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A Stereotaxic Atlas of the
Squirrel Monkey's Brain
(Saimiri sciureus)

A Stereotaxic Atlas of the
SQUIRREL MONKEY'S BRAIN
(Saimiri sciureus)

by

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Public Health Service

National Institutes of Health

Bethesda, Maryland

PUBLIC HEALTH SERVICE PUBLICATION No. 933
1962

*For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.*

Foreword

Dr. Paul D. MacLean began working with the squirrel monkey (*Saimiri sciureus*) in the Fulton laboratory at Yale in 1950, and introduced it into the NIMH laboratory in 1957. It has been an inspiration to observe the work he and his collaborators have done in the succeeding years. The squirrel monkey was first used in the United States by Heinrich Klüver. This gentle little primate from the South has continued to have increasing value for laboratory study. It is a small animal with a relatively large brain and a highly organized nervous system. It is quiet, trainable and adapts well to both acute and chronic experimentation. Large numbers can be contentedly maintained in a relatively small space. Resistance to infections, including tuberculosis, is high.

Drs. Gergen and MacLean have produced this Horsley-Clarke type of atlas with meticulous care. It includes the whole hemispheres, and great effort has been expended to show the degree of scatter to be expected. This atlas will be of great service to brain research.

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Introduction

In our experience the squirrel monkey (*Saimiri sciureus*, Voigt, 1831) has proved to be an excellent experimental animal for many kinds of brain and behavioral work for which a primate form is desired (1, 4, 5, 6). Unlike the larger primates, this New World monkey has the advantage that its brain, which is comparable to the cat's in weight and size, is of desirable dimensions for combined neurophysiological and neuroanatomical investigations. There is the added advantage that its small body makes it easy to handle and economical to maintain. Representative measurements of its body and brain are given in table I. Some details in regard to the purchase and maintenance of the squirrel monkey are discussed in the appendix.

TABLE I—REPRESENTATIVE BODY AND BRAIN MEASUREMENTS OF THE SQUIRREL MONKEY*

	Number of animals	Mean	Standard deviation
Weight.....	76	717 g.....	± 170. 4
Body length.....	49	260 mm.....	± 24. 7
Tail length.....	50	360 mm.....	± 21. 4
Total length.....	48	630 mm.....	± 35. 7
Head length.....	45	54 mm.....	± 2. 2
Head width.....	45	41 mm.....	± 3. 6
Brain weight.....	21	26 g.....	± 1. 7
Brain length.....	29	49 mm.....	± 2. 1
Brain width.....	30	35 mm.....	± 1. 7

* (From: Carmichael, M. and MacLean, P. D. *EEG Clin. Neurophysiol.*, 1961, 13: 128-129.)

The squirrel monkey is indigenous of Central America and of extensive areas of northern South America. It belongs to the family Cebidae. The generic term *Saimiri* (which is assigned a masculine gender) is presumably an Indian term for this particular type of monkey.¹ Hill (2) gives an extensive taxonomical description of a number of species and subspecies, as well as some information about their territorial origin and general behavior. The *Saimiri* are arboreal animals characterized by an elongated oval head, a somewhat flat face with closely placed eyes, and a long, nonprehensile tail. The common squirrel monkey (*Saimiri sciureus*) has soft, orange-brown to grey colored fur which is of similar hue on the back and crown.

In answer to requests for stereotaxic data on the squirrel monkey, we have sent to several laboratories a duplicated line drawing atlas. Continuing requests for this material have encouraged us to proceed with a publication of the present photographic atlas.

¹ Personal communication from Dr. David H. Johnson, Curator of Mammals, United States National Museum.

Materials and Methods

Horsley-Clarke technique

A Horsley-Clarke apparatus used for the cat or macaque may be adapted with little or no modifications for experiments on the squirrel monkey. The horizontal reference plane of most instruments is based on lines passing through each orbitale and the centers of the external auditory meati (approximate Frankfort plane). As it is undesirable to cut the lower eyelid in chronically prepared animals, it is the practice of this laboratory to elevate the level of the eye piece to allow for the thickness of the eyelid. A photograph of the eye piece and its alinement with the straight ear bars of the Horsley-Clarke apparatus used in the present study is shown in figure 1. The triangular notch in the eye piece is 1.5 mm. deep and 3.0 mm. broad; the axial center of the ear bar is on a line with the lower surface of the eye piece. The ear bars are inserted directly into the external auditory meati; the final distance between tips after insertion usually measures 19–21 mm.

Figure 1—Notched eye piece and ear bar of Horsley-Clarke apparatus used in the present study. The dotted line connecting center of ear bar and lower surface of eye piece indicates the horizontal zero plane. The notch of eye piece allows for thickness of eyelid so that the orbitale lies approximately on this plane.

Animals

The brain of SM12 for the frontal series depicted in this atlas was chosen for illustration because it was most representative of average stereotaxic measurements obtained on 31 adult male animals. The mean body weight for these animals was 821 g. (standard deviation 127 g., extremes of 550 and 1,050 g.).

Procedure

Multiple marking bars were placed under anesthesia in the brain of each animal as a guide to sectioning and to determine the position of frontal and horizontal planes. In each case X-rays were obtained of the animal's head to check the alinement of bars and to confirm the distance between them. Figure 2 illustrates the lateral skull X-ray of animal SM12.

