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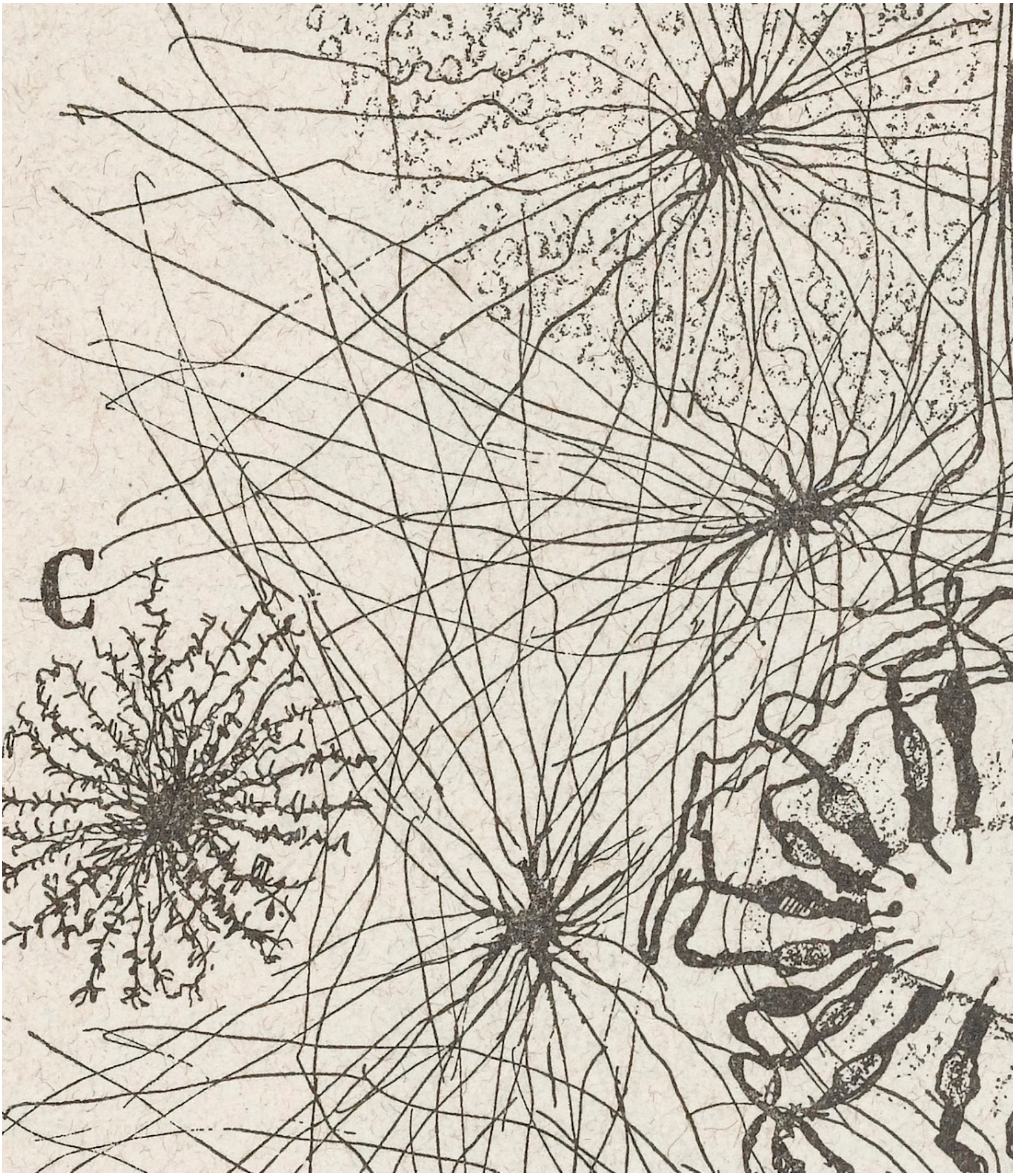

Neuroglia (detail) of the grey central region and neighbouring portions of the white substance of the spinal marrow of a boy of eight days (method of Golgi)
Drawing: Santiago Ramon y Cajal, 1899 | Wellcome Library, London | Wikimedia Commons

Interview

Rick Dove

vol 2 | 2015

People:
Interview

Authors:
Rick Dove and Norbert Hoeller

Rick Dove lives in Taos County, New Mexico, on eight acres in the mountains at 8,200 feet. Rick has an entrepreneurial background with founder and management experience in all C-level positions, and has dispatched a variety of interim executive problem-solving and program-management assignments in established organizations. He is co-inventor of the first deployed electronic postal metering device, and led its initial engineering and subsequent market introduction that established this now ubiquitous technology world-wide. In the late eighties he led the development of the first research agenda for the National Center for Manufacturing Sciences, and organized its collaborative-consortia research mechanisms. He was Co-Principal Investigator on the 1991 Lehigh study funded by the US Department of Defense that introduced the concepts of agile systems and enterprises, and led the subsequent DARPA-funded research during the nineties that established basic system fundamentals for agile systems of all kinds. In the late nineties he led industry collaborative workshops introducing agile concepts across a variety of industries through a process called Realsearch, a form of collaborative action learning.

