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Worlds Conflicting: The Cell Theories of François-Vincent Raspail and Theodor Schwann

ABSTRACT

François-Vincent Raspail (1794–1878) and Theodor Schwann (1810–1882) postulated—in 1827 and 1838, respectively—that plants and animals consist of, and originate from, cells. Whereas Raspail is mainly remembered for his involvement in the revolutions of 1830 and 1848, little is known about his scientific work. Schwann, by contrast, is regarded as one of the founders of cell theory, but historians of biology have hardly taken his philosophical, religious, and political ideas into account. Paying particular attention to Schwann's unpublished writings, this paper reconstructs the research agendas of Raspail and Schwann, and contrasts the philosophical and political beliefs and incentives behind them. Whereas Raspail was a proponent of republicanism and materialism, Schwann opposed the modernist agenda of explaining nature and humankind without God, as well a democratic reshaping of society. Contrary to the prevailing historical narrative, this paper argues that cell theory did not emerge exclusively in conjunction with the rise of liberalism and materialism. Rather, the idea of a unifying principle of organic development encompassed different and even antagonistic visions of nature, humankind, society, and the role of religion in science.

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KEY WORDS: cell theory, François-Vincent Raspail, Theodor Schwann, revolutions of 1830 and 1848, republicanism, materialism, science and religion

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The emergence of cell theory at the end of the 1830s is often described as a "scientific revolution" that heralded the end of vitalism and the introduction of materialist thinking in biology.[1] It is further assumed that this scientific revolution took place in conjunction with revolutionary politics and the rise of liberalism—a view usually based on the well-known case of Rudolf Virchow, founder of cellular pathology and one of the most prominent German liberal politicians.[2] In this essay I revisit this historical narrative by focusing on the cell theories of François-Vincent Raspail (1794–1878) and Theodor Schwann (1810–1882). Both Raspail and Schwann postulated independently, in 1827 and 1838, respectively, that plants and animals are composed of, and originate from, cells. However, the historiography has given different appraisals of their contributions to the emergence of cell theory.

The Frenchman Raspail has gone down in history above all as a republican hero. Among other things, he participated in the July Revolution of 1830, as well as in the 1848 Revolution.[3] In the history of biology, though, he ranks beside Henri Dutrochet and Pierre Turpin as one of the French forerunners of cell theory.[4] Yet few studies have undertaken a comprehensive investigation of Raspail's diverse research in the fields of botany, physiology, and organic chemistry.[5] The disdainful comments made by the botanist and cell theorist

1. See, e.g., Ilse Jahn, *Klassische Schriften zur Zellenlehre: Matthias Jacob Schleiden, Theodor Schwann, Max Schultze*, 2nd ed. (Frankfurt am Main: Harri Deutsch, 2003), 32; Eva Johach, *Krebszellen und Zellenstaat. Zur medizinischen und politischen Metaphorik in Rudolf Virchows Zellularpathologie* (Freiburg i. Br. et. al.: Rombach, 2008), 106.

2. See, e.g., Georges Canguilhem, "La théorie cellulaire," in idem, *La connaissance de la vie* (Paris: Vrin, 2009; 1st ed. 1952), 53–101; Everett Mendelsohn, "Revolution and Reduction: The Sociology of Methodological and Philosophical Concerns in Nineteenth-century Biology," in *The Interaction between Science and Philosophy*, ed. Y. Elkana (New York: Atlantic Highlands, 1974), 407–26; and literature on Virchow in ref. 96.

3. The most important biography of Raspail is still Dora B. Weiner, *Raspail, Scientist and Reformer* (New York: Columbia University Press, 1968); see also Patricia Bédéï and Jean-Pierre Bédéï, *François-Vincent Raspail. Savant et républicain rebelle* (Paris: Alvik, 2005); Jonathan Barbier, "Les républiques de François-Vincent Raspail: entre mythes et réalités" (PhD dissertation, Université d'Avignon et des pays de Vaucluse, 2016).

4. See André Pichot, *Expliquer la vie: De l'âme à la molecule* (Versailles: Quae, 2011); Georg Dhom, *Geschichte der Histopathologie* (Berlin: Springer, 2001); François Duchesneau, *Genèse de la théorie cellulaire* (Montreal: Bellarmin, 1987); Henry Harris, *The Birth of the Cell* (New Haven, CT: Yale University Press, 2000); Marc Klein, *Histoire des origines de la théorie cellulaire* (Paris: Hermann & Cie, 1936); F. K. Studnicka, "Aus der Vorgeschichte der Zellentheorie. H. Milne-Edwards, H. Dutrochet, F. Raspail, J.E. Purkinje," *Anatomischer Anzeiger* 73 (1931/1932): 390–416.

5. His bibliography contains around 150 publications. In the following I shall be focusing above all on his scientific works of the 1820s and 1830s.

Matthias Schleiden seem to have left a lasting impression on his historiography: "It seems to me irreconcilable with the dignity of science to engage with Raspail's work," he wrote in 1837.[6] In the following I do not just engage with Raspail's cell research. I also investigate the extent to which his cell theory was an answer to the scientific and political issues debated in France from the time of the Restoration up to the years after the July Revolution of 1830.