Figure 2—Lateral skull X-ray of monkey SM 12. The brain of this animal was used for making the frontal series of this atlas. Marker bars are present bilaterally at AP 18 and AP —0.5; a single horizontal bar falls at H 19.5. The opacity near the ear canal is part of the head holder.

Histological techniques

At sacrifice all animals were perfused through the heart with 100–200 cc. of normal saline at 40° C., followed by an equal amount of a mixture of 10% formalin-1.0% agar agar (U.S.P.) at 40° C. The intact head was placed in the refrigerator overnight, and the brain was removed on the following day. The 2½–3½ cm. block to be sectioned was immersed in formalin-agar agar at 40° C. for several days; 24 hours before sectioning ethyl alcohol was added to a concentration of 20%. Serial frozen sections were prepared by the Marshall technique (7) with the microtome set at approximately 50μ and cutting in a dorsal to ventral direction. The final thickness of sections was calculated by dividing the number of sections into the distance between marking bars. Sections were saved at 0.5 mm. intervals and mounted on glass slides covered with egg albumen. Facing sections were respectively stained with cresyl violet and Lillie's variant of the Weil-Weigert method (3). To judge distortions inherent in fixation, cutting and mounting, dimensions of the sections were compared with measurements taken stereotaxically from the base of the animal's skull and from its skull X-ray. Twenty-nine brains were cut in the frontal plane and two in the sagittal plane.

Variability in Position of Cerebral Structures

To estimate the variation in position of brain structures that one might expect in routine experimental procedures, an analysis was made of the coordinates of the Commissura anterior, Corpus mammillare and Nucleus habenularis. Anterior and posterior limits of these structures for a parasagittal plane were estimated from the histological material on 31, 29, and 31 animals, respectively. The anterior-posterior extent of each of these structures is plotted in a cumulative profile by the solid lines in figures 3, 4, and 5. Each of these structures typically has a maximal extent of 1–1.5 mm.; the rising slope of the solid line curves in these figures thus largely represents the anterior limits for each structure while the falling slope reflects the posterior boundary.

The data suggest that there is about a 50% chance of encountering one of these structures at its optimal stereotaxic coordinates. The variation between extremes for any one point in one of the structures exceeds 4 mm. in AP coordinates; however, 90% of the animals show a variation of 1.5 mm. or less from the average. The dotted lines represent the curves obtained after displacing all structures in any one animal by a constant distance in the anterior-posterior direction. This displacement was arbitrarily chosen to bring the coordinates of all of these structures for each animal close to the population mean. For different animals, the displacement chosen varied from +2.0 to -1.5 mm. These curves demonstrate that there is less variation in the relative position of these structures within the brain than that seen for the population.

Figures 3–5—In these figures the solid lines represent distribution profiles of the anterior-posterior extent of the Commissura anterior (CoA), Corpus mammillare (M), and the Nucleus habenularis (Ho) in 31, 29, and 31 animals, respectively, as found in routine stereotaxic procedures.

Dotted lines in these figures represent a replotting of these distribution profiles after adding on arbitrary "displacement" to all the coordinate values of each animal (see text).

After establishing a displacement distance, an additional correlation could be shown between this distance and the animal's weight.² This correlation suggested that there is a tendency for brain structures to be posterior to the average in animals which have a body weight less than the mean, whereas the opposite tendency is present in animals in which the body weight is greater than the mean.

Differences among animals in the position and size of the external auditory meati are apparently a major cause of the stereotaxic variabilities that have been described. This conclusion is based on measurements in which other cranial loci were used to obtain reference planes. Table II lists useful landmarks which can readily be determined by X-ray examination.

TABLE II—AVERAGE STEREOTAXIC COORDINATES OF CALVARIAL STRUCTURES

Structure	Anterior-posterior	Horizontal
	<i>Millimeters</i>	<i>Millimeters</i>
Anterior limit of cranial vault.	29±2	17±1
Orbital roof.	20	14.5±0.5
Floor, olfactory groove.	20	10.5±0.5
Floor, temporal fossa.	9±2	0.5±0.5
Anterior edge of posterior clinoid process.	8.5±0.5	5.5±1.0
Dorsal limit of cranial vault.	5±2	31±2
Posterior limit of cranial vault.	-22±2	15±2

A good approximation to the horizontal zero plane is provided by a line passing through the orbitale and just below the floor of the temporal fossa. The rostral boundary of the posterior clinoid processes falls at 8.5±0.5 mm. anterior to the ear canal (AP 0) of the average animal, while at 20 mm. anterior, the floor of the olfactory groove and orbital roof should lie at 10.5±0.5 mm. and 14.5±0.5 mm. above the horizontal zero. Figure 6 is a scatter diagram for 8 animals in which these skull landmarks were used to establish a stereotaxic frame of reference independent of the ear canals. Animals selected for this drawing included those with a wide deviation from the mean body weight. For comparison, the coordinates of SM12 are indicated by the heavier lines and the cross hatching. Connecting lines have been drawn through the centers of the structures of each animal to show angular relationships and the relative positions of these structures

² For the 29 animals with complete measurements on the position of all three structures, the regression line determined by the equation

$$\text{"displacement"} (\text{mm}) = 2.75 - 3.41 \times \text{weight (kg)}$$

is significant (0.01 confidence level, $T=3.47$ with 27 degrees of freedom). Weight variations, however, in any one animal in our laboratory may be as much as 200 gms.; it should also be noted that after assuming this weight correction, displacements greater than 0.5 mm. would still be needed in 12 (41%) animals to obtain the dotted curves in figures 3-5.

for any one animal. The range of scatter in this figure for the Corpus mammillare (M) and Commissura anterior (CoA) is approximately 1.5 mm. and is thus less than one half that shown in figure 3-4. The fact that coordinates for the Nucleus habenularis (Ha) show a wider scatter than the other structures suggests that cerebral distortion attributable to embryological development of the mesencephalic flexure contributes to a greater variation in the position of dorso-caudal thalamic structures than of those lying more rostral and ventral.