He is CEO/CTO of Paradigm Shift International, an applied research firm specializing in agile systems concepts and education, and leads agile self-organizing system security research and development on US DHS and OSD funded projects. He is a partner in Kennen Technologies, and was the Principal Investigator on the DHS funded projects that showed proof of concept and built prototypes for applying Kennen's patented VLSI pattern processor technology to advanced bio-inspired problem applications. This pattern processor technology is entering the market in 2015. Rick is an adjunct professor at Stevens Institute of Technology, where he develops and teaches basic and advanced graduate courses in agile systems and systems engineering. He holds a BSEE from Carnegie Mellon University.

Norbert: At a presentation you made to the Natural Systems Working Group for the International Council on Systems Engineering (INCOSE), you talked about a pattern discovery project that is abstracting security patterns in natural systems. What took you down this path?

Rick: Applied research is where I like to work. In the natural systems security area, I had to do the research before I could apply it. System security is becoming increasingly asymmetric with

Celula gigante de la porcion inferior del asta de ammon del conejo. Metodo de Ehrlich-Bethe. a. axon. c, colaterol de este ramificada en b, d varicosidades de las expansiones dendriticas

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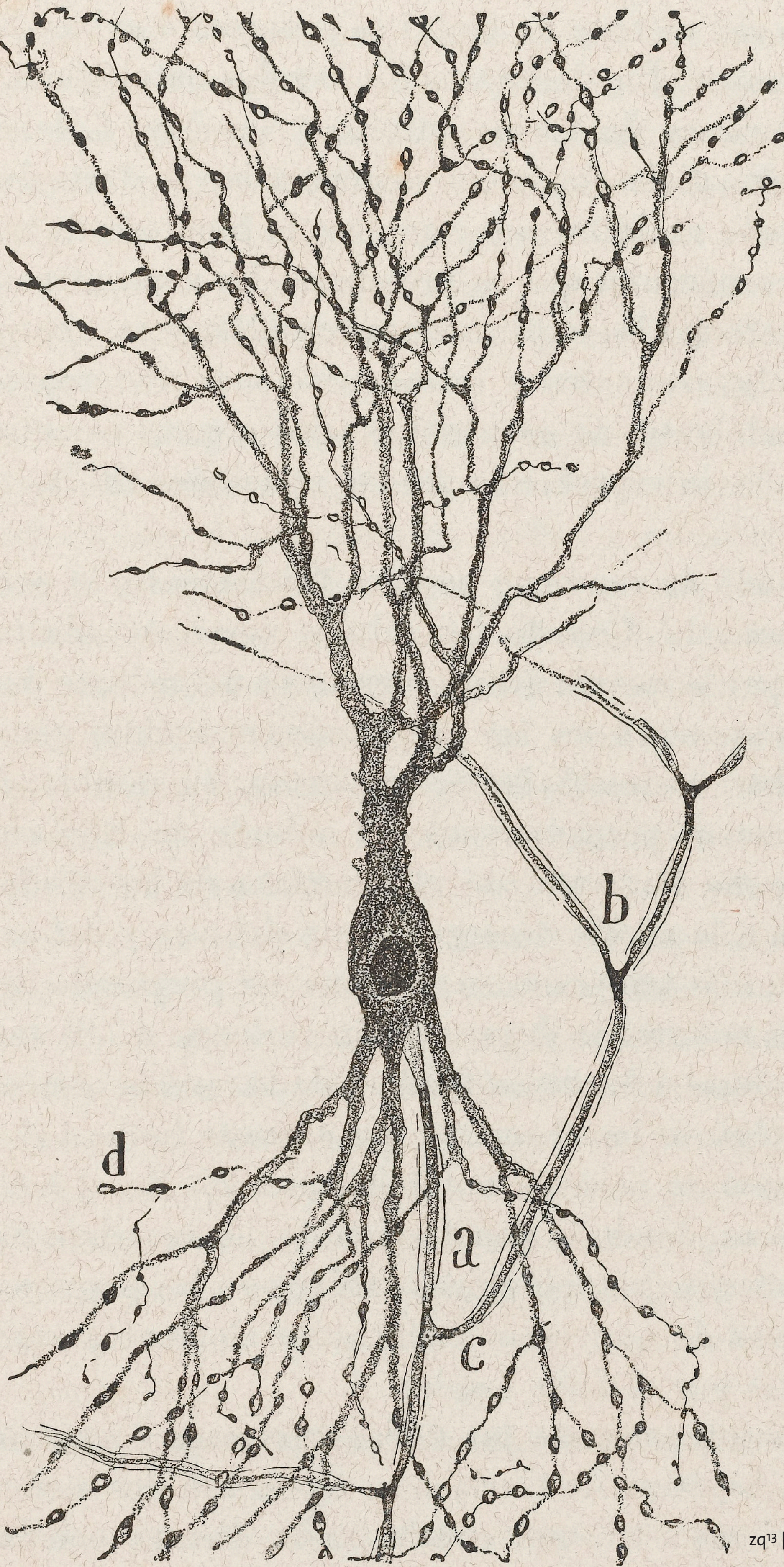
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attacks changing far faster than our ability to respond. New approaches are required based on self-organizing systems and agile system architectures "that exhibit the ability to survive, even thrive, in uncertain and unpredictable environments" (Dove & LaBarge, 2014). Patterns are traditionally abstracted from a mature body of work which does not exist in this area so I looked for patterns found in natural systems. The path was instigated by Maslow's hierarchy of needs, Carl Woese's horizontal gene transfer work, and Christopher Alexander's work in architectural patterns. The fact that security strategy is generally failing provided the impetus to focus on this area, and provided a value proposition for funding pattern-application development work. We spend more on security every year and lose more every year to security breaches. Biological evolution only works because biology has found strategies to stay alive in an uncertain and unpredictable world.

