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The Dolphin Brain - A Digital Presentation

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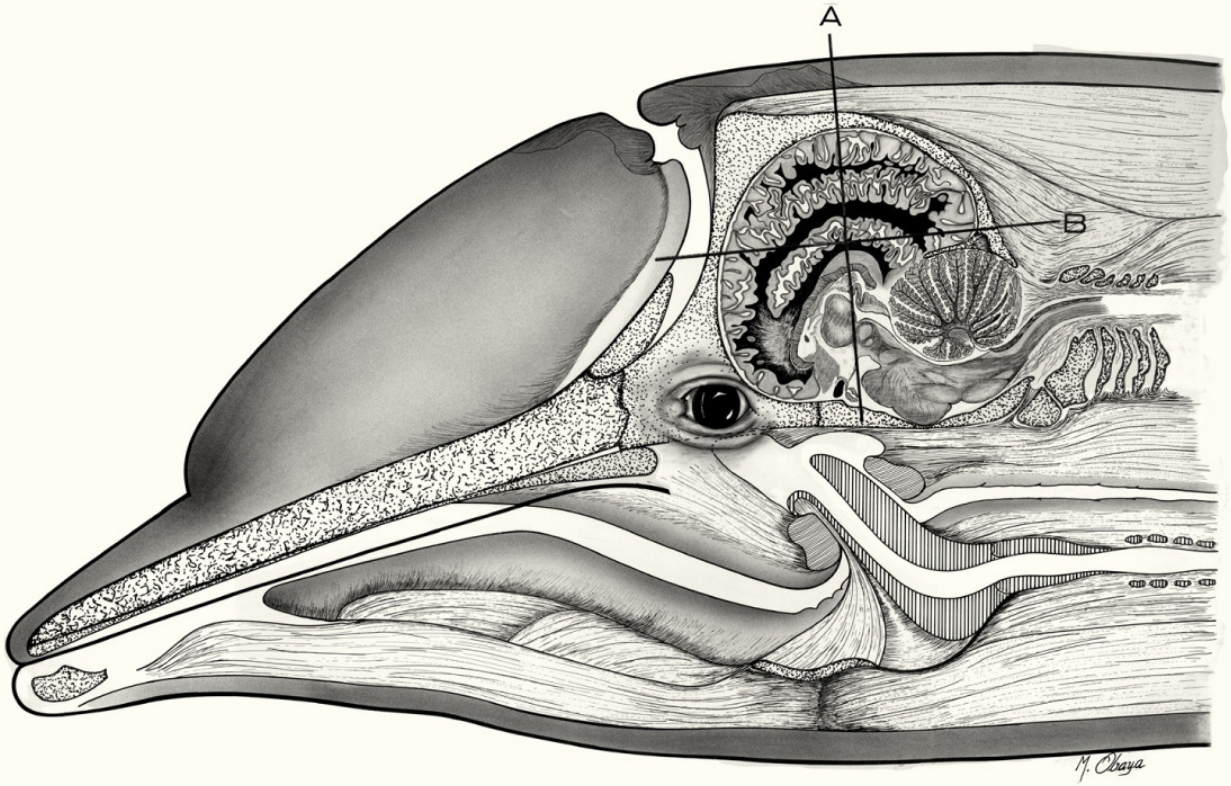
The Dolphin Brain

The Peter J. Morgane Research Collection on the Cetacean Brain, 1962-2004



The Dolphin Brain

The Peter J. Morgane Research Collection on the Cetacean Brain, 1962-2004

INTRODUCTION

In the early 1960's, Dr. Peter J. Morgane began studying the cetacean brain, striving to understand its anatomy and function. He and his colleagues conducted various experiments from neuroanatomic dissections to angiograms and brain imaging, as well as sectioning of the brains and analyzing the different cortical layers via photomicrographs. Dr. Morgane and his colleagues studied the cetacean brain from 1962 until about 2004. Throughout his career, Morgane published his cetacean work in over forty scientific papers.

Project scientists and artists synthesized images of the dolphin brain and body structures into sets of diagrammatic, publishable images for distribution. Their aim was to complete an Atlas of the Dolphin Brain. Although a complete atlas was not published, Dr. Morgane and his peers published many groundbreaking scientific papers on the various aspects and functions of the Cetacean brain.

Morgane worked at the University of New England from 1985-2010, working with over a dozen cetacean species, comparing their brains to other various mammals. He focused both on the structure and the function of their brains, uniquely working to combine both neuroscience and marine biology. The archival collection of Dr. Morgane's work has been organized and made accessible for research by scientists and students. The purpose of making this collection visible is not only to educate viewers on the cetacean brain but also to show the complex process of ground-breaking discoveries.

The Dolphin Brain

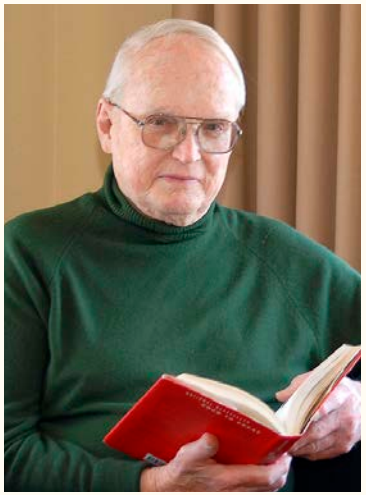
The Peter J. Morgane Research Collection on the Cetacean Brain, 1962-2004

Dr. Peter J. Morgane

Dr. Paul Ivan Yakovlev, assisted by Dr. Morgane and Dr. Myron Jacobs in the sectioning of a dolphin brain at Harvard University Medical School. Yakovlev's papers are now held at the Center for the History of Medicine at Countway Library, Harvard University.

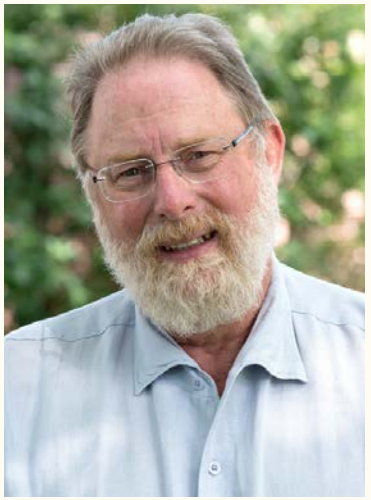
The Dolphin Brain

The Peter J. Morgane Research Collection on the Cetacean Brain, 1962-2004



Peter J. Morgane, Ph.D., was an internationally known neuroscientist and neuropharmacologist. In 1962, Morgane began working with John Lilly at the Communications Research Institute in Miami on cetacean brain anatomy. These studies were carried out in collaboration with famous neuropathologist Paul Yakovlev of the Department of Neuropathology at Harvard Medical School. Morgane studied whale brains from 1962-1998 and published several monographs and over 40 scientific papers forming some of the most definitive works on whale brains ranging from dolphins and porpoises to whales. Morgane later worked at the Worcester Foundation for Experimental Biology, the Boston University School of Medicine, and the University of New England.

Patrick R. Hof, M.D. is the Regenstreif Professor of Neuroscience at the Icahn School of Medicine at Mount Sinai. He leads the Glickenhaus Center for Successful Aging and the Kastor Neurobiology of Aging Laboratories. Hof has pioneered in cetacean research, publishing many scientific papers on whale and dolphin brain anatomy. Hof holds an extensive collection of tissue slides of bottlenose dolphins, humpback whales, and other cetaceans, many from the collection created by Morgane and his colleagues as well as a large collection of mammalian brain species that include specimens from most mammalian orders. Hof was a close collaborator of Dr. Ilya Glezer, who worked with Dr. Morgane on whale and dolphin neuroanatomy. Hof is the editor-in-chief of the Journal of Comparative Neurology.



David J. Mokler, M.D., is Emeritus Professor of Pharmacology at the University of New England's College of Osteopathic Medicine. Mokler began researching with Dr. Morgane in 1995. Their work focused closely on the effects of prenatal malnutrition on the development of the rat brain. They published extensively on the limbic system of the brain. Mokler has published widely on the serotonergic system of the brain. Recently, he has focused on the interactions of dopamine, norepinephrine, and serotonin in the prefrontal cortex on attention in rats. His research has also included contrasting the adolescent prefrontal cortex to the adult prefrontal cortex. Mokler also has faculty appointments at the Boston University School of Medicine and the University of Maine.

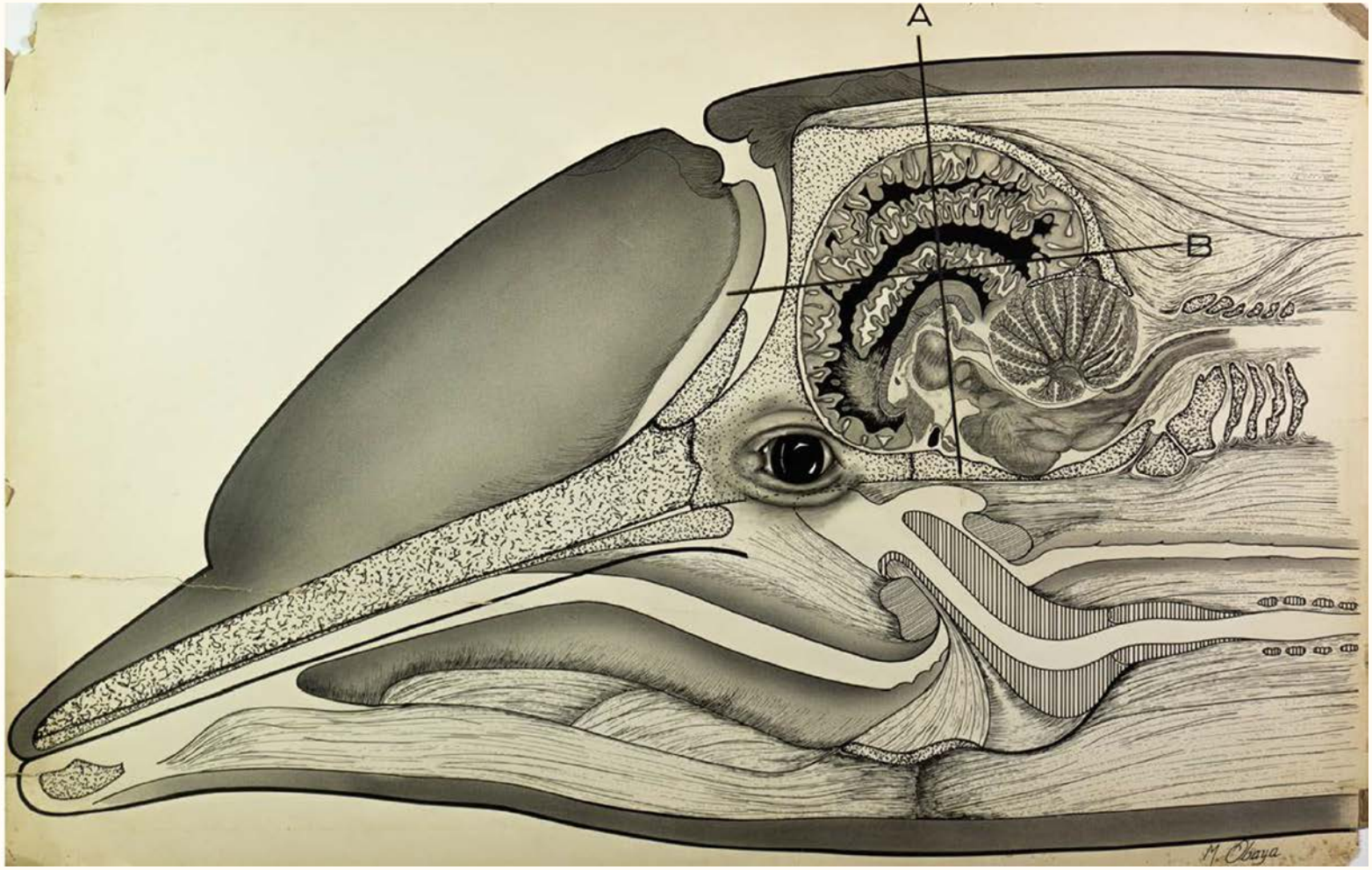
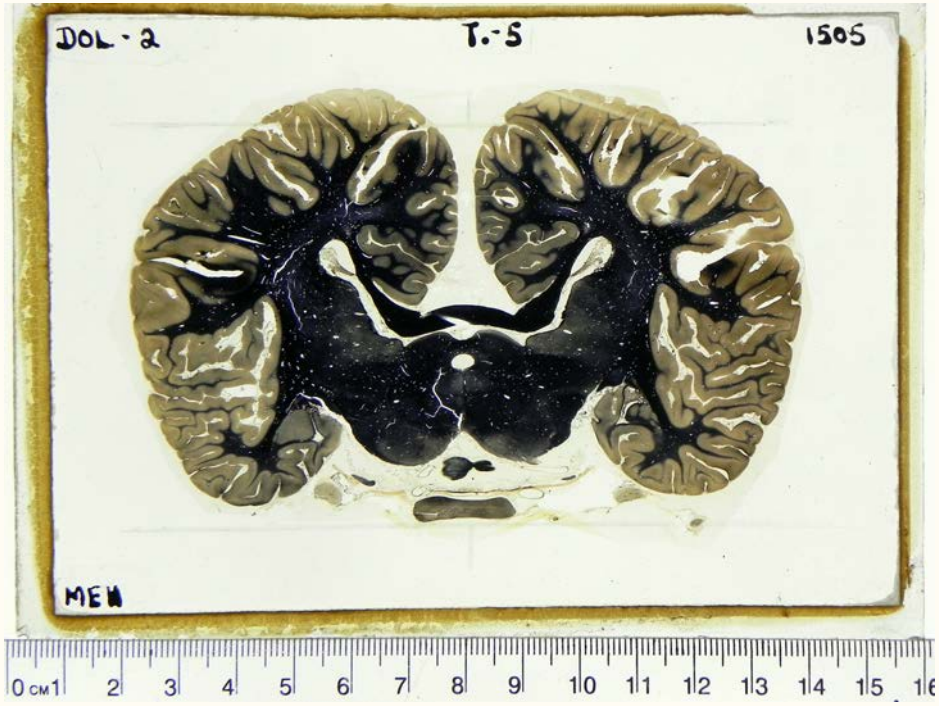