Figure 6—Scatter diagram of the parasagittal location of the Commissura anterior (CoA), Corpus mammillare (M), and Nucleus habenularis (Ha) in 8 animals in which the stereotaxic reference planes were determined by lateral skull X-ray without reference to the position of the ear canals (see table II and text). The cross-hatched areas show in addition the position of these structures in animal SM 12 used for the atlas. Lines are drawn between the approximate centers of these structures for each animal.

In summary, the findings indicate that in carrying out stereotaxic exploration under routine experimental conditions one would have a 50% chance of coming within 0.5 mm. of a point described by the coordinates of the present atlas. There would be a 90% chance of falling within 1.5 mm. of this target. In experiments in which a higher degree of accuracy is required it would be desirable to obtain appropriate X-ray data and to avoid the use of unusually large or small animals. In our experience the degree of accuracy that can be achieved in stereotaxic work in the squirrel monkey compares to that in the cat, and is significantly better than in the macaque.

Acknowledgments

Many people have contributed to the preparation of this atlas. Miss Martha Carmichael and Mr. George Creswell assisted in preparing the histological material and proofread the plates and tables. Dr. Kent D. Morest and Dr. William H. Mehler generously consulted with us in regard to the dorsal tegmentum and optic thalamus, respectively. Miss Norma Beck typed the manuscript. Mr. Levi Waters was responsible for the care of the animals.

The photography was done in the Medical Arts and Photography Branch of the National Institutes of Health under the supervision of Mr. Roy Perry and

Mr. Vernon E. Taylor. Mr. Paul Ellis photographed the slides and helped in solving problems pertaining to the grid used on the frontal sections. Mr. Ralph Fernandes enlarged and developed the prints.

We wish to express our appreciation to Dr. Wade H. Marshall of the Laboratory of Neurophysiology, National Institute of Mental Health, for his help in seeing this atlas through to publication.

Finally, we wish to acknowledge our great indebtedness to the Government Printing Office for the special care given to its production.

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Explanation of Plates

Reference Planes

The horizontal zero plane (H 0) for this atlas is defined as the plane passing along the inferior flat surfaces of the eyepieces through the center of the ear bars (see Methods). All brain structures anterior to the medulla oblongata lie above this plane. The frontal zero plane (AP 0) is defined as the plane which passes through the center of the ear bars and is perpendicular to the horizontal zero plane. The lateral zero plane is defined as perpendicular to the horizontal and frontal zero planes and passing midway between the two ear bars in their final position. The sagittal suture usually lies within 1 mm. of the lateral zero plane; best reliability is obtained by exposing and utilizing the superior sagittal sinus.

Frontal Series

In the plates for the frontal sections (SM12), AP designations represent the plane for which the section is considered representative. Positive AP numbers refer to distances in millimeters anterior to AP 0. Deviations between the desired and actual positions of any section are no more than 0.2 mm.; the calculated position of each section is given in smaller type. The grid overlying one-half of the frontal section is scored in millimeter intervals. Numbers along the sides of each plate represent 5 mm. intervals in the lateral and horizontal planes.

Sagittal Series

Following the frontal series are plates showing representative sagittal sections stained by the Weil-Weigert method. These are presented to indicate the relative position of brain structures anterior and posterior to those in the frontal series and to facilitate visualization of spatial relationships. These plates are alphabetically identified. The approximate distance of the section from the midline appears beneath the letter. The abbreviations are listed in tables III and IV.

Nomenclature

The terminology of this atlas is based on that compiled by Riley in his remarkable and recently republished "An Atlas of the Basal Ganglia, Brain Stem and Spinal Cord" (9). In 15 instances terms have been taken from other references; these are indicated by an asterisk in tables III and IV.

Labeling and Abbreviations

Structures which are comprised largely of white matter are labeled in italics on the plates showing sections stained by the Weil-Weigert method; principal cellular groups are identified by Roman letters on the plates showing the Nissl-stained sections. The corresponding abbreviations are given in tables III and IV. Initials for generic terms (e.g., nucleus) are not used except for the following: brachium, capsula, commissura, lemniscus, pedunculus, radiatio, stria and stratum. In these instances cross-references are given.