Norbert: So security is your field of focus?

Rick: It is just one of a few areas of specific focus, which all fit with a more general focus on adaptable systems engineering. Twenty-five years ago I was Co-Principal Investigator on a project that identified agile enterprise and agile systems as a necessary capability to cope with increasing uncertainty and unpredictability in system operational environments. This has been my mission ever since. I carry this out by discovering and exploring what enables systems to be highly adaptable. Early on this work looked at man-made systems, and produced a book in 2001 that exposed fundamental agile-system principles with application examples and reference models. These systems are in a class I call *reconfigurable systems* that can be adapted to changing requirements, a subject I teach at Stevens Institute of Technology in the Systems Engineering graduate department. In 2005 I started looking at systems I class as *reconfiguring systems*, ones that have self-organizing systemic capabilities. My work in this area led to natural systems for inspiration and the development of a second graduate course that explores a wide variety of different natural system types, looking for common underlying principles and patterns. Parallels can easily be drawn to the natural systems security area. Organisms deal with food and security first in order to live another day. Similarly, the security space is contending with a self-organizing community of agile attackers and is in desperate need of defense strategies with at least equal agility.

Norbert: First tell me more about those intriguing security patterns that were biomimetically inspired.

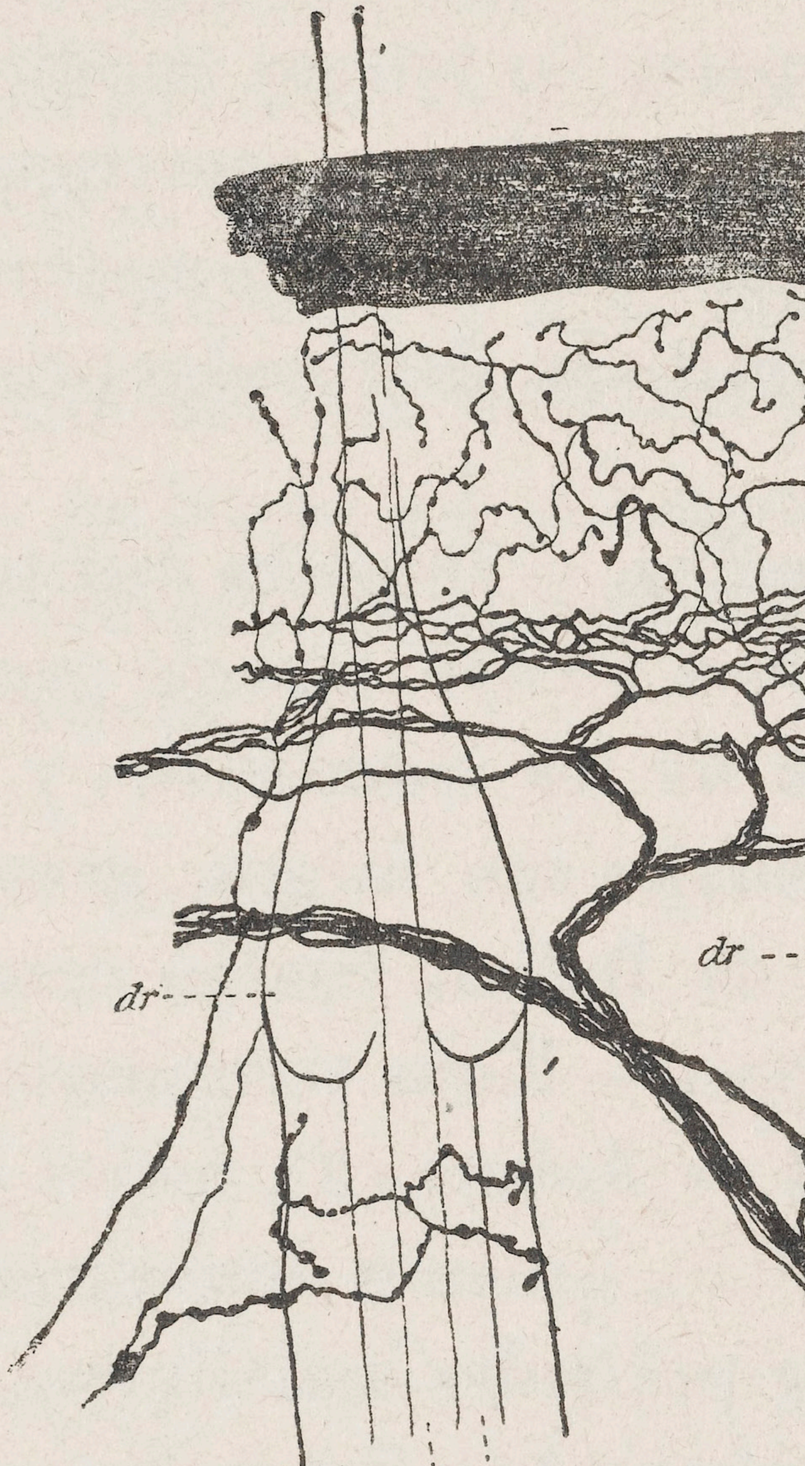
Rick: As you saw in the INCOSE presentation, we've learned and applied a very useful mechanism modeled on the adaptable immune system. Groundbreaking early work by Stephanie Forrest at the University of New Mexico and the Santa Fe Institute pioneered immune system models for security. But translating that work with high fidelity was elusive using current technology and techniques. The immune system fields about 10^9 different antibody detectors to cover the entire possible pattern space of biological invaders. It generates random detector possibilities over about a two-month continuous cycle. In cyber-security the number of possible invader patterns gets a whole lot larger, well beyond traditional computer technology's ability to detect never-seen-before invader patterns. With a new approach that is inexpensive enough to protect every individual node in a network, we showed how a space of 10^{15} patterns could be covered continuously at full data stream speed in a very small amount of pattern storage. 10^{15} patterns is not a limit, just what we chose for a proof-of-concept prototype. We mimicked and improved upon a high-fidelity model of immune system invader detection.