Whereas Raspail is little known as a cell theorist, Schwann is celebrated, together with Matthias Schleiden, as the founder of cell theory. His name can be found in any overview of the history of biology. Hence it is all the more astounding that his philosophical, religious, and political views have received little attention. It is often assumed that Schwann's critical position on natural philosophy resembled Schleiden's.[7] Politically, he is presumed to have been, like Virchow, an adherent of liberalism.[8] The fact that Schwann was a pious Catholic has not been overlooked. Nevertheless, the view prevails that his faith had been a purely private matter. "His belief in a Creator God," according to the historian of biology Ilse Jahn, did not prevent him from "paving the way for materialistic thinking in 19th century natural science."[9] In his 1960 biography of Schwann, Marcel Florkin answers the question of Schwann's relationship to religion, insofar as he divides his life into two halves: until the formulation of his cell theory in 1838, we are told, Schwann was a Catholic "rationalistic Cartesian"; afterwards, he is supposed to have turned his back on research and lapsed into "mysticism."[10]

Thus far, it has seldom been asked how much Schwann's religious faith may have contributed to his cell theory of 1838.[11] I would like to pursue this

6. Matthias Jacob Schleiden, "Beiträge zur Phytogenesis," in *Klassische Schriften zur Zellenlehre von Matthias Jacob Schleiden, Theodor Schwann, Max Schultze*, ed. Ilse Jahn (Leipzig: Akademische Verlagsgemeinschaft Geest & Portig, 1987), 47.

7. See, e.g., Thomas Cremer, *Von der Zellenlehre zur Chromosomentheorie. Naturwissenschaftliche Erkenntnis und Theorienwechsel in der frühen Zell- und Vererbungsforschung* (Berlin: Springer, 1985), 66–76.

8. See Laura Otis, *Membranes: Metaphors of Invasion in Nineteenth-Century Literature, Science and Politics* (Baltimore: John Hopkins, 1999), 14–15; Rembert Watermann, *Theodor Schwann, Leben und Werk* (Düsseldorf: L. Schwann, 1960), 26.

9. Jahn, *Klassische Schriften* (ref. 1), 32.

10. Marcel Florkin, *Naissance et déviation de la théorie cellulaire dans l'œuvre de Théodore Schwann* (Paris: Hermann, 1960), 74, 7.

11. See Franz Bosch, *Aus der Geschichte der Zellenlehre. Festschrift zum hundertjährigen Geburtstage ihres Begründers Theodor Schwann* (Düsseldorf: Verlag L. Schwann, 1910); Watermann, *Theodor Schwann* (ref. 8); Laura Otis, *Müller's Lab* (Oxford: Oxford University Press, 2007), 64–66 and literature mentioned in ref. 75.

question here, as well as to consider the research program that Schwann pursued after 1838 and after the 1848 Revolution. How did Schwann deal with the relationship among science, religion, and politics, which was intensively discussed in this post-revolutionary era? My analysis encompasses Schwann's unpublished writings, in particular his "Diary of inner occurrences" ("Tagebuch innerer Ereignisse," 1842–1881), as well as his essay "Man as he is and as he should be: Considered from a physiological standpoint" ("Der Mensch wie er ist und sein soll. Vom physiologischen Standpunkt betrachtet") of 1864.[12] These unpublished sources, as well as other scarcely acknowledged published letters or marginal papers, offer insights into Schwann's philosophical, religious, and political views, which he only articulated implicitly in his publications.

RASPAIL: ACCOUNTING FOR THE UNITY AND HISTORICITY OF THE LIVING WORLD

Raspail was born in 1794 in the southern French city of Carpentras. That same year, the reign of terror had reached its apex. The battle against the Church was fully underway; priests were being kept under the strictest surveillance. It was in this tense atmosphere that Raspail's Catholic mother had him secretly baptized. Religion played a major role in his childhood and youth, particularly through the person of the Jansenist abbot François-Siffrein Esseyric. The abbot taught Raspail Greek, Latin, French, and even Hebrew. He also awakened Raspail's interest in the natural sciences. In 1810, at the age of 16, he entered the seminary in Avignon. There, he studied theology and philosophy. Yet after just three years he left this institution—it remains unclear whether by his own free choice or by compulsion. What is certain is that by this time he had already begun to distance himself from the Church. He finally took off his seminarist's garb in 1818, two years after leaving his city of birth and moving to the capital, where he married in 1821. The five children produced by that marriage grew up, just as Raspail had, in impoverished circumstances. In Paris during the 1820s, the only option Raspail

12. Excerpts from these and other unpublished writings by Schwann can be found in Florkin, *Naissance* (ref. 10) and in Watermann, *Theodor Schwann* (ref. 8). This study is part of a larger project on Schwann's unpublished writings. In the following I refer to the transcribed version of the aforementioned two of these writings: Theodor Schwann, "Tagebuch innerer Ereignisse 1842–1881," Archives of the University of Liège, Schwann papers, Ms6078; Theodor Schwann, "Der Mensch wie er ist und sein soll. Vom physiologischen Standpunkt betrachtet," undated. In the following I refer to the version transcribed and translated by Bradley T. Scheer, Archives of the University of Liège, Schwann papers, Ms6079. Scheer assumes the text was composed in 1864.

had of earning a living was to teach in secondary schools or give private lessons to the children of the bourgeoisie and nobility. But his move to Paris brought another change: whereas so far he had been a supporter of Napoleon, he now became a republican. Already in 1814, he had experienced the restoration of the monarchy as a momentous disappointment. Now he planned to join forces with other liberals and republicans and work for the monarchy's overthrow.[13]