AP 15
(15.0)

AP 15
(15.0)

30

25

20

15

10

5

0

15

10

5

Ci

Ca

SM

Cl

Put

SL

A

R

AP 14.5
(14.4)

AP 14.5
(14.7)

AP 14

(14.1)

AP 14
(14.1)

30
25
20
15
10
5
0

15 10 5

AP 13.5

(13.6)

30

25

20

15

10

5

0

CC

CI

CE

CEx

Un

Ol

RaO

StO

14

15

10

5

AP 13.5
(13.6)

30
25
20
15
10
5
0

AP 13
(13.0)

16 15 10 5 0

AP 13
(13.0)

30

AP 12.5
(12.5)

25

20

15

10

5

0

18

15

10

5

SS

CC

OLF

CI

CE

LaL

CEX

CoA

RaO

TeM

OIH

HCCh

18

AP 12.5
(12.5)

AP 12
(12.2)

SS

Cin

CC

Olf

CI

F

CE

LaL

CEx

CoA

RaO

TeM

Un

OlH

PICh

AP 12
(12.0)

AP 11.5
(11.7)

CC

CI

F

StT

LoL

CE

CEx

CoA

TeM

OIH

ΠCh

AP 11.5
(11.4)

30
25
20
15
10
5
0

15 10 5

AP 11
(11.1)

AP 11
(10.9)

AP 10.5
(10.6)

CC
CI *StT* *F*
SEM
PVT
CE *LaL* *F*
CEx
CoA *TeM*
Un *ΠCh*

AP 10.5
(10.6)

30

25

20

15

10

5

0

15

10

5

AP 10

(10.0)

AP 10
(10.0)

30

25

20

15

10

5

0

15

10

5

Ci

Ca

Ret

PavT

VA

Put

GP

Pav

HyL

B

AC

AM

AB

ABA

AL

ACo

CerL

I

T

AP 9.5
(9.5)

30
25
20
15
10
5
0

30 15 10 5

AP 9.5
(9.5)

30

25

20

15

10

5

0

15

10

5

AP 9

(9.0)

AP 9
(9.0)

30
25
20
15
10
5
0

15 10 5

30
25
20
15
10
5
0

AP 8.5
(8.4)

34 15 10 5

AP 8.5
(8.4)

30

25

20

15

10

5

0

AP 8
(7.9)

AP 8

(8.1)

30
25
20
15
10
5
0

15

10

5

AP 7.5

(7.6)

30

25

20

15

10

5

0

AP 7.5

(7.6)

30
25
20
15
10
5
0

15

10

5

AP 7

(7.0)

30

25

20

15

10

5

0

10

15

10

5

AP 7
(7.0)

AP 6.5

(6.5)

CC

StT

E

StM

LoMT

LoLT

CI

H1

H2

CoS

HT

StT

Alv

P

III

Cin

AP 6.5
(6.5)

AP 6
(6.0)

AP 6

(6.0)

30

25

20

15

10

5

0

15

10

5

Ce

Ci

Ca

LaD

LaP

Ret

CeL

MD

Put

VPL

Cent

VPM

Par

Int

EW

Rub

SubN

Ca

Hip

AP 5.5

(5.4)

CC

StT

StM

LoMT

HI

LM

SLT

III

P

SSP

Cm

AP 5.5
(5.4)

AP 5
(4.9)

AP 5.0
(5.1)

30
25
20
15
10
5
0

15 10 5

AP 4.5

(4.6)

AP 4.5
(1.6)

15

10

5

30

AP 4.0
(4.0)

25

20

15

10

5

0

52

15

10

5

AP 4.0
(4.0)

30
25
20
15
10
5
0

15 10 5

30

AP 3.5
(3.5)

25

20

15

10

5

0

15

10

5

51

*CC**StT**LoLT**BCS**CoP**LeM**TeC**Alv**III**DBC**Cin**PMC**CS₂**SSP*

AP 3.5
(3.5)

AP 3.0
(3.0)

AP 3.0
(3.2)

AP 2.5

(2.4)

AP 2.5
(2.4)

30
25
20
15
10
5
0

15 10 5

AP 2.0
(1.9)

AP 2.0
(2.1)

AP 1.5
(1.6)

AP 1.5
(1.6)

AP 1.0
(1.0)

30
25
20
15
10
5
0

AP 1.0

(1.0)

30

25

20

15

10

5

0

15

10

5

65

AP 0.5
(0.5)

AP 0.5
(0.5)

AP 0
(0.0)

AP 0
(0.0)

30

25

20

15

10

5

0

15

10

5

AP-0.5

(-0.6)

30
25
20
15
10
5
0

70

15

10

5

AP—0.5
(—0.6)

30

25

20

15

10

5

0

15

10

5

71

A
L 0.0
(0.0)

B
L 0.25
(0.2)

F
L 1.5
(1.6)

AnV

AnD

LaMT

F

MD

VPM

PuM

ColS

C

CC

VA

Ca

R

I

CoA

PVT

AnL

IICh

SubN

III

P

PMC

Po

Br

VI

OII

CSp

Ar

ColI

Cer

IV

VII

Sol

FaC

M
L 7.0
(7.0)

O
L 9.0
(9.0)

Appendix I

Purchase and Maintenance of Squirrel Monkey

It is important to find a reliable animal dealer who will regularly provide well-nourished animals with good coats. It is our experience that animals weighing appreciably less than 500 grams are either immature or sickly.

Our experimental animals are kept in cages that are 28" long, 26" high and 18" wide. For purposes of climbing, cleanliness, and ease of inspection, the sides of cages are made of 1½" stainless steel wire mesh. Usually no more than 1 or 2 animals are kept in a cage. The animal room is maintained at an average temperature of 76°. Surplus animals are kept in large runs which have access to the out of doors during seasonable months.