Norbert: In your presentation you also showed a learning and sense-making mechanism modeled on the brain.

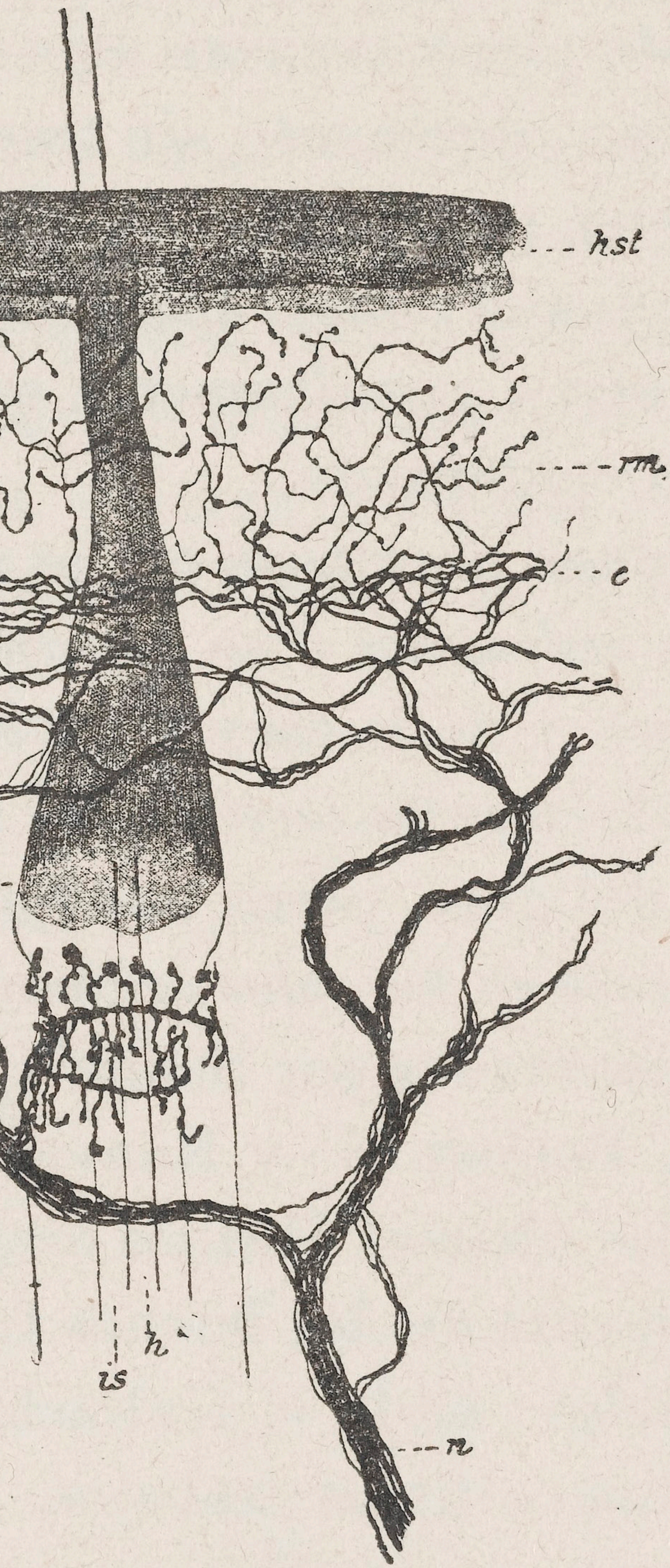
Rick: This is my favorite, as it employs only simple pattern recognition capability for learning, recognition and sense-making. And, it has application in many areas, not just security. I use the visual cortex and auditory cortex to explain the process, but the entire brain cortex works the same. The cortex has a hierarchical pattern architecture that chunks patterns at one level into primitives at the next level. The visual cortex, for instance, recognizes objects at the fourth level in about 100 milliseconds. It knows there is a face in the field of view. It doesn't know at level 4 whose face or what emotions are expressed - that happens at higher levels. The first level has about 100 pattern detectors, looking for edges represented essentially by multiple pixels that come in from the retina. The edge detectors recognize edges that are of different lengths, different angles, and black over white or white over black. An edge detector that matches the pixel stream chunks it into a single primitive for level 2. Level 2 looks for combinations of edges in spatial proximity. Again it seems that about 100 combinations are all that is recognized. Level 3 again does the same, but looking for combinations of combinations. The literature has some indication that again the number of pattern detectors at this level is about 100. At level 4 that same chunking process identifies general objects in what is known as "immediate recognition". I suspect the limit of 100 detectors evolved from biological optimization of energy propagation, speed of signal travel, and physical neuron-connection space. This resource-conserving simple architecture indicated that something less than a supercomputer might be able to accomplish something similar.