In the context of the restoration—up to the July Revolution of 1830—Raspail studied and researched intensively in the natural sciences. His interests covered botany, zoology, physiology, chemistry, and physics. Although he did not belong to any official scientific institution, he read his research results to the Académie des Sciences and published them in the renowned journal *Annales des Sciences Naturelles*. In the 1820s his work even found an audience in Germany. His first treatise from 1824, *On the formation of the embryo in grasses* (*Sur la formation de l'embryon dans les graminées*), was translated into German as early as 1826.[14] The naturalist Lorenz Oken published a review of this translation in his journal *Isis*, wherein he praised "Raspail's philosophical outlook on the development of the flower and fruit parts."[15] Through extensive microscopic investigations of the ovaries of grasses, and later of starch, Raspail traced embryogenesis back to its primordium. Like many naturalists of the time, his aim was to identify the material origin of life, not only for a particular species, but for plants in general. In 1825, he announced his discovery that in plants, the process of organic formation starts from "cells."[16] Interestingly, the choice of his object of research was not only guided by practical concerns (his specimens would be easy to pick from Parisian gardens and in the city's environs), but had political motives as well. Indeed, he wanted to restore dignity to the grasses—"these *pariahs* of vegetation that are mowed, cut and picked, but that barely find a place in the herbarium."[17] By proving that they, too, were capable of reproduction, he put them on the same level as all other plants.[18]

13. Biographical information is derived from the sources mentioned in note 3.

14. Raspail, *Abhandlung über die Bildung des Embryo in den Gräsern und Versuch einer Classification dieser Familie. Aus dem Französischen übersetzt und mit Anm. bgl. von Carl Bernhard von Trinius* (St. Petersburg: Kaiserliche Akademie der Wissenschaften, 1826).

15. Lorenz Oken, "Raspails Abhandlung," *Isis*, no. 8 (1826): 780.

16. François-Vincent Raspail, "Développement de la fécule dans les organs de la fructification des Céréales," *Annales des sciences naturelles* 6 (1825): 224–427, here 411; see "Sur la formation de l'Embryon dans les Graminées," *Annales des sciences naturelles* 4 (1825): 273–319.

17. François-Vincent Raspail, *Nouveau système de chimie organique, fondé sur les méthodes nouvelles d'observation* (Paris: J.-B. Baillière, 1833), 113.

18. See Raspail, "Sur la formation" (ref. 16), 214.

Raspail thus linked the search for a universal principle of formation with a vision of nature in which all living beings were on equal terms.

Against this background, Raspail extended his research to animals. Between 1825 and 1827, he carried out comprehensive microscopic investigations of a variety of animal tissues, including fat, blood, human skin, muscles, and nerves.[19] Since the end of the eighteenth century, botanists had generally agreed that plants were comprised of cells. But when it came to the animal organism, diverse views about their elementary structure held sway.[20] In the 1820s, for instance, the "globule" theory was highly influential. One of its main proponents was the zoologist Henri Milne-Edwards. On the basis of microscopic examinations of numerous organs of different animal species, he had determined that all animals consisted of "globules" that were identical in form and size (1/300th of a millimeter in diameter).[21] But Raspail's microscopic observations could not corroborate Milne-Edwards's results; like the plant cells he had previously studied, the basic elements of animal tissues showed virtually infinite variations in form and size. Whereas Milne-Edwards painted a static picture of the elementary units of organisms, bearing "a constant and predetermined" basic form, Raspail described "cells" that were subject to changes over time.[22] They varied in form and size because, like organisms themselves, they were involved in a process of growth. Raspail's main finding from 1827, however, was that all formative and developmental processes in animals, as in plants, were carried out through the cells. He summarized this finding in the following

19. François-Vincent Raspail, "Recherches chimiques et physiologiques destinées à expliquer non seulement la structure et la développement de la feuille, du tronc, ainsi que les organes qui n'en sont qu'une transformation, mais encore la structure et le développement des tissus animaux," *Mémoires de la société d'histoire naturelle de Paris* 3 (1827): 17–88, 209–313; "Recherches physiologiques sur le graisses et le tissu adipeux," *Répertoire général d'anatomie et de physiologie pathologiques et de clinique chirurgicale* 3 (1827): 165–82; "Premier mémoire sur la structure intime des tissus de nature animale," *Répertoire général d'anatomie et de physiologie pathologiques et de clinique chirurgicale*, 4 (1827): 148–61; "Anatomie microscopique des nerfs, pour démontrer leur structure intime et l'absence de canaux contenant un fluide et pouvant après la mort être injectés," *Répertoire général d'anatomie et de physiologie pathologiques et de clinique chirurgicale* 4 (1827): 185–92; "Second Mémoire de physiologie et de chimie microscopique sur la structure intime des tissus de nature animale," *Répertoire général d'anatomie et de physiologies pathologique et de clinique chirurgicale* 6 (1828): 135–64.

20. See Klein, *Histoire* (ref. 4); Harris, *Birth* (ref. 4), 37–46.

21. Henri Milne-Edwards, *Mémoire sur la structure élémentaire des principaux tissus organiques des animaux* (Paris: Imprimerie de Migneret, 1823). See John V. Pickstone, "Globules and Coagula. Concepts of Tissue Formation in the Early Nineteenth Century," *Journal of the History of Medicine* 28 (1973): 336–56.