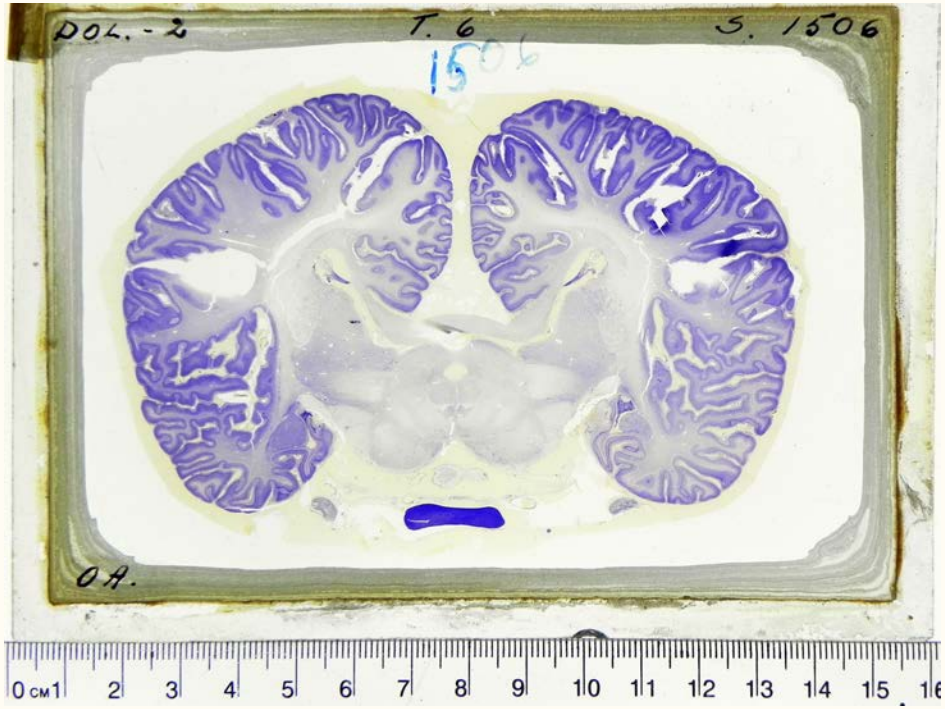
Diagram illustrating position of brain in dolphin

Planes of section for our serial sections are: A, frontal plane or plane at right angles to long axis of the body (beak-fluke axis); B, horizontal plane or plane parallel to long axis (beak-fluke axis) of the body. The third brain in our histological series was cut in the plane of the drawing and is in the sagittal series. The opening and passage anterior to the skull represent the blow-hole and bony nares. the eye has been drawn to show the retro-orbital positional relationship of the brain. From: The anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Surface Configurations of the Telencephalon of the Bottlenose Dolphin with Comparative Anatomical Observations in Four Other Cetacean Species. Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.

Morgane Project "Dolphin 1" Brain Tissue Slides

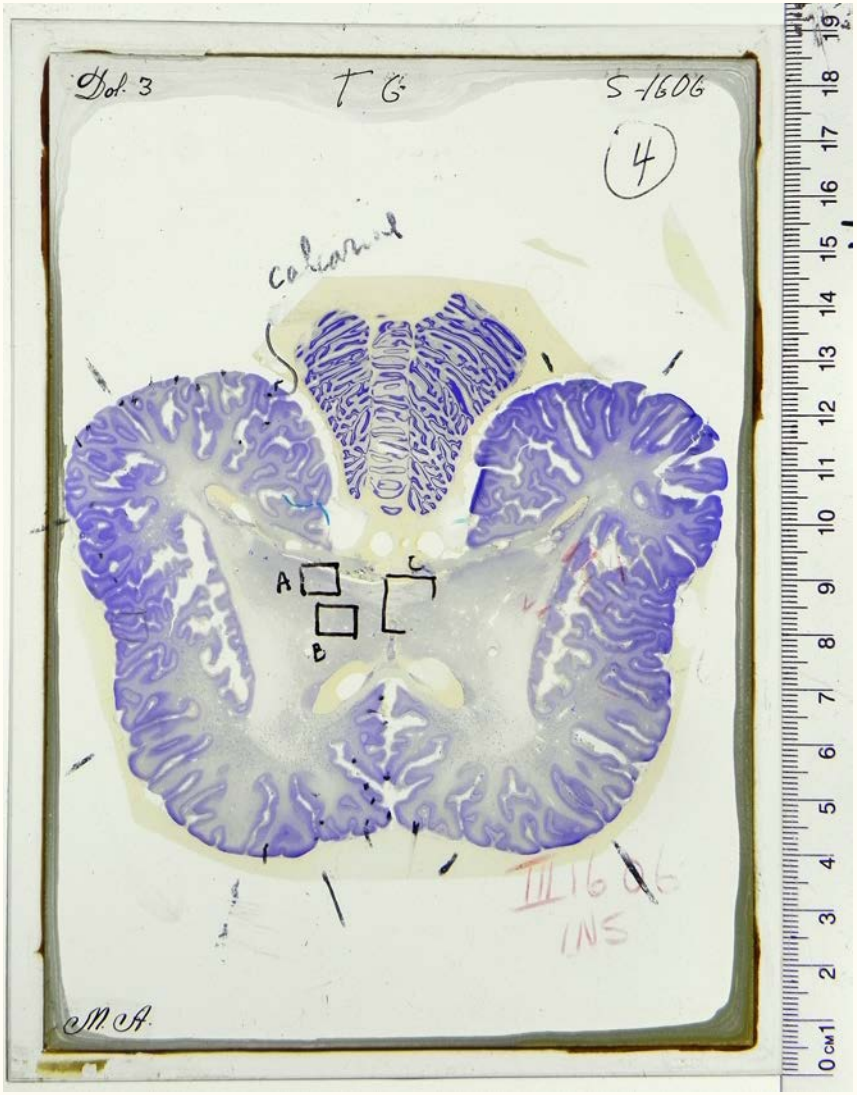
These brain tissue slides are on the sagittal plane with Nissl and Golgi stains from Morgane project taken in 1967 by Dr. Morgane and Dr. Myron Jacobs. These slides along with thousands of others reside in the Nash Family Department of Neuroscience laboratory of Dr. Patrick R. Hof of the Icahn School of Medicine at Mount Sinai. The slides are labeled with the dolphin number, and the sequential measurement of the brain section in millimeters, with "L" or "R" indicating the left or right side of the brain. The initials "OA" are probably initials of the individual laboratory staff staining the tissue and enclosing the tissue within the glass slides.