Exotic diets mimicing what the animals eat in the wild are not necessary and may even be deleterious. On the basis of over 10 years experience, it can be stated that the squirrel monkey can be maintained in good nutrition for periods up to several years on a standard diet of monkey chow (1). Ten to 12 soft biscuits (a biscuit weighs about 3.5 g.) appear to satisfy the daily food requirements of an average monkey. Favored foods such as grapes, bananas, and raw peanuts may be offered for purposes of training and taming.

The squirrel monkey is highly resistant to bacterial infections (1). We have had no cases of tuberculosis. A rare animal may go downhill and die with a nematode infestation. We have found that the condition of an animal's coat and its weight are the best indicators of its condition. Consequently, animals under chronic observation are weighed once a week. The addition of tetracycline (Terramycin) to the drinking water appears to be helpful if an animal develops loose stools. We do not use vermifuges and only occasionally give supplemental doses of vitamins. Antibiotics are not generally used following surgery.

Until one becomes adept at handling squirrel monkeys, a light fishnet is useful for apprehending them in the cage. Leather gloves should be worn at all times to avoid lacerations by their sharp teeth. The squirrel monkey responds well to gentle handling.

The greatest asset in the maintenance of animals is an animal caretaker who is solicitous of their needs and who by his voice, bodily movements, and methods of handling helps dispel fear.

Appendix II

Additional References

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TABLE III

Abbreviation	Title	Extent	Representative plates
<i>I</i>	Tractus olfactorius.....	SS ³	C, E, G
<i>IICh</i>	Chiasma nervorum opticom.....	12.5 to 10.....	12.5, 11.5, 10.5
<i>IIT</i>	Tractus opticus.....	9.5 to 6.....	9, 8, 7, 6
<i>III</i>	Nervus oculomotorius.....	6.5 to 3.5.....	6.5, 6, 5, 4
<i>IV</i>	Nervus trochlearis.....	0.5 to -0.5.....	0.5, -0.5
<i>V</i>	Nervus trigeminus.....	0.5 to -0.5.....	0, -0.5
<i>VRD</i>	Nervus trigeminus—radix descendens.....	SS.....	1, J
<i>VRM</i>	Nervus trigeminus—radix mesencephalica.....	2.5 to -0.5.....	1, 0
<i>VI</i>	Nervus abducens.....	1 to -0.5.....	0.5, 0
<i>VII</i>	Nervus facialis.....	SS.....	B, D, H, J
<i>VIII</i>	Nervus acusticus.....	SS.....	H, I, J
	Nervus abducens (see <i>VI</i>). Nervus acusticus (see <i>VIII</i>).		
<i>Al</i>	Alveus.....	9 to -0.5.....	8, 6, 3, 1
	Commissura anterior (see <i>CoA</i>).		
<i>ArL</i>	Ansa lenticularis.....	10 to 7.....	10, 9.5, 9
<i>Ar</i>	Fibrae arcuatae internae.....	SS.....	F, G
<i>BCI</i>	Brachium colliculi inferioris.....	3 to -0.5.....	2.5, 1.5, 0.5, -0.5
<i>BCS</i>	Brachium colliculi superioris.....	3.5 to 1.....	3, 2
<i>Br</i>	Brachium conjunctivum.....	3.5 to -0.5.....	2, 1, 0, -0.5
<i>CC</i>	Corpus callosum.....	15 to -0.5.....	15, 12, 9, 3
<i>CE</i>	Capsula externa.....	15 to 7.5.....	15, 13, 11.5, 8.5
<i>CEx</i>	Capsula extrema.....	15 to 7.5.....	14, 12.5, 10, 8
<i>CI</i>	Capsula interna.....	15 to -0.5.....	15, 12, 9, 6
<i>Cin</i>	Cingulum.....	15 to -0.5.....	15, 10, 5, 0
	Brachium colliculi inferioris (see <i>BCI</i>). Brachium colliculi superioris (see <i>BCS</i>).		
<i>CoA</i>	Commissura anterior.....	12.5 to 10.....	12.5, 12, 11.5, 11
<i>CoCI</i>	Commissura colliculi inferioris.....	SS.....	A, B, C
<i>CoCS</i>	Commissura colliculi superioris.....	2.5 to 0.....	2, 1
<i>CoF</i>	Commissura fornix (dorsal psalterium).....	1 to -0.5.....	0.5, 0, -0.5
<i>CoP</i>	Commissura posterior.....	3.5 to 3.....	3.5, 3
<i>CoS</i>	Commissura supramammillaris.....	7 to 6.5.....	7
<i>CS</i>	Commissura supraoptica dorsalis—pars dorsalis (Ganser).....	10.....	10
<i>CSD</i>	Commissura supraoptica dorsalis—pars ventralis (Meynert).....	10 to 9.5.....	9.5
	Brachium conjunctivum (see <i>Br</i>).		
<i>CSp</i>	Tractus cortico-spinalis.....	5 to -0.5.....	2, 1, 0, -0.5
<i>DBC</i>	Decussatio brachii conjunctivi.....	4 to 1.5.....	3, 2.5, 1.5
<i>DPy</i>	Decussatio pyramidalis.....	SS.....	A, B, C
	Capsula externa (see <i>CE</i>). Capsula extrema (see <i>CEx</i>). Nervus facialis (see <i>VII</i>). Commissura fornix (see <i>CoF</i>).		
<i>F</i>	Fornix.....	12.5 to -0.5.....	12, 9, 6, 3
<i>H1</i>	Area tegmentalis—pars dorsalis.....	9 to 6.....	8.5, 8, 7
<i>H2</i>	Area tegmentalis—pars ventralis.....	9 to 6.....	8.5, 8, 7
<i>III</i>	Fasciculus habenulo-interpeduncularis.....	6 to 4.....	6, 5, 4
	Capsula interna (see <i>CI</i>).		
<i>La</i>	Lamina medullaris incompleta (pallidi).....	10 to 8.....	10
<i>LaL</i>	Lamina medullaris lateralis (pallidi).....	12.5 to 6.....	12.5, 11.5, 10, 8
<i>LaLI</i>	Lamina medullaris lateralis thalami.....	10 to 0.....	9, 7.5, 3.5
<i>LaM</i>	Lamina medullaris medialis (pallidi).....	10 to 7.5.....	10, 9, 8
<i>LaMT</i>	Lamina medullaris medialis thalami.....	8.5 to 3.5.....	8.5, 7.5, 6.5, 4.5
<i>LeL</i>	Lemniscus lateralis.....	1.5 to -0.5.....	0.5, 0, -0.5
<i>LeM</i>	Lemniscus medialis.....	6.5 to -0.5.....	3, 1.5, -0.5
<i>LM</i>	Fasciculus longitudinalis medialis.....	7 to -0.5.....	6, 4.5, 3, 0
<i>MaT</i>	Fasciculus mammillo-tegmentalis.....	SS.....	C, D
<i>MT</i>	Fasciculus mammillo-thalamicus.....	9.5 to 7.5.....	9.5, 9, 8.5, 8
	Lemniscus medialis (see <i>LeM</i>). Pedunculus medius cerebelli (see <i>PMC</i>).		