22. Raspail, "Recherches chimiques" (ref. 19), 48.

paraphrase of Pierre Simon Laplace's famous formulation: "Give me a cell within which other cells can proliferate into infinity, and infiltrate each other at will, and I shall hand back to you all the forms of the organized world."[23]

For Raspail, the cell was first and foremost a generative unit that chemically produced the fluids needed to form tissues.[24] Cells continuously and endlessly engendered other cells. Envisioning endogenous cell formation as a process establishing continuity between generations of cells, as well as between parents and their offspring, was a central aspect of his theory.[25] Interestingly, however, continuity for Raspail did not mean constancy. He concluded his 1827 treatise with the remark that in fertilization and the further course of development, "accidents" were always possible. They brought about "unusual developments"—"monstrosities."[26] At the same time Raspail was carrying out his first embryological studies, the French scientist Étienne Geoffroy Saint-Hilaire was investigating deformities in embryos. Geoffroy, professor at the Musée National d'Histoire Naturelle, was one of the few established French scientists to support Raspail. When the latter read his first treatise on the embryogenesis of grasses to the Académie des Sciences, for instance, Geoffroy was the only listener who did not disregard his results. "Take courage," he is reputed to have told Raspail, "you are fifty years ahead of them."[27] Raspail's derivation of organic formation from matter reinforced Geoffroy's epigenetic and transformist views.

For Geoffroy and Raspail alike, unpredictable, environmentally conditioned transformations affected not only individual organisms, but also entire species.[28] In his 1827 study, Raspail emphasized that the continual cross-generational process of cell formation always involved "new losses and new acquisitions." It was therefore possible that "after centuries," "nothing more" would remain of the initial plant.[29] In the following years Raspail resumed his studies of grasses, which he had begun four years before. This time it was not embryogenesis but evolutionary development that stood at the center of his

23. Ibid., 306.

24. Raspail, "Second Mémoire" (ref. 19), 158. See also Raspail, *Nouveau système* (ref. 17), 27. Some authors consider Raspail as the founder of histochemistry; see Dhom, *Geschichte* (ref. 4), 14; Harris, *Birth* (ref. 4), 34.

25. See Raspail, "Recherches chimiques" (ref. 19), 284, 297.

26. Ibid., 309, see also 284.

27. Cited in Eugène de Mirecourt, *Raspail*, 3rd ed. (Paris: Librairie des contemporains, 1869), 25. See also Bédéï and Bédéï, *François-Vincent Raspail* (ref. 3), 54–57.

28. On Geoffroy's research of the 1820s, see Toby A. Appel, *The Cuvier–Geoffroy Debate: French Biology in the Decades Before Darwin* (New York: Oxford, 1987), 130–36.

29. Raspail, "Recherches chimiques" (ref. 19), 297.

inquiry. Of the highly diverse species of grasses he had examined in the Parisian suburban gardens, every trait exhibited variations. For him, the plants were each conditioned by the soil in which they grew, and by other environmental factors. Raspail could find no evidence for the view that each species was an "immediate daughter of Creation," which would have preserved its original traits over many generations.[30]

Around roughly the same time, in 1829, Raspail was also studying 250 belemnoids, one of the largest groups of fossil cephalopods. He was interested in the analogies between these fossils and living cephalopods. It was precisely these analogies that the most prominent natural scientist in France, Georges Cuvier, rejected.[31] In his 1812 work *Researches on fossil bones* (*Recherches sur les ossements fossiles*), Cuvier argued that even the youngest fossils would differ markedly from living species. He absolutely ruled out gradual transformations of fossil species into living ones.[32] Raspail's cell theory thus formed part of a greater endeavor to conceive of nature as transforming continually and contingently over the course of time. His theory not only ascribed the origin of animals and plants to a consistent, elementary unit of organic matter, but also furnished an explanation for the transformation of species—a theory that became the focus of scientific debate in the early decades of nineteenth-century France.[33] But as I would like to show, the implications of Raspail's cell theory became fully clear in light of the well-known controversy between Geoffroy and Cuvier.

RASPAIL: FIGHTING THE MONARCHY, IMAGINING THE REPUBLIC

The debate between Cuvier and Geoffroy, which split the French scientific community of the early nineteenth century into two opposing camps, reached

30. François-Vincent Raspail, "Essai d'expériences et d'observation sur l'espèce végétale en général et en particulier sur la valeur spécifique des graminées," *Annales des sciences d'observation* 1 (1829): 406–38, on 407; see also "Déviations physiologiques et metamorphoses réelles du Lolium," *Annales des sciences d'observation* 2 (1829): 233–44.

31. François-Vincent Raspail, "Histoire naturelle des Bélemnites, accompagnée de la description et de la classification des espèces que M. Emeric, de Castelane, a receuillies dans les Basses-Alpes de Provence," *Annales des sciences d'observation* 1 (1829): 271–331.

32. See Martin J. S. Rudwick, *Georges Cuvier, Fossil Bones, and Geological Catastrophes: New translations and interpretations of primary texts* (Chicago: University of Chicago Press, 1997), 168–69.

33. See Pietro Corsi, *The Age of Lamarck: Evolutionary Theories in France, 1790–1830* (Berkeley: University of California Press, 1988), and Appel, *The Cuvier–Geoffroy Debate* (ref. 28).

its climax between February and April 1830, just a few months before the July Revolution. In her study of this controversy, Toby Appel vividly describes how it led to a confrontation between different religious and political positions. Cuvier was a staunch supporter of the constitutional monarchy. When the ultra-royalist Charles X came to power, he supported Cuvier's reactionary politics and his measures to strengthen the Church's control over society and education. Cuvier wanted to avoid a repetition of the 1789 Revolution at all costs, and he saw in the Church a guarantee of order and social stability. In his early works, to be sure, he avoided explicitly addressing questions of Christian doctrine. But beginning in the 1820s, he rejected epigenetic and evolutionary theories because they limited the Creator's power. Appel remarks that for Cuvier it was unthinkable to seek the origin of organic formation. Generation was a mystery that, from his point of view, could not be an object of research.[34] As we have seen, this was precisely the question at the heart of Raspail's research program. Like Geoffroy and his followers, he held that the study of nature should proceed independently from religious dogmas. Although he did not formulate this position explicitly, he did express it obliquely with his above-mentioned reference to Laplace, the figurehead of anti-dogmatic science. But Laplace—who died in 1827, the year Raspail formulated his cell theory—was as far from atheism as Geoffroy or Raspail. In 1864, Raspail asserted that cell theory was merely "another way to comprehend God's eternal work."[35] The Catholic Church nonetheless placed his book *New System of Organic Chemistry* (1833), in which he laid out his cell theory, on the Index Librorum Prohibitorum.[36]