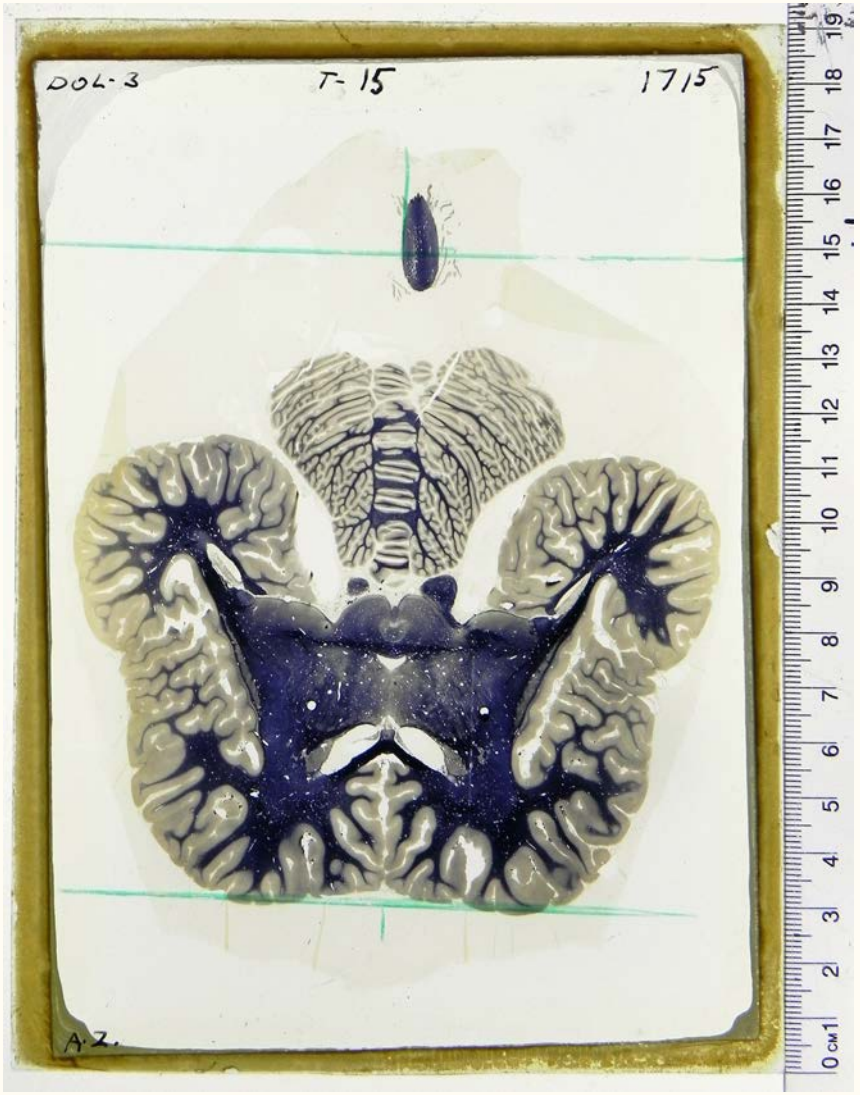




Morgane Project "Dolphin 2" Brain Tissue Slides

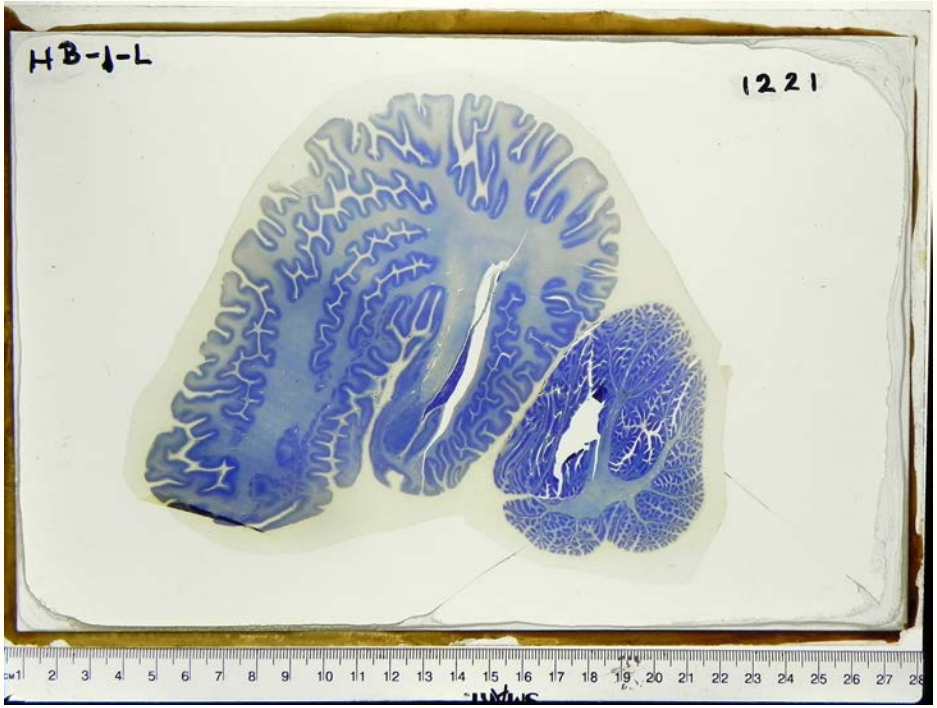
These brain tissue slides are on the coronal plane (from front to back) with Nissl and Golgi stains from Morgane project taken in 1967 by Dr. Morgane and Dr. Myron Jacobs. These slides along with thousands of others reside in the Nash Family Department of Neuroscience laboratory of Dr. Patrick R. Hof of the Icahn School of Medicine at Mount Sinai. The slides are labeled with the dolphin number, and the sequential measurement of the brain section in millimeters. The initials "OA" and "MEH" are probably initials of the individual laboratory staff staining the tissue and enclosing the tissue within the glass slides.

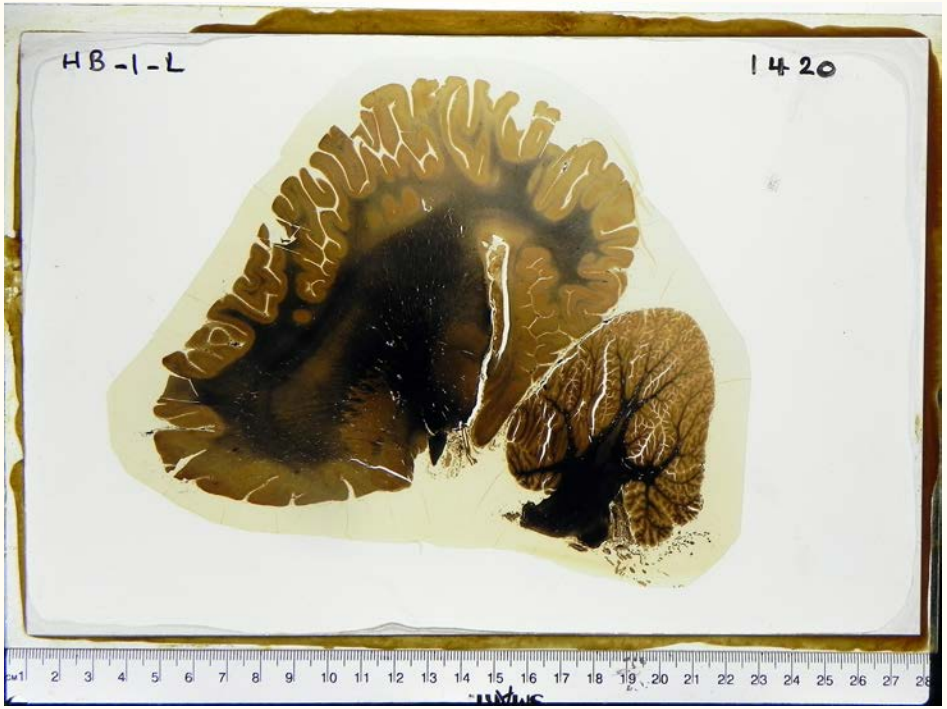




Morgane Project "Dolphin 3" Brain Tissue Slides

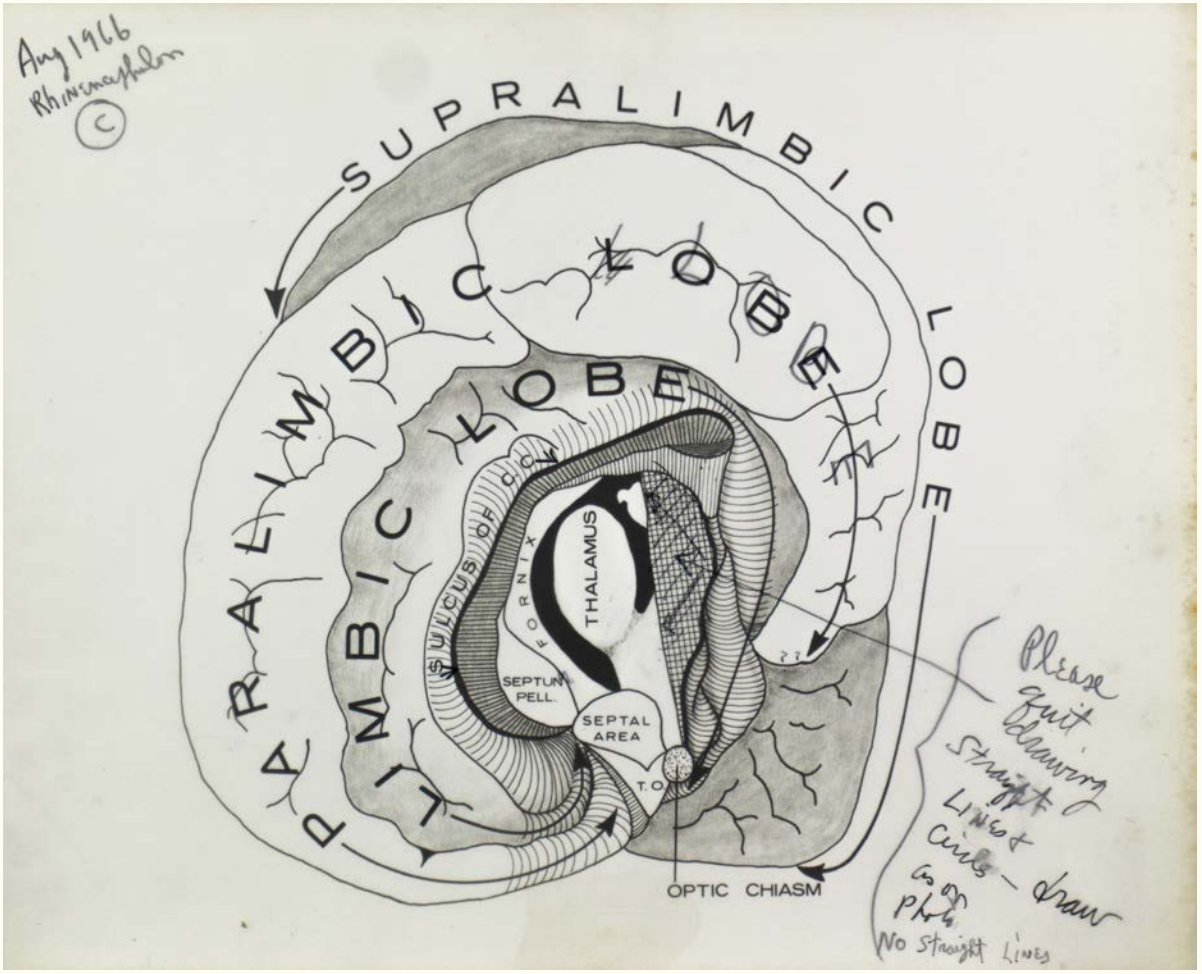
These brain tissue slides are on the horizontal plane (from above) with Nissl and Golgi stains from Morgane project taken in 1967 by Dr. Morgane and Dr. Myron Jacobs. These slides along with thousands of others reside in the Nash Family Department of Neuroscience laboratory of Dr. Patrick R. Hof at the Icahn School of Medicine at Mount Sinai. The slides are labeled with the dolphin number, and the sequential measurement of the brain section in millimeters. The initials "MA" and "AZ" are probably initials of the individual laboratory staff staining the tissue and enclosing the tissue within the glass slides.





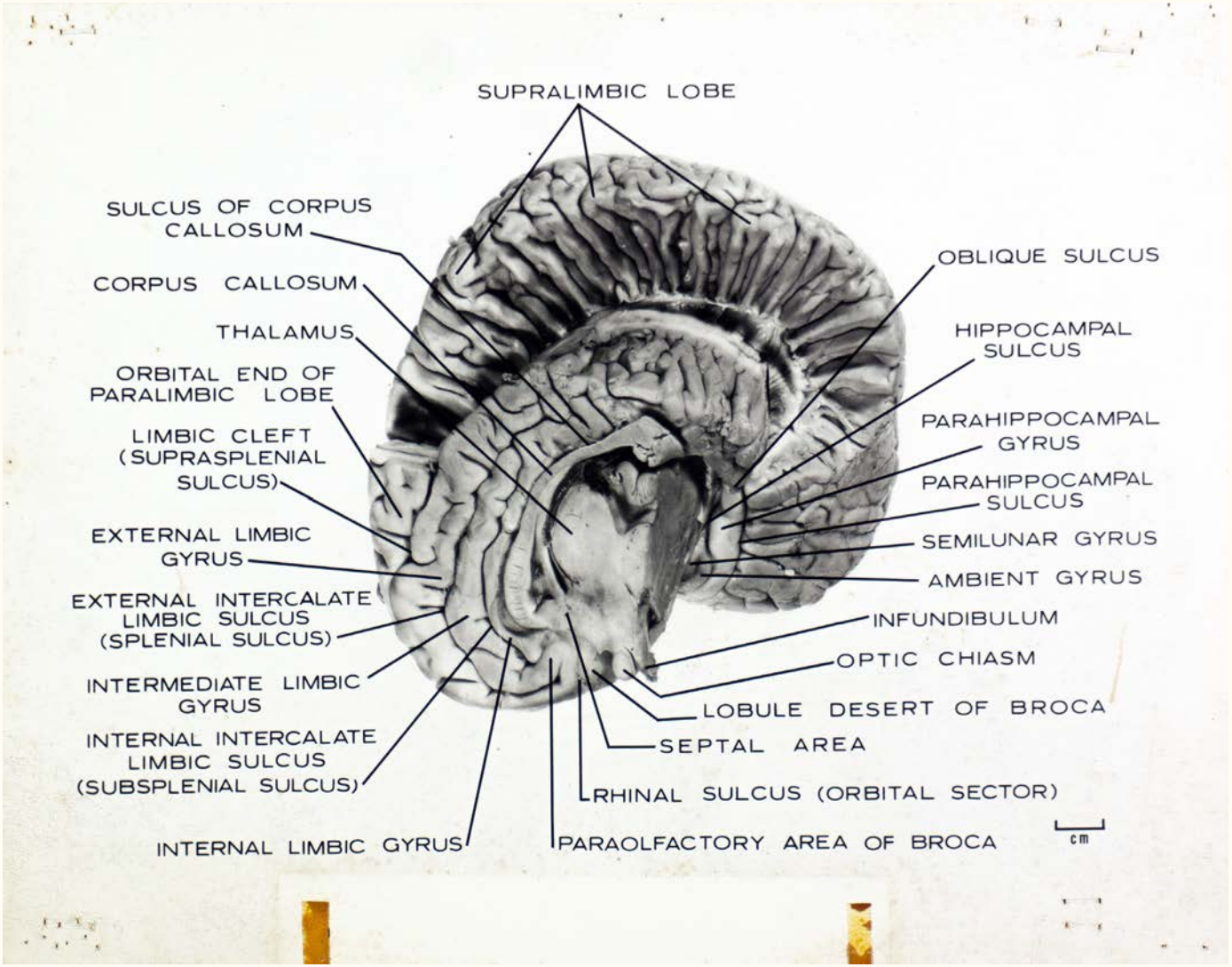
Humpack Whale Brain Tissue Slides

These brain tissue slides are on the sagittal plane with Nissl and Golgi stains, and reside with the thousands of Morgane project dolphin brain slides in the Nash Family Department of Neuroscience laboratory of Dr. Patrick R. Hof at the Icahn School of Medicine at Mount Sinai. The slides are labeled with the dolphin number and the sequential measurement of the brain section in millimeters. Ruler on the bottom measures centimeters.