TABLE III—Continued

Abbreviation	Title	Extent	Representative plates
	Lamina medullaris incompleta (pallidi) (see <i>La</i>).		
	Lamina medullaris lateralis (pallidi) (see <i>LaL</i>).		
	Lamina medullaris lateralis thalami (see <i>LaLI</i>).		
	Lamina medullaris medialis (pallidi) (see <i>LaM</i>).		
	Lamina medullaris medialis thalami (see <i>LaMT</i>).		
	Stria medullaris thalami (see <i>StM</i>).		
	Nervus oculomotorius (see <i>III</i>).		
	Stria olfactoria lateralis (see <i>StO</i>).		
	Radiatio olfactoria profunda (see <i>RaO</i>).		
<i>Ol</i>	Fasciculus olfactorius (Zuckerland)*.....	14 to 13.....	14, 13.5, 13
<i>OlF</i>	Fasciculus olfactorius fornix (fornix longus).....	13 to 11.5.....	12.5, 12
<i>OlH</i>	Fasciculus olfactorius hippocampi (diagonal band of Broca)*.....	13 to 11.....	13, 12, 11
	Tractus olfactorius (see <i>I</i>). Chiasma nervorum opticom (see <i>IICh</i>). Tractus opticus (see <i>IIT</i>).		
<i>P</i>	Pes pedunculi.....	8 to 4.....	7.5, 6.5, 5.5, 4.5
<i>PMC</i>	Pedunculus medius cerebelli (brachium pontis).....	6 to -0.5.....	2, 1, 0, -0.5
<i>PVT</i>	Pedunculus ventralis thalami.....	10.5 to 9.....	10.5, 10, 9.5
	Commissura posterior (see <i>CoP</i>). Decussatio pyramidalis (see <i>DPy</i>).		
<i>RaO</i>	Radiatio olfactoria profunda.....	15 to 11.5.....	15, 14, 13, 12
<i>Res</i>	Corpus restiforme (pedunculus inferior cerebelli).....	SS.....	I, J
<i>Sol</i>	Fasciculus solitarius.....	SS.....	E, F
<i>Spl</i>	Tractus spino-thalamicus.....	SS.....	I
<i>SS</i>	Stratum subcallosum (Muratoff).....	15 to -0.5.....	15, 13, 11, 9
<i>SSP</i>	Stratum superficiale pontis.....	6 to 1.5.....	5.5, 5, 4
<i>StM</i>	Stria medullaris thalami.....	11.5 to 3.5.....	10.5, 9.5, 7.5, 5.5
<i>StO</i>	Stria olfactoria lateralis.....	15 to 13.....	15, 14.5, 13.5
<i>StT</i>	Stria terminalis (stria semicircularis)*(10).....	11.5 to 0.....	11.5, 10, 8.5, 5.5
	Stratum subcallosum (see <i>SS</i>). Commissura supramammillaris (see <i>CoS</i>). Commissura supraoptica dorsalis—pars dorsalis (see <i>CS</i>). Commissura supraoptica dorsalis—pars ventralis (see <i>CSD</i>). Area tegmentalis—pars dorsalis (see <i>H1</i>). Area tegmentalis—pars ventralis (see <i>H2</i>). Tractus tegmentalis centralis.....		
<i>TeC</i>	Tractus tegmentalis centralis.....	5 to -0.5.....	4, 3, 2, 0
<i>TeM</i>	Fasciculus telencephalicus medialis (median forebrain bundle).....	12.5 to 7.....	12, 11, 10, 9
	Stria terminalis (see <i>StT</i>). Corpus trapezoides.....		
<i>Trz</i>	Nervus trigeminus (see <i>V</i>). Nervus trigeminus—radix descendens (see <i>VRD</i>). Nervus trigeminus—radix mesencephalica (see <i>VRM</i>). Nervus trochlearis (see <i>IV</i>).	1 to -0.5.....	1, 0.5
<i>Un</i>	Fasciculus uncinatus.....	15 to 7.....	14, 12, 11, 10
	Pedunculus ventralis thalami (see <i>PVT</i>).		