To switch metaphors, think about learning your native language as a child by listening to noises made by people. Conceptually, the same cortical architecture is employed. Level 1 learns repetitive sounds: phonemes. Level 2 learns repetitive combinations of phonemes as words. Level 3 learns repetitive combinations of words as phrase grammar. Level 4 learns repetitive combinations of phrases as sentence grammar.

We built a software feasibility prototype that sat in front of a network server and listened to the incoming data stream conversation, eventually learning to distinguish between normal server conversation and words, grammar and sentences not heard before. It is always in learning mode, but doesn't sound an alarm until it crosses a threshold of sufficient learning to understand reasonable conversation, and suddenly hears something new. At that point it asks for a human decision to classify this newness as benign, suspicious, or known bad. We achieved zero false positives and zero false negatives si-



Rat nerve endings | Drawing: Santiago Ramon y Cajal, 1899 | Wellcome Library, London | Wikimedia Commons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multaneously for an SQL server. We wanted to do this using industrial control system devices, where the conversations are more regular and the threat to national critical infrastructure is more pressing, but we didn't have ready access to those data streams, and the SQL server satisfied our need to prove the general approach.

A prime goal of this work was to accomplish learning somewhat like a natural neural net, without resorting to the computational math intensity typical of artificial neural nets. Backpropagation, for instance, is a respected artificial neural net learning algorithm for convergent discovery of the optimal parameters in a complex mathematical model of the network – a trial and error method that knows what the network output should be for a given input and feeds back the error magnitude for adjusting all of the equation's parameters for the next trial and error cycle. This algorithm effectively converges on optimal parameter values. There is no evidence that the brain does this, yet the brain continues to be the benchmark for pattern recognition.

Norbert: You made a big point out of horizontal gene transfer as an inspiration.

Rick: This is seminal work by Carl Woese. He showed that genes are transferred among species and even among plants and animals. In a real sense that's what we are doing with biomimicry – taking patterns we see in biology and employing them in other domains. Woese suggests that the real innovation that has occurred in the evolution of the species is principally from this horizontal evolution mechanism, and not from Darwinian vertical evolution that refines an existing theme. Fortunately for us these trans-species genes are rarely expressed, but lie dormant in our DNA. Expression in general occurs when an organism is under very high survival stress that apparently triggers gene-expression experimentation. If you think about it, we see this process reflected in Clayton Christiansen's book, *The Innovator's Dilemma*, where a functioning corporation suppresses radical ideas viewed as threatening to the organizational system that is already in place. Most real innovation we witness occurs from combining ideas employed in other domains to solve a problem in a specific domain in a very new way, a concept I call horizontal meme transfer. I also see this as the core of collaborative group diversity values. Diversity of collaborative thought and knowledge leads to new and relevant understandings that are unlikely to emerge from a single specialized mind blinded by what it already knows.

Norbert: What are you working on right now?

Rick: I'm trying to discover what's behind the art of embraceable system design – fundamental design thinking and method that make system acceptance and usage embraceable, rather than enforceable. Why do a few designers repeatedly get acclaim and following for the systems they design? The ones we are interested in are recognized for repeatedly designing works that are broadly embraced. I principally examine artists that span many domains because the effectiveness of their work requires that their work be embraced, and that their diverse users declare the artist's success by broad voluntary usage and acclaimed appreciation. Here again, I am looking outside the engineering community for the patterns of interest, attempting to find common threads that cause embraceable user acceptance and joy in usage. What made Frank Lloyd Wright's work stand out? What did he think about and bring to bear in his approach to design? The principles we want to find will be universal, and I suspect will have a lot to do with deep user empathy, a systems-thinking understanding of the usage environment, and synergy among all the parts of a simple but complex system. This discovery project will be done in a series of collaborative workshops this fall.