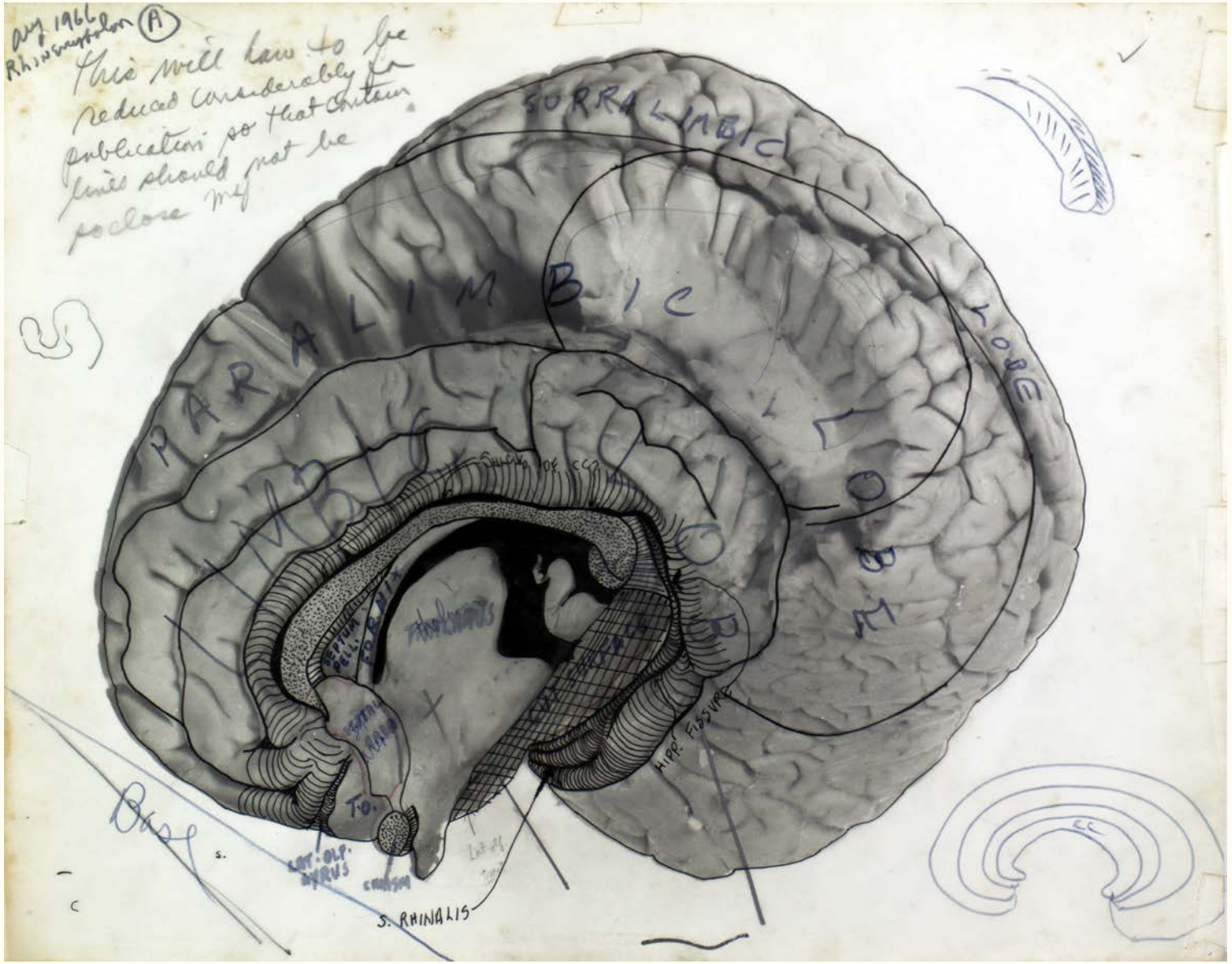
Draft illustration of the Limbic Lobe. Note the straightforward comments, by which scientist we do not know, "Please quit drawing straight lines and circles ~ draw as on photo" and another comment in pencil "no straight lines"

One overarching concept under consideration was 'what is the nature of intelligence' and 'how do parts of the brain work together to drive this complex concept of intelligence.' In order to understand this, all the various structures of the brain were investigated. The scientists generally worked from the physical whole brains or dissections of the brain, working from the closest possible image of a brain segment, gradually transforming it into a graphic object focusing only on the particular structure that was the subject of that experiment. They worked as a team with artists, usually Marcelino Obaya, to accurately reflect the internal topography of the structure, adding the proper names of structures and adding captions connecting the graphic image to the text furnishing the data and conclusions in the published articles. Nothing that was not explicitly proven by project data was included in the illustrations.



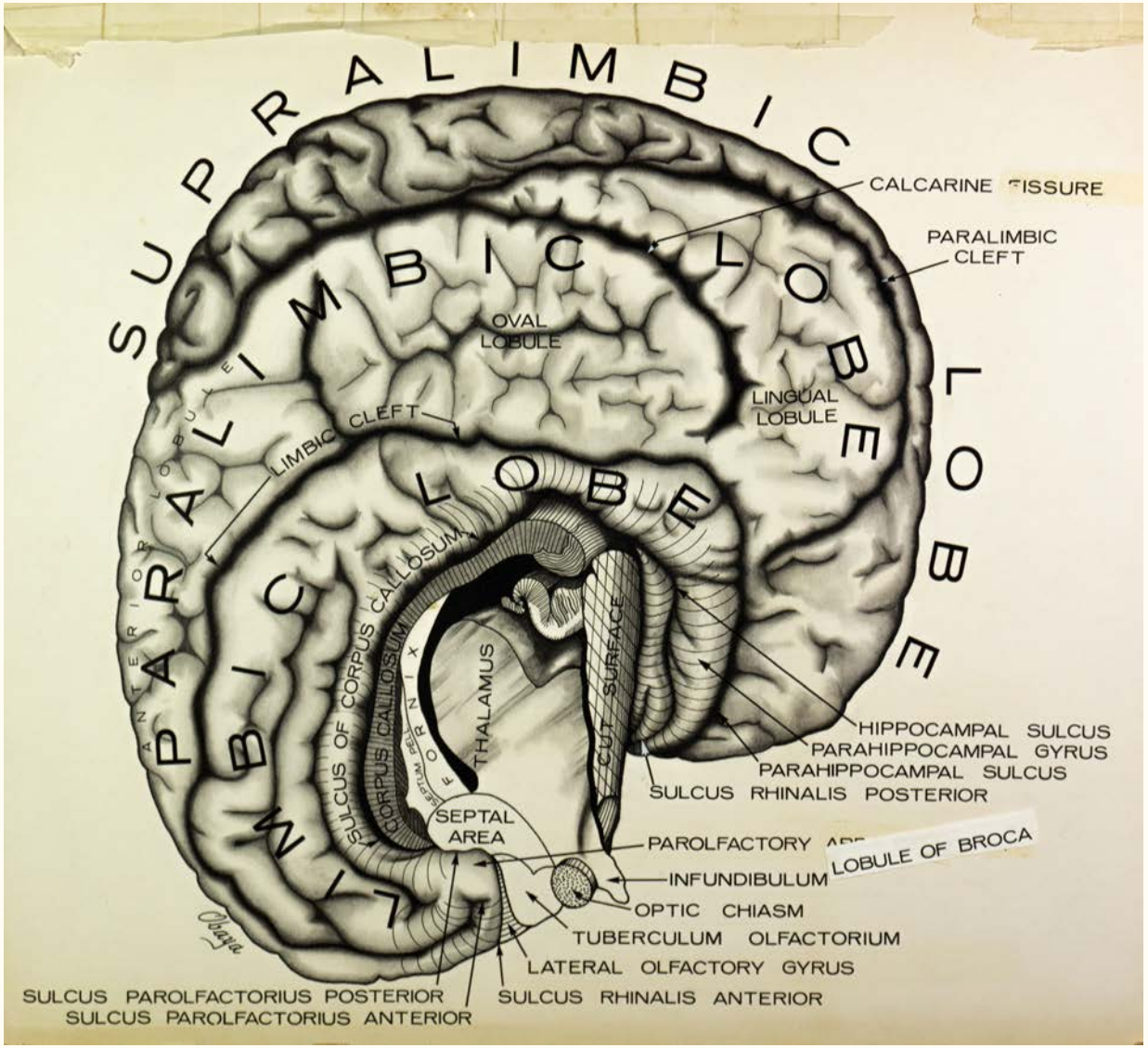
Photograph of dolphin brain in medial view showing the limbic ring extending from the parolfactory lobule (Broca) into the uncal and mid-temporal regions.

In this illustration of the limbic lobe, note that a photographic image of a dissected brain is labeled. At top are marks from thumb tacks and at bottom are marks from transparent tape used to hold the drawings on the board for purposes of comparison.