For Raspail, however, science was also a question of political stance. When the Revolution broke out in July 1830, Raspail fought on the barricades. For him, this struggle against the monarchy was inseparably bound with his personal struggle against Cuvier. Shortly after the Revolution, he composed a statement defending Geoffroy's position against Cuvier. At first sight, it dealt with the question being debated before the Académie des Sciences in 1830: whether mollusks were organized according to the same basic plan as vertebrates, or whether their organization followed another pattern. To refute the latter view, Raspail pointed out analogies between the organization of mollusks

34. See Appel, *The Cuvier-Geoffroy Debate* (ref. 28), 40–59, 108, 136–42.

35. François-Vincent Raspail, *Nouvelles études scientifiques et philologiques 1861–1864* (Bruxelles: Librairie nouvelle, 1864), 376.

36. See Weiner, *Raspail* (ref. 3), 114.

and vertebrates. He referred to his own earlier studies of polyps, in which he had not only shown that these were mollusks, but had also determined that they propagated by the same means as all other animals, namely through "eggs and buds." For Raspail, this provided proof of a "primary connection" between higher animals and these "so-called" lower ones.[37] Here, as in his cell theory, he turned against a classification system founded on hierarchies and inequalities. The postulate of his cell theory, according to which all plants and animals consisted of, and originated from, cells, provided a common principle for the formation of all living beings—even the outcast grasses and the "low" polyps.

This view corresponds to a political critique of the same elitist, conservative, and centralized scientific system in France that had enabled Cuvier's dominant position.[38] Through the plethora of offices he held—he was, among other things, the permanent secretary of the Académie des Sciences, professor at the Musée National d'Histoire Naturelle, as well as at the Collège de France—Cuvier ruled monarchically over Parisian science like the king over France. He possessed the power to accept young scientists into any of these scientific institutions. In his statement, Raspail described how this system promoted a servile attitude. He also condemned Cuvier's numerous strategies for silencing dissenting opinions within the Académie des Sciences, and even in the public reporting of the debate. Finally, he denounced the very system that provided one person with such lavish material and personal resources, while a great many other intellectuals were condemned to conduct their research in poverty and without institutional positions.[39] Raspail naturally had his own situation in mind, which resembled that of the grasses and polyps. He associated the Revolution with the hope for the establishment not only of a republic, but also of a new system of science that would allow a position for him in one of the Parisian scientific institutions.[40]

But these hopes were not to be fulfilled. During the July Monarchy, Raspail continued his research as an outsider, even in prison; Cuvier, meanwhile, kept all of his offices. The last king to rule France, Louis Philippe of Orleans, took tough action against the republican opposition, despite his liberal sentiments.

37. François-Vincent Raspail, *Nouveaux coups de fouet scientifiques* (Paris: librairie Meilhac, 1831), 19; see Raspail, "Histoire naturelle de l'Alcyonelle fluviatile," *Mémoires de la Société d'histoire naturelle de Paris* 4 (1828): 75–165.

38. See Appel, *The Cuvier–Geoffroy Debate* (ref. 28), 8, 145.

39. See Raspail, *Nouveaux coups* (ref. 37).

40. On August 19, 1830, he even approached Louis Philippe directly by letter to request a position, see Bédéï and Bédéï, *François-Vincent Raspail* (ref. 3), 79.

Raspail belonged to the victims of this political repression. As a consequence of the critique of the regime and military he had published in the newspaper *La Tribune* on February 18, 1831, but above all because of his activities in the republican association Les Amis du Peuple, Raspail spent 15 months in prison between 1831 and 1832.[41] During the July monarchy, he was repeatedly sentenced to jail time for such offenses.[42] In spite of this, he co-edited a journal, *The Reformer* (*Le Réformateur*), in 1834–1835, in which he articulated his ideas for political, social, and economic reforms.[43]

In accordance with his vision of an organic nature that was subject to continual transformations over time, Raspail held that changes in human society too unfolded slowly and "without leaps and interruptions."[44] The notion of building a new sociopolitical order through revolution or class struggle was, he felt, obsolete. For him, civil wars like the one he had experienced in his childhood were a thing of the past.[45] What mattered now was to deliberate about progressive, persistent, and far-reaching reforms. Just as the environment caused species to transform over the course of history, so too did it influence human societies. Raspail believed the causes of degenerative phenomena, which especially affected the populations of large cities, lay in poor working and living conditions. This tendency could be reversed by creating new economic, social, and political frameworks. The reforms that Raspail imagined embraced a correspondingly wide scope: they contained proposals for the increase of agricultural production, the institution of a new tax system, as well as the introduction of general suffrage.

But the crux of his reforms was the radical decentralization of power relations. Through administrative reform, Raspail wanted to do away with the concentration of power in one person and, especially, in one place: Paris. He

41. Three of his works—*Cours élémentaire d'agriculture et d'économie rurale à l'usage des écoles primaires* (1832); *Le nouveau traité de chimie organique* from 1833 (which was translated into German, English, and Italian) and *Nouveau système de physiologie végétale* (1837)—were written largely in prison.