I'm also working on principles for meaningful innovative group work among volunteers. I chair the INCOSE working groups for Agile Systems and Systems Engineering and also Systems Security Engineering. All members are volunteers that have demanding day jobs scattered around the world. Keeping them motivated, inspired, and supported to produce effective project outcomes to schedule has been a challenge across INCOSE's 60 some working groups. For me this is a mission, currently being tested in my working groups and already demonstrating good results.

I'm passionately involved with a number of other projects as well, which appear to some as unrelated. I've found a way to understand them all as synergistic. For me the key is a focus on underlying systemic principles that beg application in diverse domains.

Norbert: What is your favorite inter-disciplinary work of all time?

Rick: There are three I consider favorites.

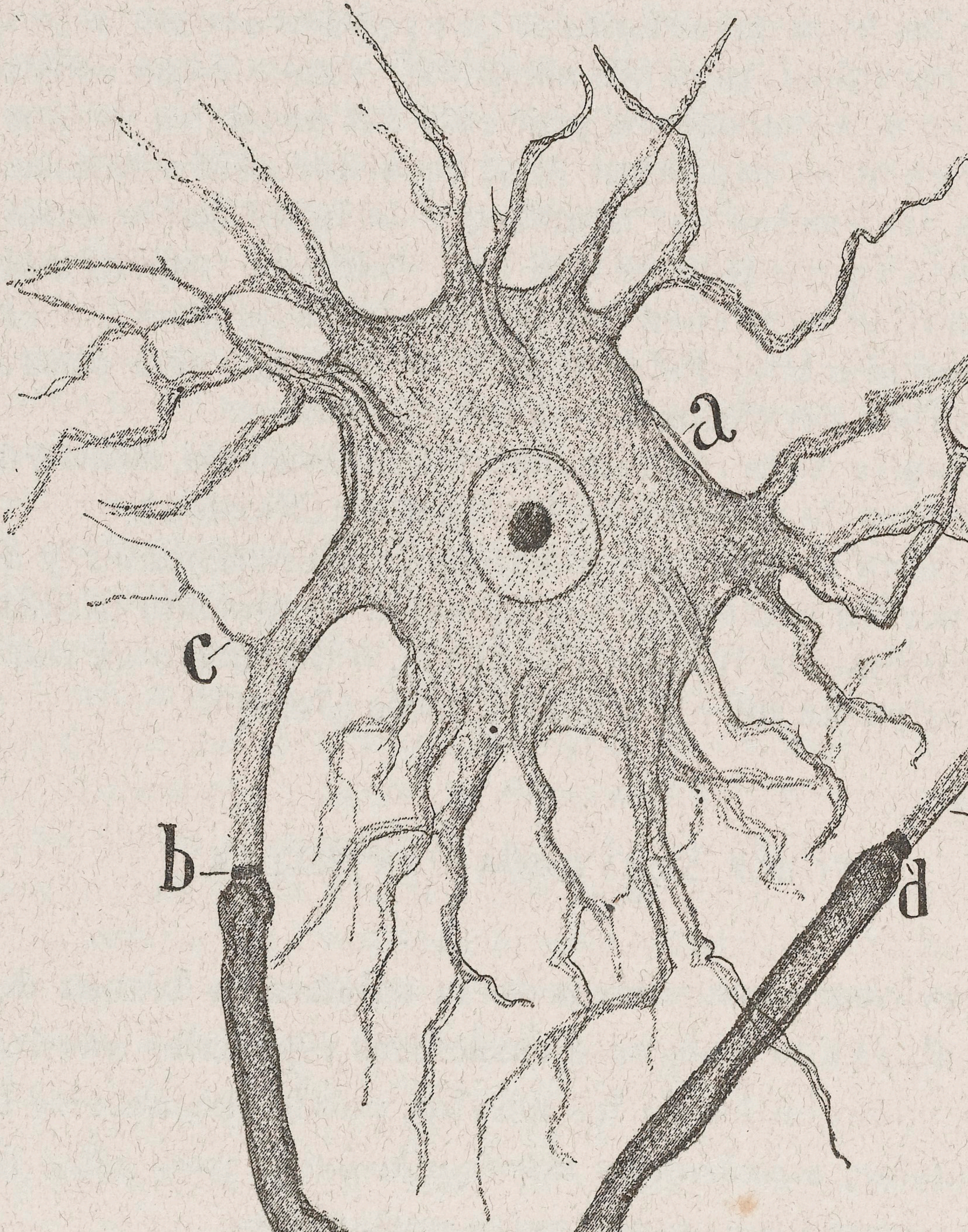
Dan Dennett, the philosopher, wrote a 1,000 page book on natural selection called *Darwin's Dangerous Idea*. I couldn't imagine how he'd keep me engrossed beyond a few chapters. What's awesome is how ubiquitous and powerful this algorithm is in driving the evolution of everything: ideas, technology, society, and of course organisms. Natural selection is a relentless algorithm with absolutely no objective, but very deep implications. The environment kills off what is less effective under continuous experimentation.