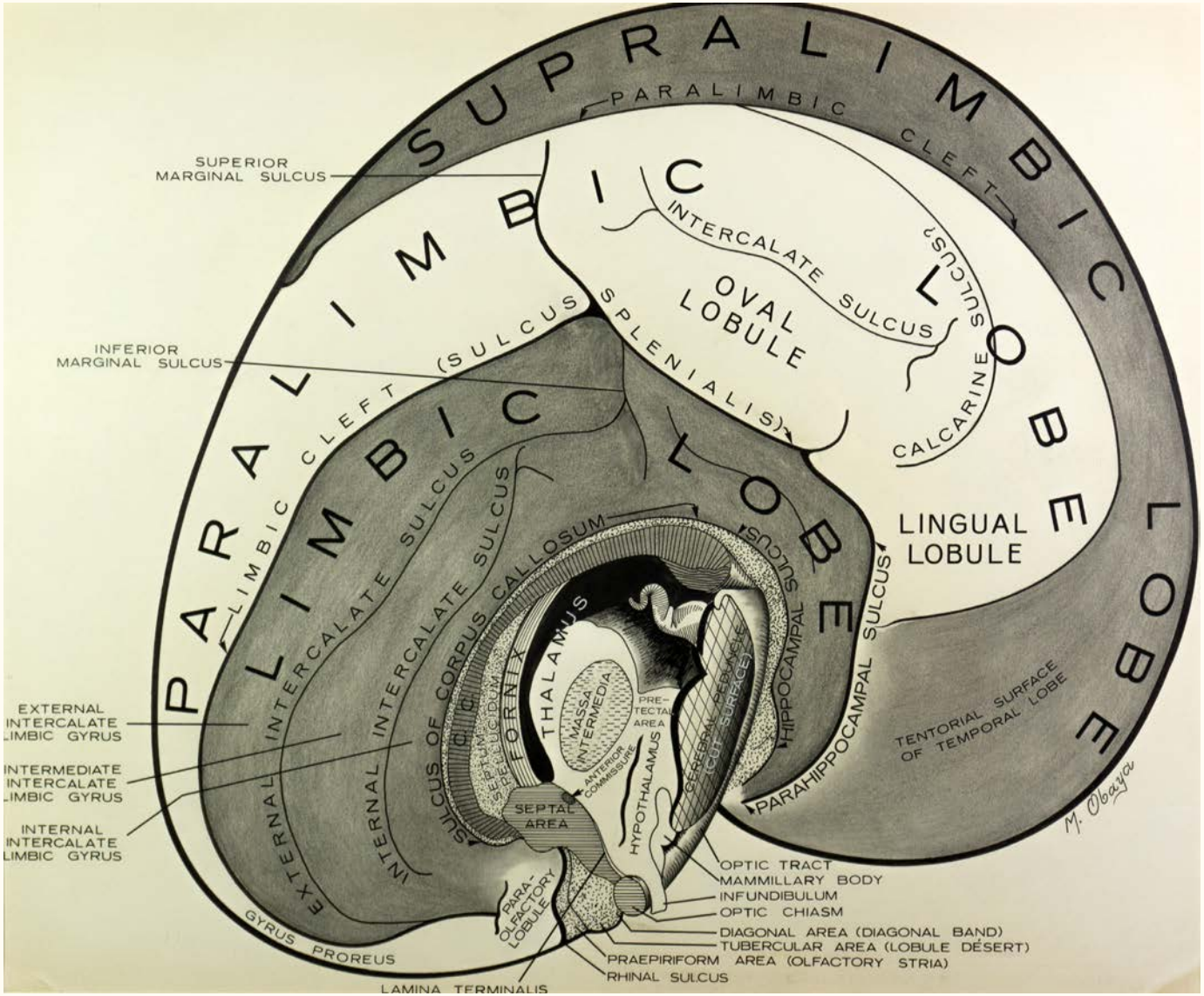
Rough draft of the Paralimbic Lobe of the dolphin brain showing the transformation from the photograph of a dissected brain into the beginning of a graphic representation for the Rhinencephalon paper.

The process of moving from a photograph of the brain to a graphic object representing the brain is apparent.



Interpretive drawing of the medial wall of the right hemisphere in the dolphin (Tursiops truncatus)

Shows the major sulci (clefts), gyri, and lobular formations. Note the merging of photographic and graphical elements.



Interpretive drawing of the medial wall of the right hemisphere in the dolphin (Tursiops truncatus)

This illustration shows the major sulci (clefts), gyri, and lobular formations (Artwork by M. Obaya). From: Comparative Anatomy of the Cetacean Nervous System. Morgane, P.J. and Jacobs, M.S. In: Functional Anatomy of Marine Mammals. Ed. Harrison, R.J. Academic Press, London, 1972, pp 117-124.

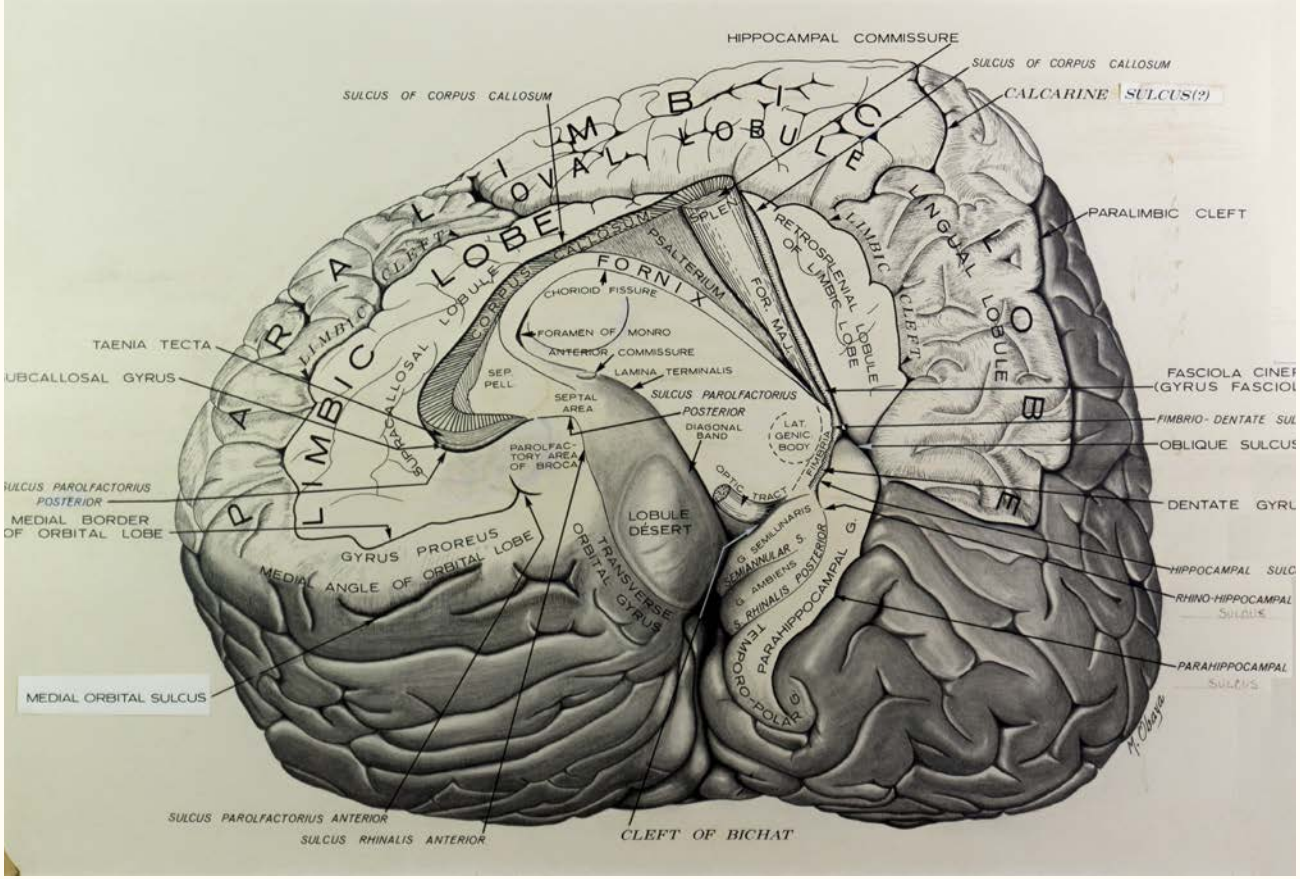
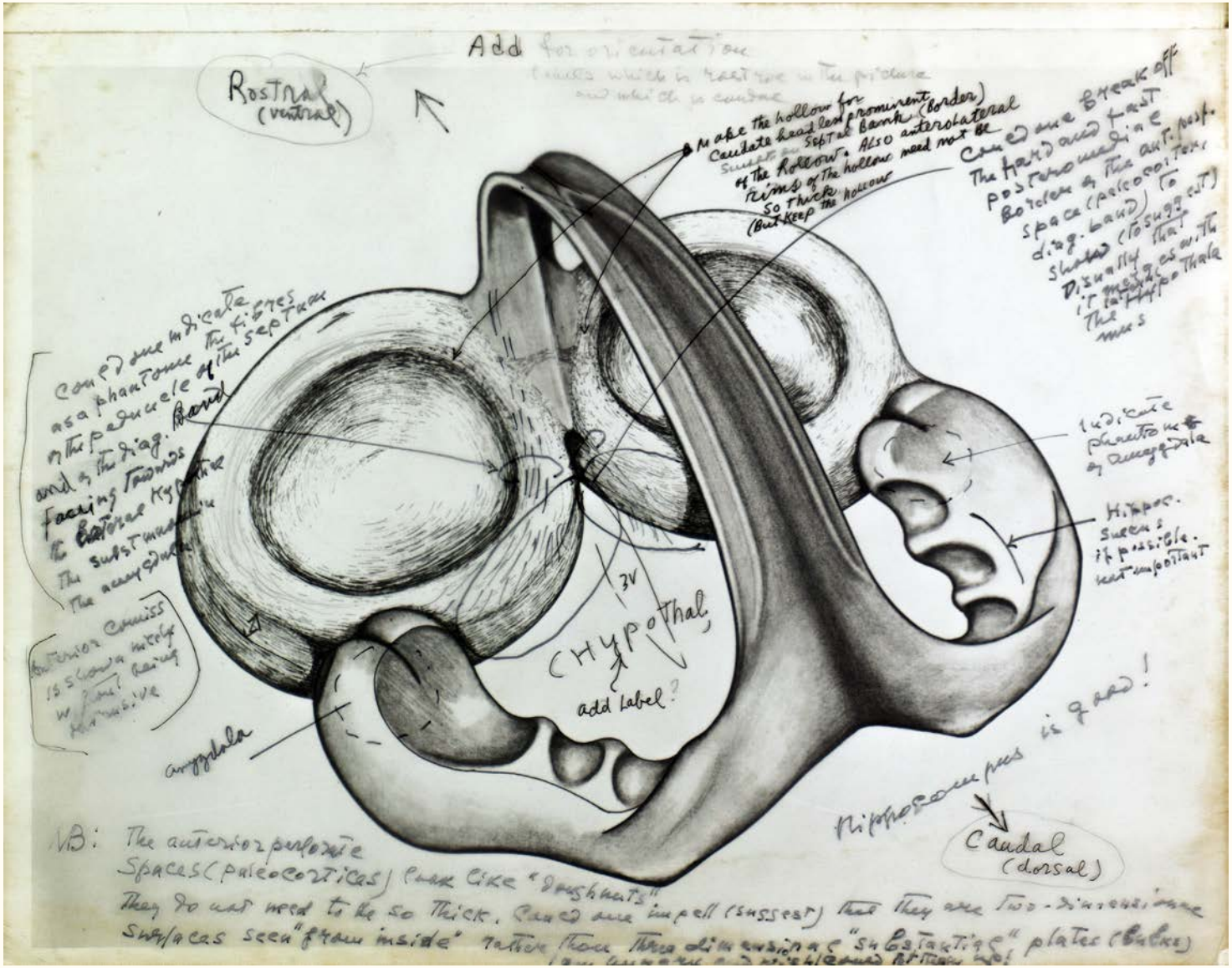


