1	1·5—1	1·5—1	1·5—1	1—1

Case 7.—Alcoholic deterioration. Duration, six months. Age at death, 68 years. Autopsy number, xvii-13.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	1—1	1—1	1—1	1—1	1—1
(4)	—	1—1	1—1	1—1	1—1
(5)	1—1	1—1	1—1	1—1	1—1
(6)	1·5—1	1·5—1	1—1	1·5—1	1·5—1

Case 8.—Korsakow psychosis. Duration, ten years. Age at death, 57 years. Autopsy number, xvii-28.

	PCI.	PoCl.	F.	T.	Occ.
(1)	—	—	—	—	—
(2)	0	0	0	0	0
(3)	0	0	0	0	0
(4)	—	1—1	—	0	0
(5)	1—1	1—1	1—1	1—1	0
(6)	1—1	1—1	1·5—1	1—1	1—1

Case 9.—Delirium tremens. Duration, several days. Age at death, 42 years. Autopsy number, xvii-33.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	0	...	0	...	0	...	0	...	0
(4)	—	...	1—1	...	—	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	0
(6)	1—1	...	1·5—1	...	1·5—1	...	1—1	...	1—1

Case 10.—Alcoholic deterioration. Duration, two years. Age at death, 61 years. Autopsy number, xvii-38.

	PCI.		PoCl.		F.		T.		Occ.
(1)	—	...	—	...	—	...	—	...	—
(2)	0	...	0	...	0	...	0	...	0
(3)	1—1	...	1—1	...	0	...	0	...	0
(4)	—	...	0	...	—	...	0	...	0
(5)	1—1	...	1—1	...	1—1	...	1—1	...	0
(6)	1·5—1	...	1—1	...	1—1	...	1—1	...	1—1

ANALYSIS AND DISCUSSION.

In order to enable the more ready interpretation of the foregoing data in analytical form it has been deemed advisable to reduce the tables to a figure which will indicate at once the relative severity of reaction both in regard to the number of laminæ involved and the grade of involvement in each. This figure, which for convenience will be called the satellite index, is made up by counting the number of layers involved, giving each at the same time a value equivalent to the satellite—nerve-cell ratio. Thus the post-central cortex of Case I, 1, shows three laminæ with a count of 1 to 1 and one of 1·5 to 1, giving a satellite index of 4·5, while the frontal cortex of the same case has two laminæ with 1 to 1 reaction, and one each of 1·5 to 1 and 2 to 1, giving an index of 5·5. In all cases where a layer is wanting, e.g., precentral stellate, the interpretation has been made on the basis of the layer immediately above. That is the occurrence of a 1 to 1 reaction in the lamina ganglionaris is taken as evidence of an extension of the process above the position which a stellate layer would occupy and is considered as though a similar reaction occurred there. These methods of analysis are of course open to some question, but they will probably indicate the conditions within reasonable limits of error.

The records all tend to show a marked predilection for the deeper cell layers. Almost without exception the numerical record shows slight, if any, reaction in the upper laminæ, but a marked tendency

to an increasing ratio as one after another of the subjacent laminae is reached. Not only does the reaction tend to increase as one passes to the deeper layers, but even within one layer there may be a noticeable difference at various levels. Thus the deeper portions of the lamina pyramidalis and the lamina multiformis contain a noticeably larger number of satellites in the majority of instances than the upper levels. (This has been taken into account in the record of findings as mentioned above.) No attempt has been made to estimate the number of cells of the neuroglia type in the subcortical white matter, but the survey has given rise to a strong impression that those cases showing marked satellitosis also show an increase here.

An analysis of the satellite indices by laminae of the whole series gives the following results:—

Lamina	Total indices (50 cases)				Average index		
Granularis externa (2)	0	...	...	0	0
Pyramidalis (3)	59	...	...	1.18	1.18
Granularis interna (4)	88	...	...	1.76	1.76
Ganglionaris (5)	171.5	...	...	3.43	3.43
Multiformis (6)	276.5	...	...	5.53	5.53

The increase on reaching successively deeper layers is strikingly shown.

