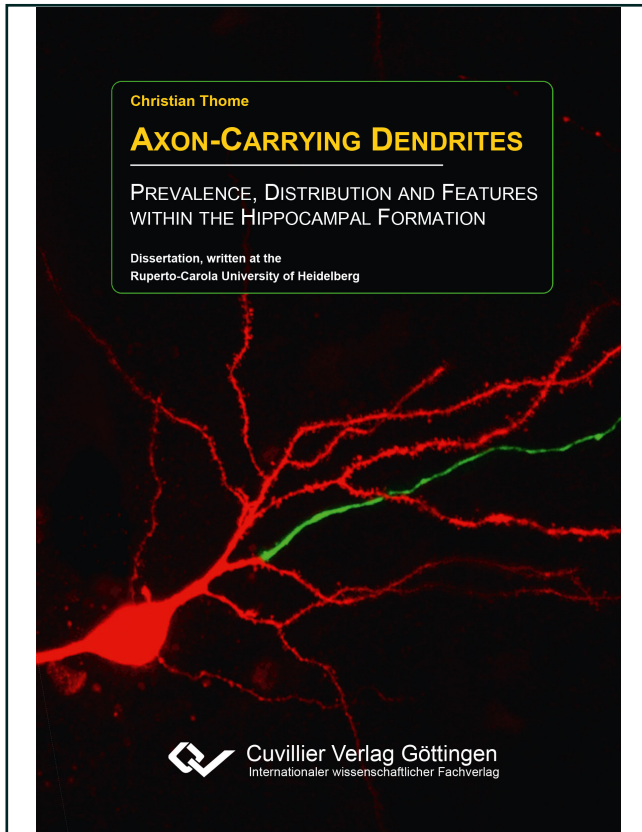




Christian Thome (Autor)  
**Axon-Carrying Dendrites**

*Prevalence, Distribution and Features within the Hippocampal Formation*



<https://cuvillier.de/de/shop/publications/7624>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany  
Telefon: +49 (0)551 54724-0, E-Mail: [info@cuvillier.de](mailto:info@cuvillier.de), Website: <https://cuvillier.de>



# Contents

<b>Abstract - Zusammenfassung</b>	<b>XI</b>
<b>1 Introduction</b>	<b>1</b>
1.1 The Hippocampal Formation . . . . .	1
1.1.1 Proposed Functions . . . . .	1
1.1.2 Anatomical Architecture . . . . .	3
1.1.3 Laminar Organization of CA1 . . . . .	5
1.2 Neuronal Signal Processing . . . . .	7
1.2.1 Dendritic Input Integration . . . . .	7
1.2.2 Somatic Summation and Recurrent Inhibition . . . . .	9
1.2.3 Axonal Output Generation . . . . .	10
1.3 Specific Properties of CA1 Pyramidal Cells . . . . .	12
<b>Aims of the Study</b>	<b>17</b>
<b>Contribution of Others</b>	<b>19</b>
<b>2 Materials and Methods</b>	<b>21</b>
2.1 Stainings and Imaging . . . . .	21
2.1.1 Chemicals and Solutions . . . . .	21
2.1.2 Animals and Slice Preparations . . . . .	21
2.1.3 Immunohistochemistry . . . . .	23
2.1.4 Confocal Laser Scanning Microscopy . . . . .	23
2.1.5 Multiphoton Fluorescence Imaging . . . . .	24
2.2 Electrophysiology . . . . .	26
2.2.1 Animals and Slice Preparations . . . . .	26
2.2.2 Patch Clamp Recordings . . . . .	26
2.2.3 Multiphoton Uncaging . . . . .	28
2.3 Computer Simulations . . . . .	31
2.3.1 Passive Model Parameters . . . . .	31
2.3.2 Active Model Parameters . . . . .	32
2.4 Analysis and Statistics . . . . .	33
2.4.1 Morphological Measurements . . . . .	33
2.4.2 Electrophysiological Data Analysis . . . . .	34
2.4.3 Statistical Analysis . . . . .	34



<b>3</b>	<b>Results</b>	<b>37</b>
3.1	Characterization of Axonal Roots in CA1 Pyramidal Neurons . . . .	37
3.1.1	Dendritic Origin of Axons . . . . .	38
3.1.2	Reliable Detection of AcD Anatomy by Several Markers . . . .	39
3.1.3	Breed and Species Specificity . . . . .	39
3.1.4	Proximal Morphology of the AcD-AIS Arbor . . . . .	41
3.1.5	AIS Location within the Axonal Branch . . . . .	42
3.1.6	Length of AIS at Distal Positions . . . . .	43
3.1.7	Multiple AcD Side Branches . . . . .	45
3.1.8	Axon Origin at Apical Dendrites . . . . .	46
3.1.9	Initial Segment Proteins in Dendritic Structures . . . . .	47
3.2	Prevalence of AcD Morphology within the Hippocampus . . . . .	50
3.2.1	AcD Cells in CA3 and Subiculum . . . . .	51
3.2.2	Distribution in CA1 Sub-Regions . . . . .	52
3.2.3	Age Dependent Incidences . . . . .	53
3.3	Electrophysiological Characteristics: AcD vs nonAcD Cells . . . . .	55
3.3.1	Passive Membrane Properties . . . . .	55
3.3.2	Neuronal Excitability . . . . .	57
3.3.3	Action Potential Properties . . . . .	58
3.3.4	Firing Behavior . . . . .	60
3.4	Dendritic Excitability: AcD vs nonAcD Branches . . . . .	62
3.4.1	Unitary EPSPs and Linear Integration . . . . .	62
3.4.2	Dendritic Spikes . . . . .	64
3.5	Output Generation: AcD vs nonAcD Sources . . . . .	68
3.5.1	Action Potential Properties . . . . .	68
3.5.2	Impact of Dendritic Spikes . . . . .	72
3.6	Biophysical Processes and Computational Consequences . . . . .	75
3.6.1	Influence of Axon Origin on Dendritic Excitability . . . . .	75
3.6.2	Threshold of AcD Driven Action Potentials . . . . .	76
3.6.3	Input Efficiency: AcD vs nonAcD Branches . . . . .	78
3.6.4	Complex AcD Morphologies . . . . .	80
<b>4</b>	<b>Discussion</b>	<b>83</b>
4.1	Previous Reports on Dendritic Axon Origins . . . . .	83
4.2	AcD Cells as Neuronal Subpopulation . . . . .	84
4.3	Genesis of AcD Cells within the Hippocampus . . . . .	86
4.4	Excitability of AcD Branches . . . . .	87
4.5	Propensity of Dendritic Spikes . . . . .	89
4.6	Electrotonic Isolation of the AcD-AIS Circuit . . . . .	89
4.7	Impact of Perisomatic Inhibition . . . . .	91
4.8	Incorporation of AcD Branches into Hippocampal Circuits . . . . .	92
4.9	Gaps and Future Directions . . . . .	93
	<b>Acknowledgements - Danksagung</b>	<b>97</b>
	<b>References</b>	<b>103</b>