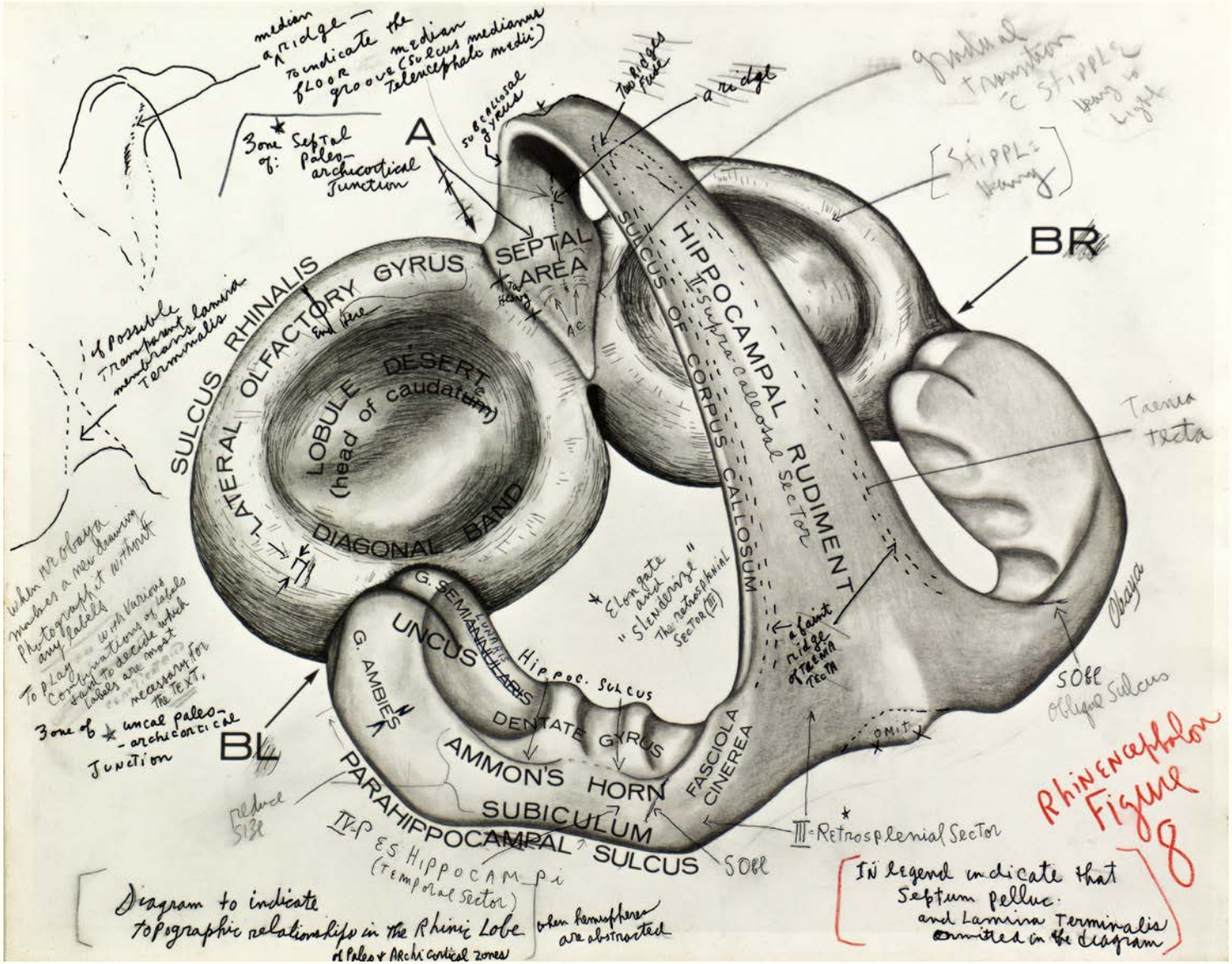
Diagram of the basomedial aspect of the right hemisphere (end brain) of Tursiops Truncatus, mid-sagittal plane of section.

This view illustrates the relations of the archicortical and paleocortical formations to the limbic lobe, paralimbic lobe, basal-temporal part of the supralimbic lobe and the orbital lobe. This schema shows well the surface relations of the retrosplenial and temporal sectors of the limbic lobe to surrounding formations. It is noteworthy that the temporal pole in Tursiops forms a hub of four cardinal grooves arising anteriorly in the region of the septal area and extending posteriorly to the region of the uncus in the temporal lobe: (1) the posterior rhinal and the hippocampal sulci between, respectively, the olfactory lobe and hippocampus and the lumbus of the hemisphere; and (2) the circular and parahippocampal sulci which demarcate the insula and parahippocampal gyrus, respectively, from the operculum and from the basolateral (temporal) wall of the hemisphere. The converging polar ends of these cardinal and constant grooves in the temporal lobe form a characteristic S-shaped gyrus which may be designated as the temporo-polar or sigmoid gyrus of the temporal lobe. From: The limbic lobe of the dolphin brain. A quantitative cytoarchitectonic study. Morgane, P.J., Jacobs, M.S., and McFarland, W.L., Journal fur Hirmforschung 23, 465-552, 1982.



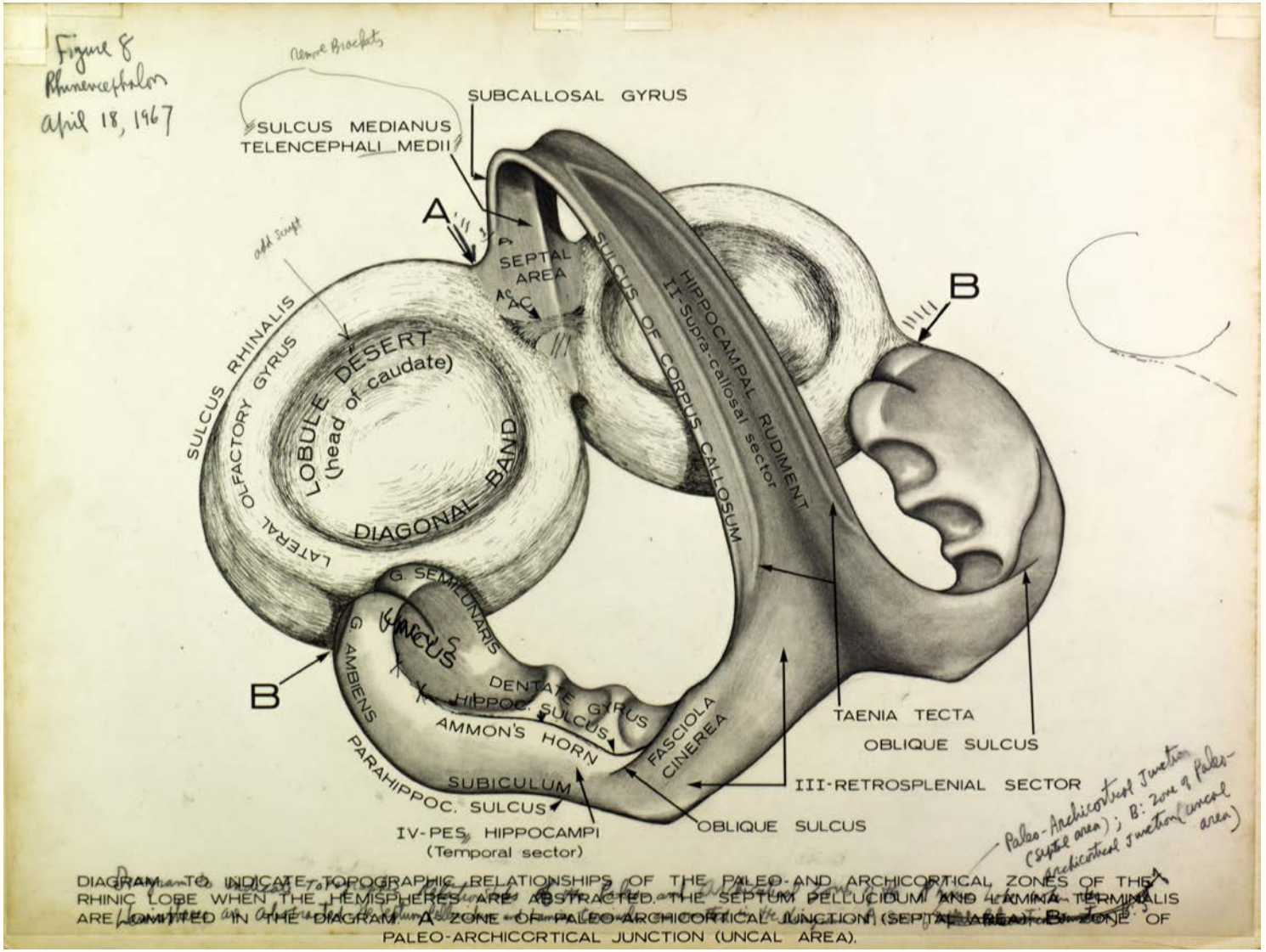
Early draft of schematic representation of the archicortical and paleocortical formations of the brain of the dolphin viewed from above and behind.

Final draft in: The Anatomy of the Brain of the Bottlenose Dolphin (Turisops truncatus). Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.



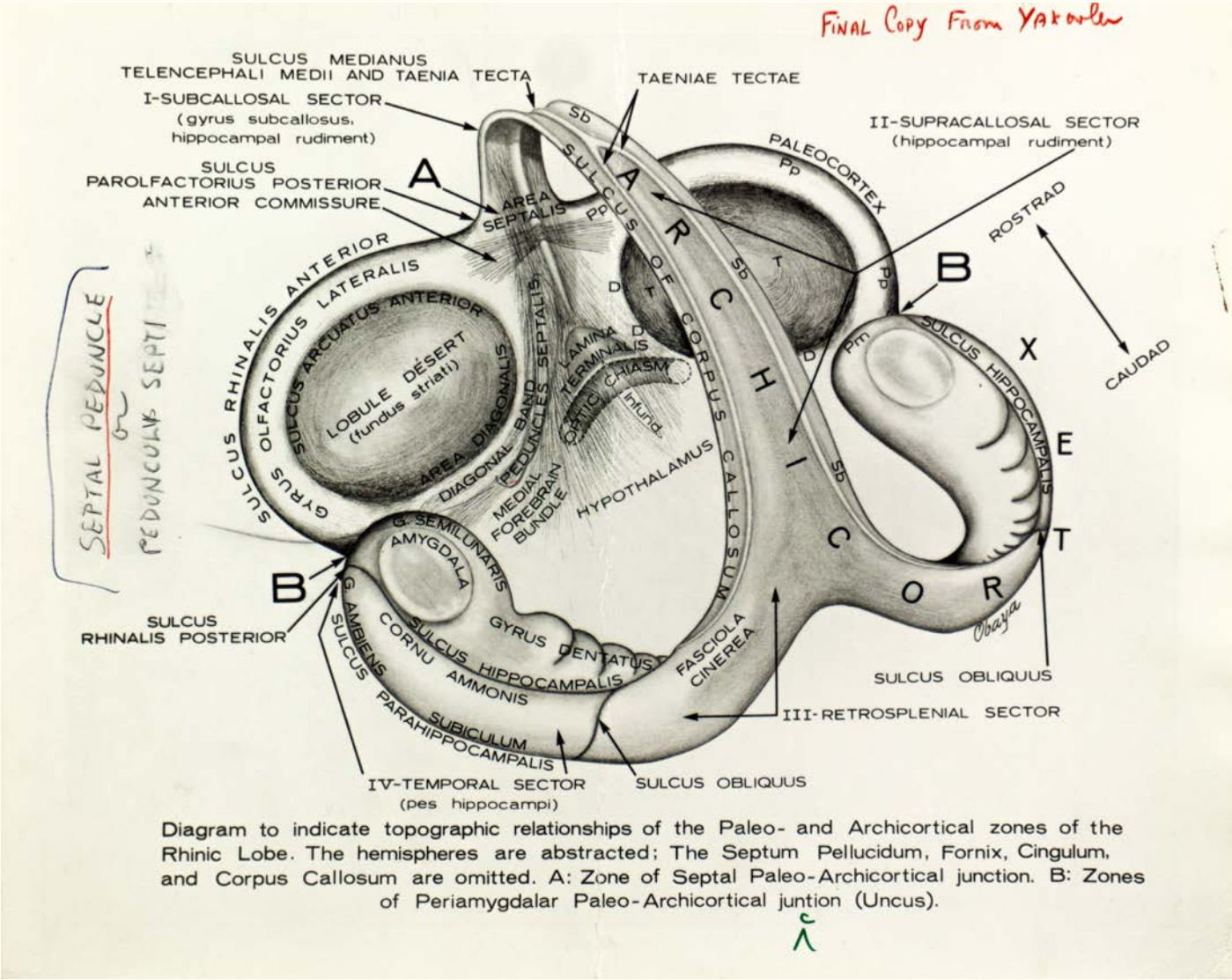
Additional early draft of schematic representation of the archicortical and paleocortical formations of the brain of the dolphin viewed from above and behind.

Final draft in: The Anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.



Third draft of schematic representation of the archicortical and paleocortical formations of the brain of the dolphin viewed from above and behind

Final draft in: The Anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.



Schematic representation of the archicortical and paleocortical formations of the brain of the dolphin. This version by Obaya. Final published version by artist Prudence Carter.

Schematic representation of the archicortical and paleocortical formations of the brain of the dolphin viewed from above and behind. Notation indicates "final copy from Yakovlev". Final draft of figure from: The Anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.