There is also a fairly constant tendency toward milder involvement of the occipital and temporal regions, as is shown by the following table:—

Region	Total indices (50 cases)				Average index		
Precentral	149.5	...	...	2.99	2.99
Postcentral	131.5	...	...	2.63	2.63
Frontal ¹	132.0	...	...	2.64	2.64
Temporal	102.5	...	...	2.05	2.05
Occipital ²	79.5	...	...	1.59	1.59

¹ Eighteen of the fifty cases represent a-granular frontal or cortex of the effector type.

² Twenty-three of the fifty cases are calcarine cortex.

In this table it must be considered that the inclusion of ten cases of general paralysis in which the severest expression is usually pre-rolandic or involves the pre-rolandic and post-central fields might play some part, but a similar analysis of the averages with the general paralysis series omitted has yielded about the same result.

The analysis by groups of psychoses has been carried out in a slightly different manner. In order to simplify the interpretation the cases have been separated into five groups, viz., (1) negative, those with a satellite count less than the nerve-cell count in all laminae; (2) slight, where the satellite index was below 5; (3) moderate, with

a satellite index between 5·5 and 10; (4) marked between 10·5 and 15; and (5) intense with an index above 15·5. This arrangement has yielded the following result:—

	Negative		Slight		Moderate		Marked		Intense
Maniacal depressive ...	0	...	0	...	1	...	4	...	5
Dementia præcox ...	4	...	4	...	2	...	0	...	1
Senile psychoses ...	0	...	2	...	1	...	4	...	3
General paralysis ...	0	...	0	...	2	...	6	...	2
Alcoholic psychoses ...	0	...	3	...	0	...	4	...	3

The most striking results of this analysis are the relation of the maniacal depressive and dementia præcox groups.

The first group, that of the maniacal depressive series, shows a marked tendency towards high indices, with one case in the moderate column and all of the remainder either marked or intense, while the dementia præcox group, in sharp contrast, shows fairly consistent low indices. This condition in dementia præcox stands in sharp contrast to the active neuroglia reaction (amœboid neuroglia and neurophagocytosis), which Alzheimer and others have shown in the active stages of the disease, but these changes are probably evanescent and would not be expected to play an important rôle in a series of cases such as the present, which are for the most part of long standing. Alzheimer emphasizes that the degree of these changes is in relation to the severity of the attack rather than its clinical expression, and that soon after an acute catatonic "storm," for instance, little of this sort of alteration may be demonstrable. In none of the other three groups were there cases of entirely negative count, but otherwise the distribution is more general.

In the one case of moderate reaction of the maniacal depressive group (Case I, 6) the patient died at the age of 41, while the patient with dementia præcox with an intense reaction lived to be 83. To control the influence of age the data have been arranged in a table by decades with the following result:—

	Negative		Slight		Moderate		Marked		Intense
Under 30 ...	0	...	1	...	0	...	0	...	0
31—40 ...	0	...	1	...	1	...	5	...	0
41—50 ...	3	...	1	...	1	...	3	...	1
51—60 ...	1	...	2	...	1	...	2	...	1
61—70 ...	0	...	2	...	2	...	5	...	6
71—80 ...	0	...	0	...	1	...	2	...	5
Over 81 ...	0	...	1	...	0	...	1	...	1

This table seems to indicate a tendency for the more intense reactions to occur in the latter decades, but that age is not the only

factor may be seen from Case III, 10, a senile dement, aged 84, with a satellite index of 3, which places it in the slight group.