The book *Rethinking Innateness* (Elman, et al.) is masterfully written, surprisingly readable, and absolutely fascinating. It is about the architecture of the brain, which is born with virtually no content, but is organized for compulsive learning from its environment. I believe the only content at birth relates to the general features that indicate a face is present in the field of view, and it appears that the recognition of snakes is also innate.

Carlson, Doyle, and Csete have written a number of papers on complex biological systems, and show fundamental patterns that are mirrored in so many other domains that they could be universal natural laws of systems. They make the point that underneath all that seeming complexity in cellular biology are very simply system patterns that appear repeatedly in most complex systems of any kind. I highly recommend a look at what they call the Bow Tie pattern, for its simple elegance and broad application.

Norbert: What work have you seen recently that really excited you?

Rick: I just spent a full day looking through conference videos about Google's Advanced Tech-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nology and Products (ATAP) group. I'm blown away with the purposeful system design behind what and how ATAP, as an innovation machine, does what it does. It fits with all I've been working on and much of what we've talked about here. They designed a complex system with simple fundamentals that leverages truly remarkable resources organized in a Bow Tie pattern. ATAP functions as the Bow Tie knot, designing and providing a development infrastructure that enables a vast number of developers to service a vast number of technology application opportunities in what I consider to be a classic agile-system design.

Norbert: Who do you admire?

Rick: Carl Woese, because he was vilified for many years, but persevered and won out with major new and now accepted understandings; Frank Lloyd Wright, for the way he integrates system design with the environment and the humanism of his users; Christopher Alexander, because he looks for timeless truth; and Bill Gates and Warren Buffet, because they apply their time and resources to big problems that can make a large difference in the world. I could name some more, but that's enough.

Norbert: What's your favorite motto or quotation?

Rick: I expect our favorite quotations are pithy very-personal statements that articulate what we already believe. Nolan Bushnell, the founder of Atari, a long time ago in the San Francisco Chronicle was quoted as saying "Ideas are shit, implementation is everything. Anybody in the shower for more than ten minutes gets more ideas than can be implemented in a lifetime." I find frequent reason to inform people of this. Also William Gibson, for his oft quoted "The future is already here, it's just not evenly distributed." This thought drives my search for horizontal meme transfer opportunities.

Norbert: What is your idea of perfect happiness?

Rick: Pursuing a mission with passion.

Norbert: If not being who you are, who/what would you be?

Rick: In third grade when asked what I wanted to be when I grew up, I said from the heart, a wise man. That felt so much better than becoming a policeman or a train engineer. But I haven't grown up yet, so there's still time. A while back I started writing a book called *On Purpose*, with double entendre intended. I got far enough to know I'll not finish it. There's too many other things to do. ×

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Celula del lobulo cerebral electrico del torpedo. Coloracion por el liquido de boberi.

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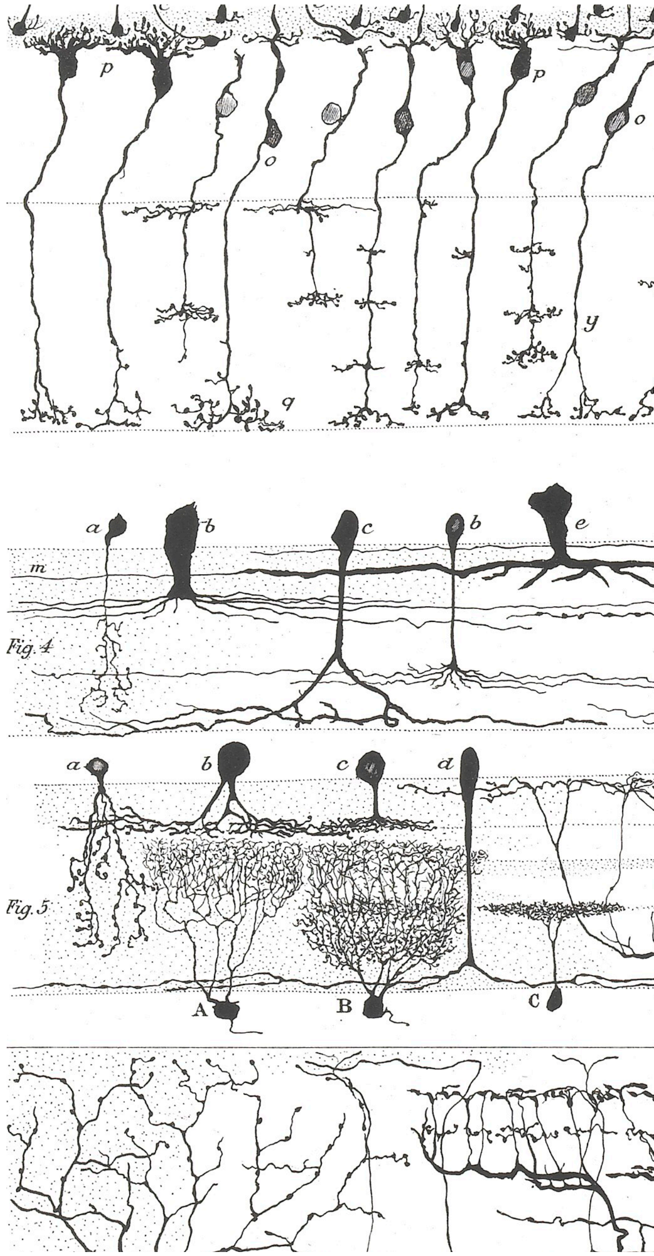