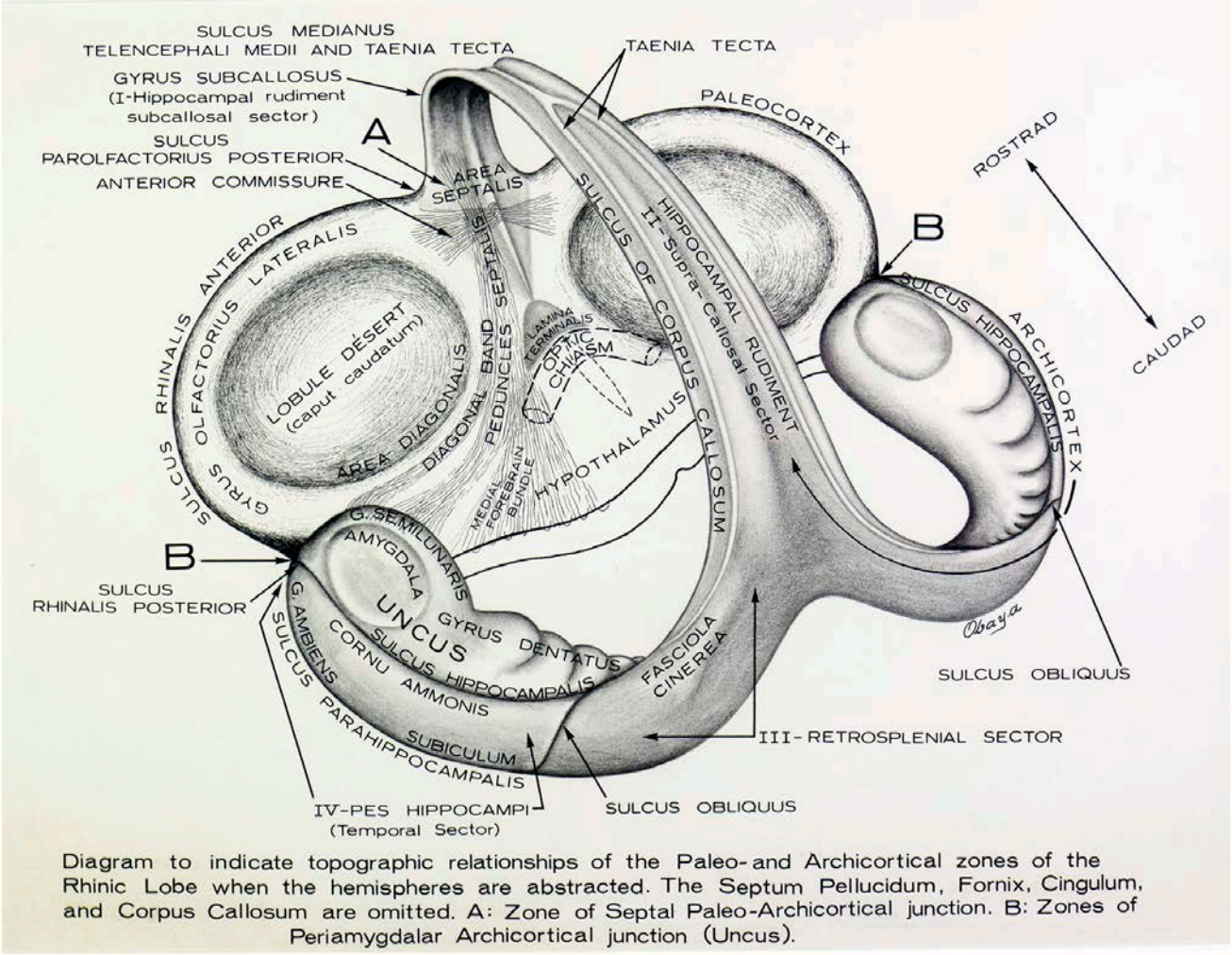
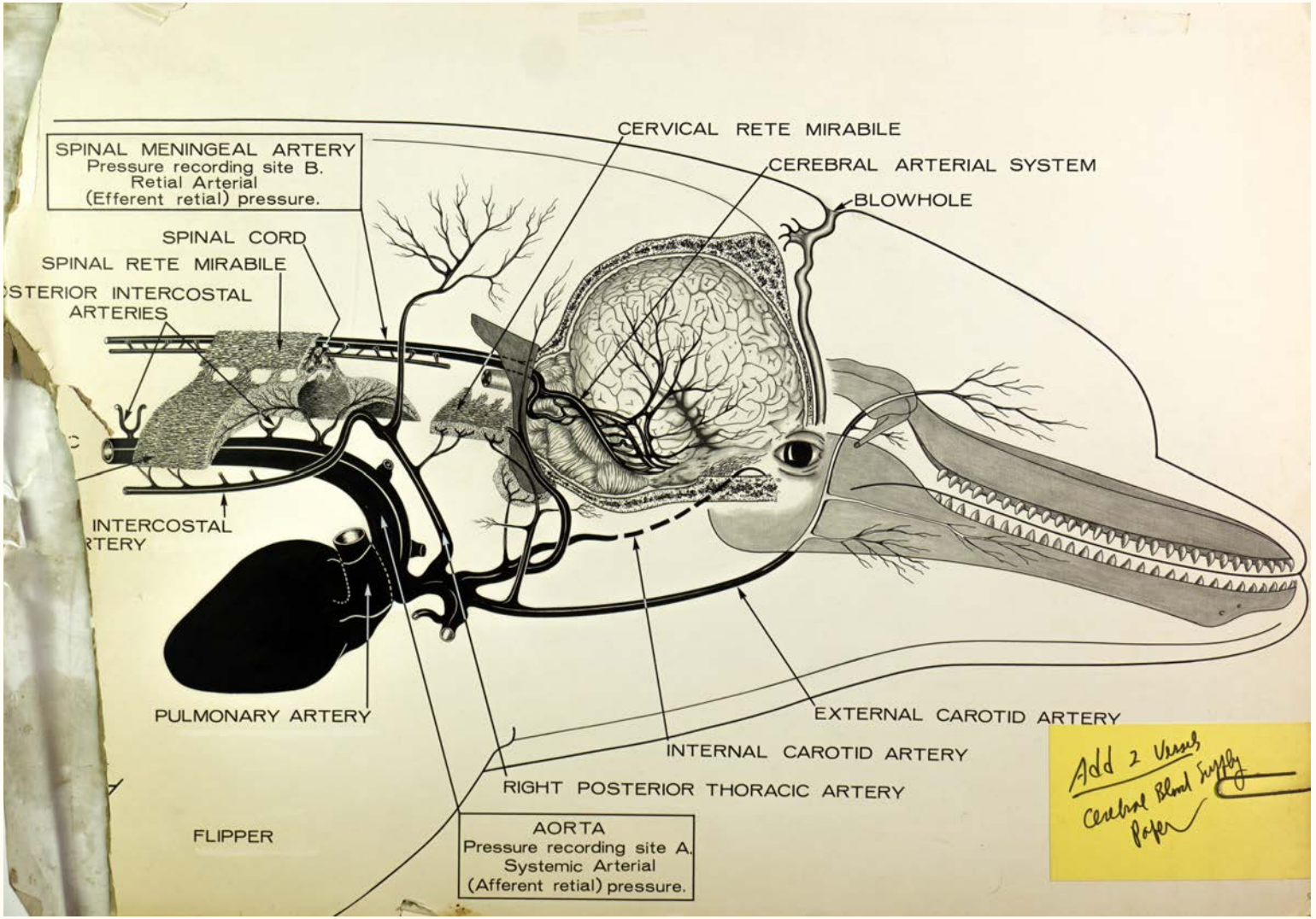


Diagram to indicate topographic relationships of the Paleo- and Archicortical zones of the Rhinic Lobe when the hemispheres are abstracted. The Septum Pellucidum, Fornix, Cingulum, and Corpus Callosum are omitted. A: Zone of Septal Paleo-Archicortical junction. B: Zones of Periamygdalar Archicortical junction (Uncus).

Schematic representation of the archicortical and paleocortical formations of the brain of the dolphin. Published version by Prudence Carter.

Schematic representation of the archicortical and paleocortical formations of the brain of the dolphin viewed from above and behind. From: The Anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.

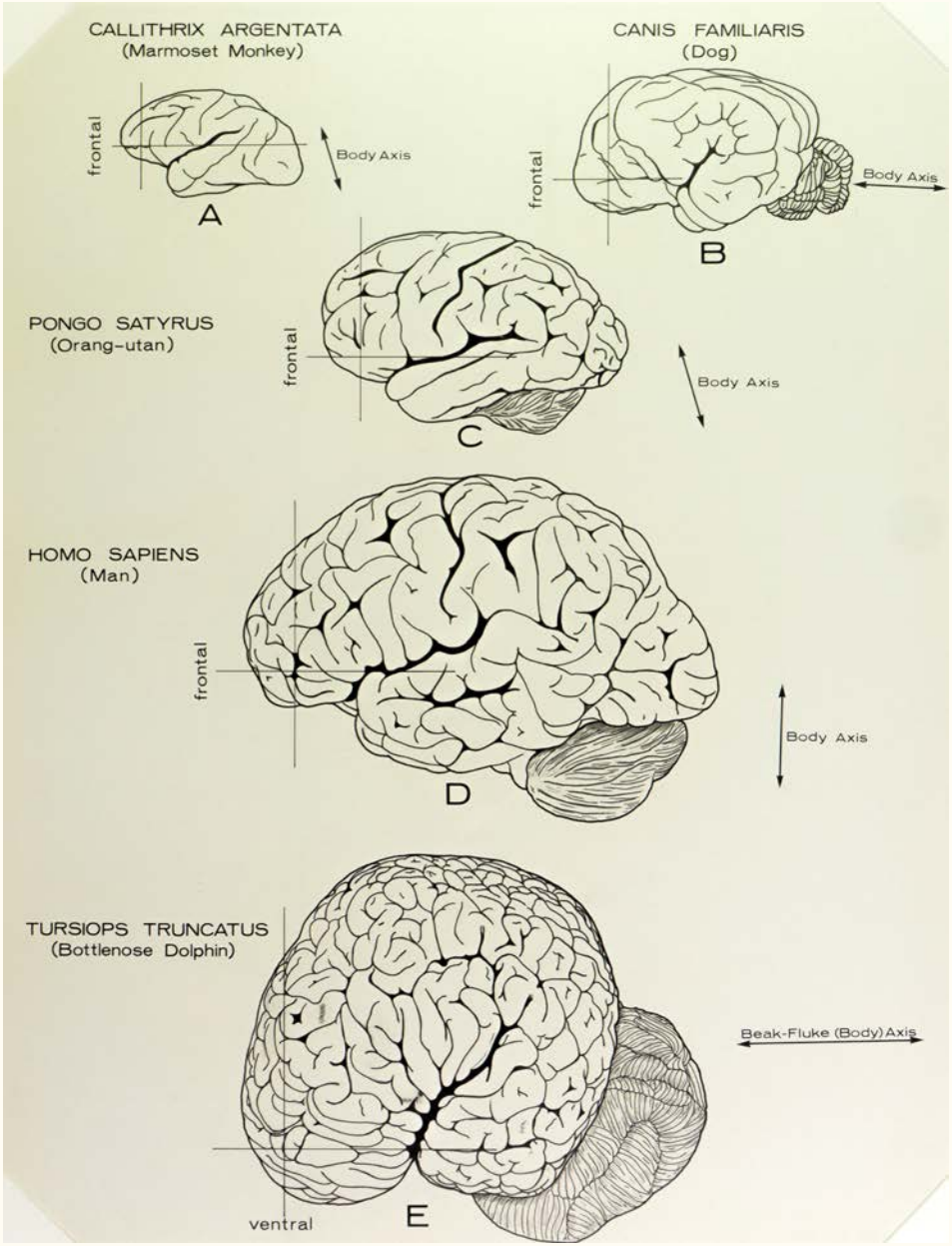


Representation from the right side of part of the thoracico-spinal arterial and cervical arterial system of the dolphin (Tursiops truncatus)

Final illustration found in: Blood Supply to the Brain of the Dolphin (Tursiops truncatus). McFarland, W.L. Jacobs, M.S., and Morgane, P.J. Neuroscience and Biobehavioral Reviews, Vol. 3, Supplement 1.