Finally, the data have been rearranged to determine any possible relation between the duration of the psychosis and the degree of reaction. This is manifestly a difficult task as the time of onset in many of the included cases is difficult to determine with accuracy. In the maniacal depressive group the duration has been reckoned from the onset of the first attack. In the alcoholics no attempt was made to estimate the period of the habit, but the figures are taken from the onset of mental symptoms sufficient to result in hospital commitment. The table follows:—

		Negative		Slight		Moderate		Marked		Intense
Less than 1 year	...	0	...	2	...	3	...	3	...	4
1 to 5 years	...	2	...	1	...	1	...	8	...	2
5 to 10 years	...	1	...	3	...	0	...	4	...	3
Over 10 years	...	1	...	2	...	2	...	3	...	5

Here there seems to be no definite relationship. The marked and intense cases are distributed with relative evenness throughout the varying periods. The eight cases in the 1- to 5-year period in the marked column seems disproportionate, but this is accounted for by the occurrence here of six cases of general paralysis.

CONCLUSIONS.

The analysis of the relative numerical occurrence of satellite cells in ten cases, each of five psychoses, seem to warrant the conclusion that satellitosis cannot be considered in any sense indicative of the type of psychosis, although it has in this series appeared with more consistent intensity in the maniacal depressive cases and has been of very much less prominence in dementia præcox.

The reaction elects the deeper cell layers both in regard to frequency of occurrence and degree of reaction.

The cortices of the dome, precentral, postcentral and frontal, seem to show the reaction with greater intensity than do the temporal and occipital regions.

Age at the time of death seems to play some part in the occurrence of severe reactions, but cannot be considered the only factor.

The duration of the psychosis bears no demonstrable relation to satellitosis.

BIBLIOGRAPHY.

- [1] ALZHEIMER. *Zeitschr. f. d. Gesamte Neurol. u. Psychol.*, 1911, Bd., iv, S. 356.
- [2] BERKLEY, H. J. *Philadelphia Med. News*, 1883, vol. xliii, p. 200.
- [3] CLARKE, J. M. *Brain*, 1897, vol. xx, p. 22.
- [4] COLLINS, J. *Amer. Journ. Med. Sci.*, 1898, vol. cxvi, p. 275.
- [5] FACKLAM, F. C. *Arch. f. Psychiat.*, 1898, Bd. xxx, S. 137.
- [6] GREPPIN, L. *Arch. f. Psychiat.*, 1892, Bd. xxiv, S. 155.
- [7] KATTWINKEL. *Deutsche Arch. f. klin. Med.*, 1899, Bd. lxvi, S. 517.
- [8] KÖLPIN. *Journ. f. Psychol. u. Neurol.*, 1908-9, Bd. xii, S. 57.
- [9] L'ANNOIS, M., and PAVIOT, J. "Neurographs," 1908, vol. i, No. 2, p. 105.
- [10] MARGULIS, M. S. *Journ. nervopat. i psikhiat.*, Korsakova, 1910, Bd. x, S. 1191.
- [11] MENZIES, W. F. *Journ. Ment. Sci.*, 1892, vol. xxxviii, p. 560; *ibid.*, 1893, vol. xxxix, p. 50.
- [12] MODENA. *Annuario del Manicomio prov. di Ancona*, 1905.
- [13] MONNIER. *Thèse de Paris*, 1911.
- [14] OPPENHEIM, H., und HOPPE, H. H. *Arch. f. Psychiat.*, 1893, Bd. xxv, S. 617.
- [15] RAECKE. *Arch. f. Psychiat.*, 1910, Bd. xlvi, S. 727.
- [16] RUSK, G. Y. *Amer. Journ. Insan.*, 1902-03, vol. lix, p. 63.
- [17] SCHULZ. *Charité-Annalen*, 1908, Bd. xxxii, S. 189.
- [18] STIER, E. *Arch. f. Psychiat.*, 1903, Bd. xxxvii, S. 62.
- [19] WEIDENHAMMER. *Neurol. Centralbl.*, 1901, Bd. xx, S. 1161.
- [20] WOLLENBERG, R. "Nothnagel's Specielle Path. u. Therapie," 1899, Bd. xii, Teil II, Abt. 3.