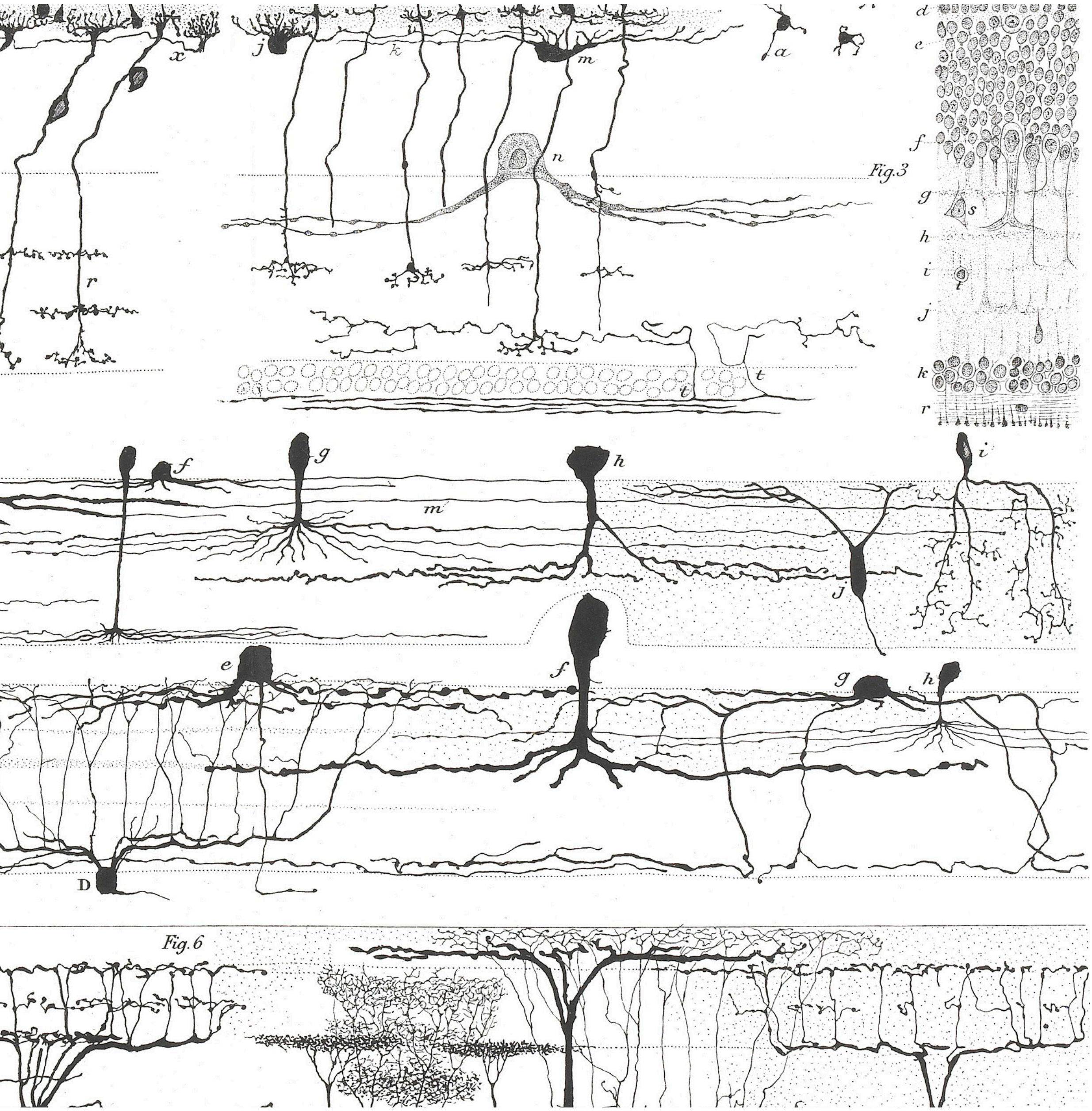

Line drawing of the retina (detail)

Drawing: Santiago Ramon y Cajal, 1899 | Wellcome Library, London | Wikimedia Commons