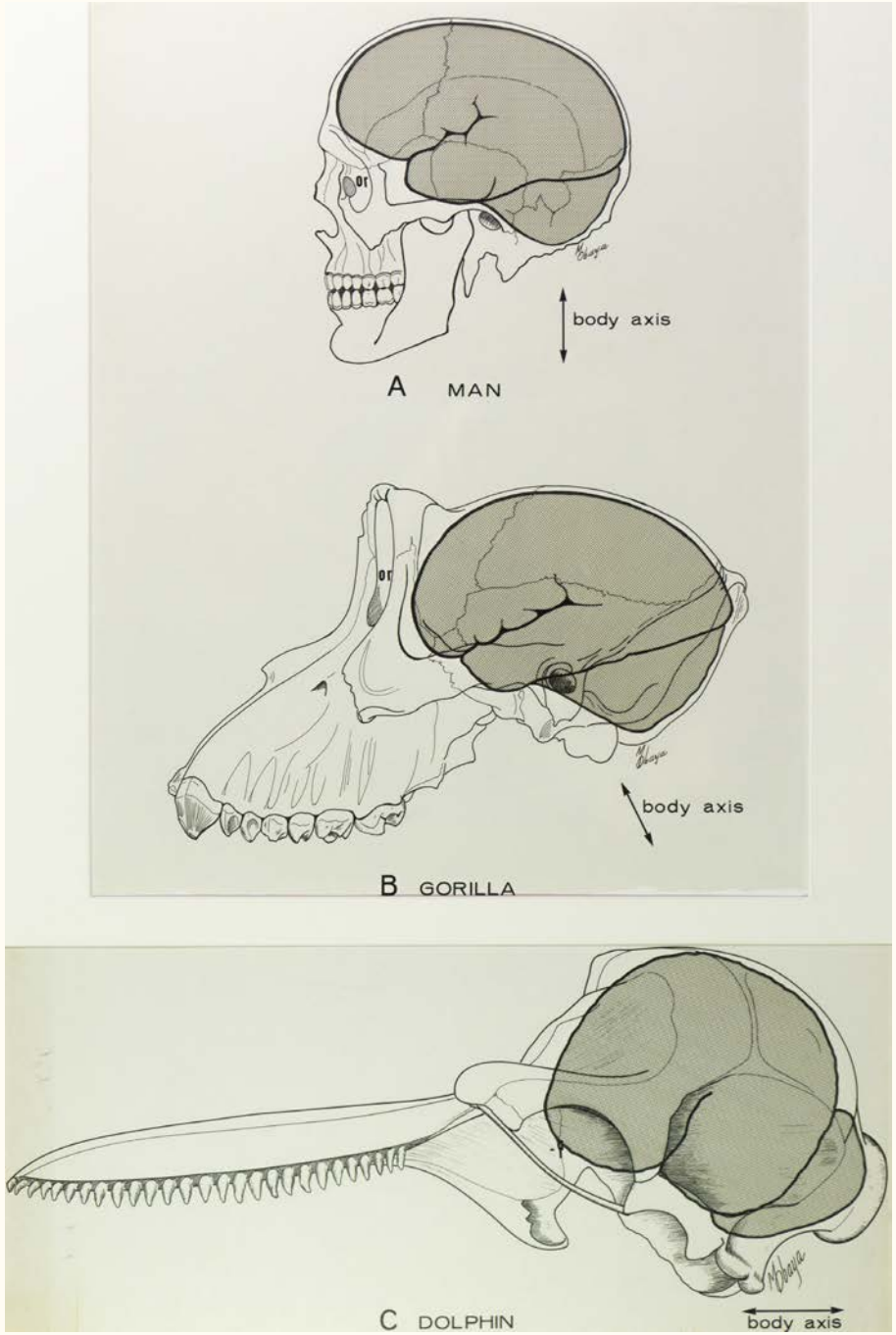
Dorsal view of spinal rete mirabile complex of the dolphin (Tursiops truncatus)

Dorsal view of spinal rete mirabile complex showing dorsal spinal meningeal vessels described in text. Body of animal was digested in acid leaving cast intact. From: Comparative Anatomy of the Cetacean Nervous System. Morgane, P.J., and Jacobs, M.S. In Functional Anatomy of Marine Mammals. Ed. Harrison, R. J. Academic Press, London, 1972, pp 117-244.



Comparative Anatomy of Some Common Mammalian Brains

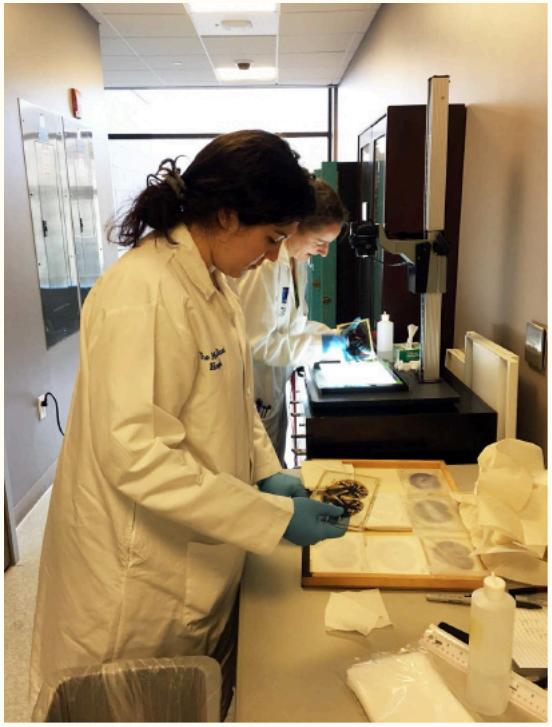
Illustration showing in lateral view the brains of the (A) monkey, (B) dog, (C) orangutan, (D) man, and (E) dolphin, and indicating the position of each with respect to the long axis of the body. Note that in man and dolphin the fronto-occipital axis of the brain is approximately at right angles to the body axis, whereas in the dog this axis is more nearly parallel to the body axis. In the monkey this axis is in an intermediate position. From: The Anatomy of the Brain of the Bottlenose Dolphin (Turisops truncatus). Surface Configurations of the Telencephalon of the Bottlenose Dolphin with Comparative Anatomical Observations in Four Other Cetacean Species. Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.



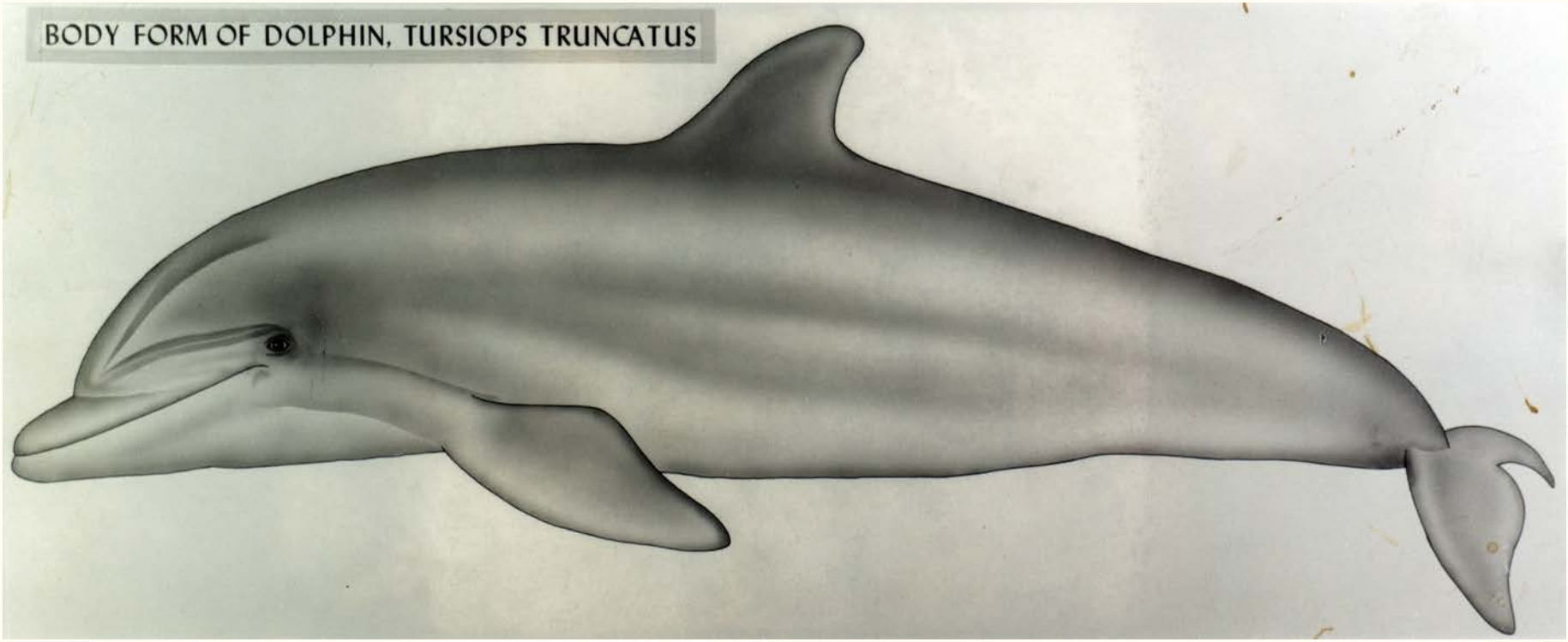
Sketch showing the positions of the brain in the skull of man (A), gorilla (B), and dolphin (C).

Note the position of the frontal (or orbital) lobes in relation to the orbits (or) in man as compared to the gorilla and dolphin. Drawings are not to scale (Artwork by M.Obaya.) From: The Anatomy of the Brain of the Bottlenose Dolphin (Tursiops truncatus). Surface Configurations of the Telencephalon of the Bottlenose Dolphin with Comparative Anatomical Observations in Four Other Cetacean Species. Morgane, P.J., Jacobs, M.S. and McFarland, W.L. Brain Research Bulletin, Vol. 5, Supplement 3, 1980.

The Dolphin Brain



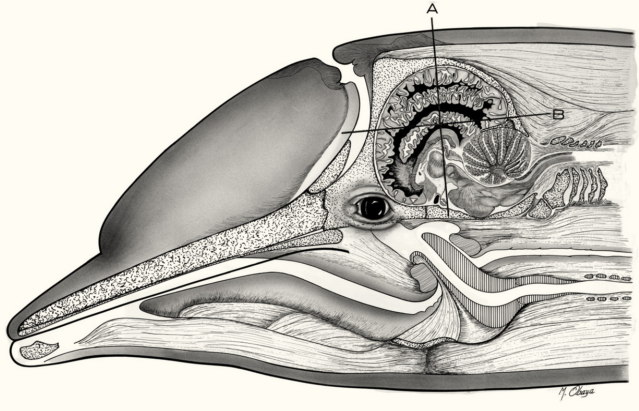
University of New England student Samia Pratt ('20) and Lab Manager Bridget Wicinski in 2019, cataloging and photographing tissue slides from the The Morgane-Hof-Glezer Histological Collection of Cetacean Brains in the Nash Family Department of Neuroscience laboratory of Dr. Patrick R. Hof at the Icahn School of Medicine at Mount Sinai in New York City.



The Dolphin Brain

ACKNOWLEDGMENTS

THE DOLPHIN BRAIN EXHIBITION



In 2010, Dr. Peter J. Morgane bequeathed this professional papers to Dr. David Mokler, Professor Emeritus at the University of New England College of Osteopathic Medicine. In 2017, a set of over 2400 of Dr. Morgane's slides was transferred to Ketchum Library for digitization by a team of student workers. Students also assisted Dr. Mokler in organizing and arranging the papers for analysis. Students and UNE Library Services' Special Collections staff processed selected parts of the records of Morgane's 1960's research on the dolphin brain.

We wish to thank all who contributed to work on this historical scientific research

The estate of Peter J. Morgane
Samia Pratt (UNE '20)
Dr. Patrick J. Hof
Bridget Wicinski
Dr. Kathy Ono
Michael D'Apice
Angela Morse
Andrew Golub

Scanning project students

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