42. Bédéï and Bédéï, *François-Vincent Raspail* (ref. 3), 61–89.

43. In 1872, he published these articles together in a treatise. The following citations refer to this publication; see François-Vincent Raspail, *Réformes sociales* (Bruxelles: Librairie nouvelle, 1872). On *The Reformer* and on Raspail's republican thinking of the 1830s in general, see Barbier, *Les républiques* (ref. 3), 165–251, and Ludovic Frobert, "Théorie cellulaire, science économique et république dans l'œuvre de François-Vincent Raspail autour de 1830," *Revue d'histoire des sciences* 64 (2011): 27–58.

44. Raspail, *Réformes* (ref. 43), 166.

45. See ibid., 128–33.

demanded that the central administration be divided into small local units: "the central administration must be fragmented, divided and subdivided down to the last and small towns; and each city, forming an administrative unit, will decide the interests of its community. . . ."[46] The last and smallest unit of administration was the "commune." Raspail did not compare the commune to the cell, but he did claim that political organization could be analyzed by the same inductive methods as organic nature. The commune was the basic unit of the new political order he imagined in 1835. At the level of the commune, a new economic and social system was supposed to be established.[47] Raspail didn't just link the association of individuals in communes with the utopia of a decentralized and egalitarian state. The very association of communes with each other, extending beyond the borders of nation-states, was supposed to put an end to antagonisms and wars between nations. Just as in his cell theory Raspail projected the vision of an organic nature in which all plants and animals were equal, so too he dreamt of a future egalitarian and solidary world society: "one day France, Europe, and later the entire universe will form but a single vast family, where men will again become brothers and no longer the subjects of kings."[48] During the 1848 Revolution, Raspail employed the expression "universal republic" in connection to this.[49] That was also the watchword of the supporters of the Paris Commune in 1871. For many nineteenth-century revolutionaries, the decentralization of the state and the abolition of borders and hierarchies between nations were two closely interconnected goals.[50]

Convergences can, therefore, be discerned between Raspail's cell theory and his political thought. And yet he did not equate nature with society, animal with man. In Raspail's eyes, what distinguished human from animal was—besides his intelligence—his "sociability": "that is to say, the irresistible and enduring need a man has to live together with those whom nature made his brothers, in organizing them like him."[51] Animals were of course social beings as well, but their *sociabilité* was far less pronounced—even in the case of man's closest neighbors, the apes. In the attempt to determine the difference between human and animal, Raspail intentionally refrained from making reference to

46. Ibid., 172.

47. See ibid., 169–83.

48. Ibid., 208.

49. François-Vincent Raspail, *L'Ami du Peuple*, 27 Feb 1848.

50. See Kristin Ross, *Communal Luxury: The Political Imaginary of the Paris Commune* (New York: Verso, 2015).

51. Raspail, *Réformes* (ref. 43), 238.

an immaterial soul. In this he was far from discounting the human's moral constitution; rather, for him, body and mind were inextricably intertwined. Virtuous action in humankind depended upon the satisfaction of his material needs. The scientific discipline most adequate to determining those needs, and to finding means of "protecting, nourishing, enlightening, and comforting" was "political economy."[52] Indeed, Raspail ultimately concluded that dealing with man, rather than nature, meant leaving the field of biology behind. After the 1830s, he directed his scientific interest increasingly toward human health problems; he even practiced illegally as a doctor. His medical interests did not fail to feed back into his biological ideas; in 1843, he identified pathological cells as the cause of illnesses.[53] Finally, Raspail's examination of economic, medical, and moral problems strengthened his conviction that the study of humankind must be separated from metaphysics, whether of religious or philosophical nature.[54] At this same time, Theodor Schwann was developing a research program that was defined, to a large extent, by religious metaphysics.

SCHWANN: ACCOUNTING FOR THE HUMAN SOUL AND FOR DIVINE PURPOSIVENESS

Theodor Schwann was born in 1810, sixteen years after Raspail, in the small Rhenish town of Neuss. Like Raspail, he grew up in a pious Catholic family. The young Schwann was close to his older brother Peter, who later went on to become a priest and theologian. But unlike his brother, Theodor chose to study not theology, but medicine, first in Bonn, then in Würzburg. In 1833, he moved to Berlin to complete his medical degree and to write his doctoral dissertation under the supervision of Johannes Müller. Müller, professor of anatomy and physiology at the University of Berlin, offered him a position as his assistant at the "anatomical museum." It was during this time—between 1835 and 1838—that Schwann made a number of important discoveries and ultimately formulated his famous cell theory.[55] The prevailing historical narrative of this propitious moment for biology has been heavily influenced by

52. Ibid., 235.

53. François-Vincent Raspail, *Histoire naturelle de la santé et de la maladie chez les végétaux et chez les animaux en général et en particulier chez l'Homme* (Paris: chez l'éditeur de M. Raspail, 1843).