Footnote 3:

SS in tables III and IV refers to the sagittal sections. The structures having this designation have been labeled only in the sagittal series of plates; other structures may be labeled in both frontal and sagittal plates.

TABLE IV

Abbreviation	Title	Extent	Representative plates
IIIN	Nucleus nervi oculomotorii	5 to 2	4.5, 4, 3.5, 3
IVN	Nucleus nervi trochlearis	1.5 to 0.5	1.5, 1, 0.5
VM	Nucleus motorius nervi trigemini	—0.5	—0.5
VS	Sulcus trigeminalis pontis	1.5 to —0.5	0.5, 0, —0.5
VIN	Nucleus nervi abducentis	SS ³	D, E
VIIN	Nucleus nervi facialis	SS	H
A	Nucleus accumbens septi	15 to 12.5	15, 14, 13
AB	Nucleus amygdalae basalis	11.5 to 8.5	11, 10.5, 10, 9
ABA	Nucleus amygdalae basalis accessorius	11.5 to 9	11, 10.5, 10, 9.5
AC	Nucleus amygdalae centralis	11.5 to 9	11, 10.5, 10, 9.5
ACo	Nucleus amygdalae corticalis	12.5 to 8.5	12, 11, 10, 9
AL	Nucleus amygdalae lateralis	12 to 7.5	12, 11, 10
AM	Nucleus amygdalae medialis	11.5 to 7.5	10, 9.5
AmA	Area amygdaliformis anterior	12.5 to 11.5	12.5, 12
AnD	Nucleus antero-dorsalis thalami	9 to 6.5	8, 7.5
AnM	Nucleus antero-medialis thalami	9.5 to 8.5	9.5, 9
AnV	Nucleus antero-ventralis thalami	10 to 6.5	9.5, 9, 8, 7.5
Aq	Anulus aquaeductus	3.5 to —0.5	3.5, 2.5, 1.5, 0.5
B	Nucleus basalis	12.5 to 6.5	12, 11, 10, 9
	Locus caeruleus (see LoC)		
C	Fissura calcarina	SS	E, G, J
Ca	Nucleus caudatus	15 to —0.5	15, 11, 7, 3
Ce	Nucleus centralis (Rolandi)* (10)	6	6
	Substantia centralis grisea (see SubC)		
CeL	Nucleus centralis lateralis* (8)	6 to 3.5	6, 5, 4
Cen	Nucleus centralis superior (Bechterew)	4 to 0.5	2.5, 2, 1.5, 1
Cent	Nucleus centri mediani thalami	6.5 to 4	6, 5.5, 5, 4
Cer	Hemisphaerium cerebelli	—0.5	—0.5
CerL	Fissura cerebri lateralis (Sylvius)	15 to —0.5	13, 10, 8.5, 6.5
Ci	Gyrus cinguli	15 to —0.5	15, 10, 5, 0
Cir	Sulcus circularis insulae (limitans insulae)	13.5	13.5
Cl	Clastrum	15 to 7.5	15, 13.5, 12, 9
ColI	Colliculus inferior	0.5 to —0.5	0, —0.5
ColS	Colliculus superior	2.5 to —0.5	2.5, 1.5, 0.5, —0.5
D	Nucleus Darkschewitsch (commissurae posterioris)*	6 to 4	5.5, 5, 4.5
Den	Gyrus dentatus	SS	L
Dent	Nucleus dentatus cerebelli	SS	I, J
DT	Nucleus dorsalis tegmenti (Gudden)	—0.5	—0.5
EW	Nucleus Edinger-Westphal (parvocellularis nervi oculomotorii)*	6 to 4.5	5.5, 5
FaC	Nucleus fasciculi cuneati (Burdach)	SS	F, G, H
FaG	Nucleus fasciculi gracilis (Goll)	SS	B, D, E
Fas	Nucleus fastigii cerebelli	SS	B, C, D
GL	Corpus geniculatum laterale	5.5 to 2	5, 4, 3, 2
GM	Corpus geniculatum mediale	4 to 2	3.5, 3, 2.5
GP	Globus pallidus	12.5 to 6	12.5, 10, 8, 6.5
H	Area tegmentalis (Forel)	7 to 6	6.5
Ha	Nucleus habenularis	SS	B, C, D
HaL	Nucleus habenularis—pars lateralis	4.5 to 3	4, 3.5, 3
HaM	Nucleus habenularis—pars medialis	4.5 to 3	4, 3.5, 3
Hip	Hippocampus (cornu ammonis)	8.5 to —0.5	8, 2, —0.5
HyA	Area hypothalamica anterior	12 to 10	12, 11.5, 11
HyD	Area hypothalamica dorsalis	10 to 7.5	9.5, 9, 8
HyL	Area hypothalamica lateralis	11 to 7.5	10, 9, 8
HyP	Area hypothalamica posterior	8 to 7.5	7.5
HyV	Nucleus hypothalamicus ventromedialis	10 to 8.5	9.5, 9
	Zona incerta (see ZI)		
I	Insula	13.5 to 7.5	13, 12, 11, 10
In	Nucleus interpeduncularis	6 to 3.5	5.5, 5, 4.5, 4
Inp	Nucleus interpositus (cerebelli)	SS	H
Inf	Nucleus interstitialis (Cajal)	6 to 4.5	6, 5.5, 5, 4.5