54. See Raspail, *Réformes* (ref. 43), 238–40.

55. On Schwann's life, see Florkin, *Naissance* (ref. 10) and Watermann, *Theodor Schwann* (ref. 8).

Schwann's own account. In a speech he delivered in 1878, at the celebration of the fortieth anniversary of his cell theory, Schwann insisted upon the decisive role his encounter with Schleiden in October 1837 had played in his findings. Schleiden had then recently highlighted the importance of the "nucleus" in the development of plant cells. Schwann recalled his realization, upon this meeting, that by proving that the cell nucleus played the same role in the development of animals as in plants, one could definitively disprove the existence of a vital force.[56] This account is problematic, and not just because he composed it with forty years of hindsight. A letter written by the zoologist Edouard van Beneden, the man in charge of that celebration in honor of his cell theory, reveals that Schwann had initially planned to make a philosophical and religious statement on this occasion. Unlike his father—the zoologist Pierre-Joseph van Beneden, a friend of Schwann, a supporter of Cuvier's fixed species philosophy, and a standard-bearer for Catholicism—Edouard was a Darwinian and materialist. He tried to persuade Schwann "not to leave the territory of science."[57] Schwann not only complied with this request, but also refrained from publishing his numerous philosophical and theological essays, thereby contributing to a historical narrative of cell theory that was untouched by metaphysical considerations. In this section, I offer new insights into the relationship between science and religion in Schwann's 1830s agenda.

A letter written to his brother Peter in March 1835 sheds light on the intellectual context in which Schwann's research began. In this letter, Schwann expressed his disagreement with Müller's position on the question of the location of the soul, which was inspired by the philosophy of Friedrich Wilhelm Joseph von Schelling.[58] Müller—as Schwann explained to his brother—was trying "to prove that the psychic principle extends throughout the entire body."[59] For

56. Commission organisatrice, *Manifestation en l'honneur de M. le professeur Th. Schwann, Liège, 23 juin 1878; liber memorialis* (Düsseldorf: Schwann, 1879), 51.

57. Letter of Edouard van Beneden to Jean Servais Stas, 18 May, 2 Jun, 15 Jun 1878. Fonds J. S. Stas, Université de Bruxelles, quoted in Marcel Florkin, *Lettres de Théodore Schwann* (Liège: Société Royale des Sciences de Liège, 1961), 206. On the father and son van Beneden, see G. Hamoir, "Du fixiste Pierre-Joseph van Beneden à son fils Darwinien Edouard," *Revue médicale de Liège* 54, No. 7 (1999): 636–43.

58. See Nelly Tsouyopoulos, "Schellings Naturphilosophie: Sünde oder Inspiration für den Reformer der Physiologie Johannes Müller?" in *Johannes Müller und die Philosophie*, ed. Michael Hagner and Bettine Wahrig-Schmidt (Berlin: Akademie Verlag, 1992), 65–83. On Müller and on his relationship with Schwann, see Otis, *Müller's Lab* (ref. 11).

59. Letter from Schwann to Peter Schwann, 7 Mar 1835, printed in Florkin, *Lettres* (ref. 57), 31–32, on 32.

Müller the "psychic principle" was equivalent to the life-force, or the soul. Like many other physiologists of that time, he assumed that organic processes were manifestations of such an immaterial principle.[60] This approach troubled Schwann, since it undermined the idea "that each individual is endowed with his own, unique, and new psychic principle."[61] The distinctiveness of the human soul and free will was central to Schwann's thinking. He first encountered this notion through his religious instructor, the priest and novelist Wilhelm Smets. In his diary Schwann recalled: "When during my 16th and 17th years I attended Smets's religious lessons in Cologne, a wholly new field was opened to me: the teaching of God and the dignity of man, who distinguishes himself from all of nature through his freedom, made the deepest of impressions upon me."[62] Schwann's science would always be shaped by the dualism between body and mind.

The fact that Schwann enclosed excerpts of this letter in his research notebooks from 1835, shows that metaphysical concerns were entangled with his science from the very beginning.[63] Between 1835 and 1837, Schwann conducted investigations of muscle contraction, stomach digestion, putrefaction, and fermentation. He wanted to prove that living phenomena had physical, material causes, rather than being manifestations of some immaterial vital force. Cells were largely absent from this initial research program.[64] According to his own narrative, mentioned earlier, the encounter with Matthias Schleiden in October 1837 gave him a strong incentive to formulate a general law of organic development. But did Schleiden und Schwann discuss only cells? Schleiden was also dissatisfied with the impact of Schelling's philosophy on natural science in general, and on Müller's physiology in particular. He, too, contended that

60. See Johannes Müller, *Handbuch der Physiologie des Menschen*, Vol. 2 (Coblenz: Hölscher, 1840), 505–10.

61. Letter from Schwann to his brother Peter, 7 Mar 1835, in Florkin, *Lettres* (ref. 57), 32.

62. Schwann, "Tagebuch" (ref. 12), 40.

63. Ohad Parnes has provided an in-depth analysis of Schwann's research notes ("Tagebuch über naturwissenschaftliche und medizinische Beobachtungen und Versuche") and found excerpts of the aforementioned letter in the entry of March 18; see Ohad Parnes, "From Agents to Cells. Theodor Schwann's Research Notes of the Years 1835–1838," in *Reworking the Bench: Research Notebooks in the History of Science*, ed. Frederic Holmes, Jürgen Renn, and Hans-Jörg Rheinberger (Dordrecht: Kluwer, 2003), 119–39.

64. Ibid. See also Ohad Parnes, "Vom Prinzip zum Begriff. Theodor Schwann und die Entdeckung der Zelle," in *Begriffsgeschichte der Naturwissenschaften. Zur historischen und kulturellen Dimension naturwissenschaftlicher Konzepte*, ed. Ernst Müller und Falko Schmieder (Berlin: de Gruyter, 2008), 27–51; Otis, *Müller's Lab* (ref. 11), 59–64; Watermann, *Theodor Schwann* (ref. 8), 55–171.

Müller did not sufficiently distinguish between "physical life" and "independent spiritual life."[65] Supposing they did converse about philosophy, Schwann's encounter with Schleiden might thus have reinforced his drive to formulate a theory of life based on a strict mind-body dualism.