TABLE IV—Continued

Abbreviation	Title	Extent	Representative plates
Is	Islands of Calleja	14 to 11	13.5
LaD	Nucleus lateralis dorsalis (disseminati dorsales thalami)* (8)	7 to 4	6.5, 6, 5.5, 5
LaP	Nucleus lateralis posterior thalami	6 to 3	6, 5.5, 5, 4.5
LaV	Nucleus lateralis ventralis thalami	9.5 to 6.5	8.5, 8, 7, 6.5
Le	Nucleus lemnisci lateralis (dorsalis lemnisci lateralis)* (10)	1 to —0.5	1, 0.5, 0, —0.5
LoC	Locus caeruleus	—0.5	—0.5
M	Corpus mammillare	7.5 to 7	7.5, 7
MD	Nucleus medialis dorsalis thalami	8.5 to 3.5	8, 7, 6, 4
	Substantia nigra (see SubN)		
OcT	Fissura occipito-temporalis	5 to —0.5	4.5, 3.5, 2.5, 0.5
Olf	Area olfactoria (tuberculum olfactorium)	14.5 to 13	14, 13.5, 13
OII	Nucleus olivaris inferior	SS	E, F, G
OIS	Nucleus olivaris superior accessorius	0 to —0.5	0, —0.5
Pac	Nucleus paracentralis* (8)	9.5 to 6	9, 8, 7
Paf	Nuclei parafasciculares thalami	7 to 4	6.5, 5.5, 4.5
Pat	Nuclei parataeniales thalami	9 to 5	9, 7.5, 5.5
Pav	Nucleus paraventricularis hypothalami	11.5 to 9.5	11, 10.5, 10
PavT	Nucleus paraventricularis thalami* (10)	11 to 5	11, 10.5, 10
Per	Nucleus peripeduncularis dorsalis	5.5 to 3	5, 4, 3
Pin	Corpus pineale	2.5 to 2	2.5, 2
Po	Nucleus pontis	5.5 to 1	5, 4, 3, 2
Pr	Nucleus praegeniculatus	5.5 to 5	5.5, 5
Pro	Area praeoptica	12.5 to 12	12.5, 12
Prt	Area praetectalis	3.5 to 3	3.5, 3
PuI	Nucleus pulvinaris inferior thalami	3.5 to 2	3, 2.5, 2
PuL	Nucleus pulvinaris lateralis thalami	3.5 to 0	3, 2, 1
PuM	Nucleus pulvinaris medialis thalami	3.5 to 0	3, 2, 1
PuO	Nucleus pulvinaris oralis thalami* (8)	4.5 to 3	4, 3.5, 3
Put	Putamen	15 to 4	15, 12, 9, 6
R	Gyrus rectus	15 to 14.5	15
Re	Formatio reticularis	4.5 to —0.5	3, 2, 1, 0
ReP	Nucleus reticularis tegmenti pontis (pterygoideus)	3.5 to 0.5	3, 2, 1
Ret	Nucleus reticularis thalami	11 to 0	11, 9, 6, 3
Rub	Nucleus ruber tegmenti	6 to 3.5	5.5, 5, 4.5, 4
SL	Area septalis—pars lateralis*	15 to 12	14, 13, 12
SM	Area septalis—pars medialis*	15 to 12	14, 13, 12.5
SO	Nucleus striae olfactoriae lateralis	13 to 12	12.5
ST	Nucleus striae terminalis*	12.5 to 11	12, 11.5, 11
SubC	Substantia centralis grisea	SS	A, B
SubN	Substantia nigra	7.5 to 3	7.5, 6, 5, 4
Subt	Corpus subthalamicum	8 to 6.5	7.5, 7, 6.5
Sug	Nucleus suprageniculatus	3.5 to 3	3.5, 3
Suo	Nucleus supraopticus hypothalami	12 to 10	12, 11
Sut	Nucleus supratrochlearis substantiae griseae	0.5 to 0	0
	Area tegmentalis (see H)		
T	Fissura temporalis superior	11.5 to —0.5	11, 9.5, 4.5, 0.5
Tri	Area triangularis (Wernicke)	5.5 to 4	5, 4.5
	Sulcus trigeminalis pontis (see VS)		
Tu	Pars tuberalis hypothalami	9.5 to 7.5	9.5, 9, 8
U	Gyrus uncinatus	10 to 7.5	9.5, 9, 8
VA	Nucleus ventralis anterior thalami	10.5 to 9	10.5, 10, 9.5
VPL	Nucleus ventralis postero-lateralis thalami	8.5 to 4	7, 6, 5, 4.5
VPM	Nucleus ventralis postero-medialis thalami	7.5 to 5	6.5, 6, 5.5, 5
ZI	Zona incerta	9.5 to 6	8, 7.5, 7, 6.5

Footnote 3:

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