However, the political context of the year 1837 could also have influenced his research. That year was marked by a conflict between the government of Prussia and the archbishop of Cologne (Clemens August Droste zu Vischering) over the education of children of mixed—Protestant and Catholic—marriages. The conflict ended in November 1837 with the arrest of the archbishop.[66] Like many Prussian Catholics, Schwann seems to have been split between his patriotic and religious commitments. Reflecting on this event in his diary, Schwann wrote: "The news of the archbishop Clemens August led me to think more earnestly about religion. I was, to be sure, on the side of the government; and yet I yearned to break free from my religious state, which was Catholic but nonetheless based on rationalism. . . . "[67] It was during the following months, in the year 1838, that Schwann investigated analogies between plant and animal cells and formulated a principle of development common to both realms of nature. At the final stage of writing his treatise, *Microscopic Researches into the Accordance in the Structure and Growth of Animals and Plants*, Schwann voluntarily submitted his manuscript to the archbishop of Mechelen (the primacy in Belgium). This fact comes down to us through Jakob Henle, who was Müller's favorite student and a close colleague of Schwann during his years in Berlin.[68] At that time, Schwann had received a job offer for a professorship from the Belgian University of Louvain. Apparently, he desired his scientific work to meet with the approval of the Catholic authorities in his new home country.

Thus, Schwann intended to formulate a theory of life consistent not only with his personal faith, but also with Catholic doctrine. But to what degree did

65. Matthias Schleiden, *Grundzüge der wissenschaftlichen Botanik nebst einer methodologischen Einleitung als Anleitung zum Studium der Pflanze* (Leipzig: Engelmann, 1842), 77; and Schleiden, *Schelling's und Hegel's Verhältnis zur Naturwissenschaft. Zum Verhältnis der physikalistischen Naturwissenschaft zur spekulativen Naturphilosophie*, ed. Olaf Breidbach (Weinheim: VCH, Acta Humanoria, 1988 [original edition 1844]), 1–13. On Schleiden's dualism, see Bernhard Kleeberg, *Theophysis. Ernst Haeckels Philosophie des Naturganzen* (Köln: Böhlau, 2005), 46–57.

66. See Manuel Borutta, *Antikatholizismus. Deutschland und Italien im Zeitalter der europäischen Kulturkämpfe* (Göttingen: Vandenhoeck & Ruprecht, 2010), 269–73.

67. Schwann, "Tagebuch" (ref. 12), 41. See Watermann, *Theodor Schwann* (ref. 8), 28.

68. See Jakob Henle, *Theodor Schwann. Nachruf* (Bonn: Verlag Cohen und Sohn, 1882), 42; and Watermann, *Theodor Schwann* (ref. 8), 26.

the content of his cell theory reflect this intention? How much did Schwann's and Raspail's divergent views on science and religion impact their respective research approaches and theories? As with Raspail, Schwann's microscopic investigations of animal tissues in 1838 consisted of tracing their development back to its first, primitive stages. This approach allowed him to posit that animal tissues were formed from cells—cells that were analogous to plant cells.[69] Yet, although their cell research was based on a similar developmental approach, their concepts of "development" differed in significant ways. For Schwann, cells of animal tissues were generally formed "exogenously" (between cells, not inside them) from a "cytoblastem," a structureless intracellular substance. In cases where cells were engendered by other cells, he assumed that the "nucleus"—the first, primitive element of the cell formation process—would be "resorbed."[70] This second model of cell formation offered a new, cellular explanation of organic formation. Schwann defined the egg as a cell, and the primitive unit of organic formation—the "Keimbläschen"—as the nucleus of the cell.[71] He postulated that this unit would disappear after fertilization. Thus, contrary to Raspail's, Schwann's cell theory did not envision the existence of a continuity between generations of cells and organisms. The notion of an organic nature subject to contingent changes over time was totally absent from his theory. Indeed, its purpose was not to account for the historicity of the living world, but to account for an organic nature regulated by a divine plan.

In the last, theoretical part of his treatise, Schwann claimed that to reject the notion of a vital force did not entail a denial of purposiveness. Rather, it was to assume that in organic as well as inorganic nature, there existed no finality except God's. This assumption motivated his attempt to rethink the forces of the living world by analogy with the physical—"blind"—forces of inorganic nature. Indeed, his treatise ends with an extensive comparison of the formation of cells to the formation of crystals.[72] As Henle pointed out, Schwann's intention was not an "undeification [*Entgötterung*] of nature," but, on the contrary, the reconstruction of a worldview that "imagines all developmental plans united in the hand of an immaterial Creator."[73] Schwann opposed vitalism because, in his

69. Theodor Schwann, *Mikroskopische Untersuchungen über die Uebereinstimmung in der Struktur und dem Wachsthum der Thiere und Pflanzen* (Berlin: Reimer, 1839).

70. Ibid., 45, 44.

71. Ibid., 258–59.

72. Ibid., 222–56.

73. Henle, *Theodor Schwann* (ref. 68), 41–42.

eyes, the notion of an independent force governing processes of the living world weakened God's almightiness.[74] Few historians of biology have acknowledged this central aspect of Schwann's research agenda.[75] In his influential study *The Strategy of Life*, Timothy Lenoir argues that German biologists of the nineteenth century—including Schwann—never made use of "the notion of a purposeful divine architect. This position was expunged by Kant as having no place in natural sciences."[76] This judgment should be revisited. As we will see in the next section, in the Germany of the 1850s and 1860s, the relationship between natural science and religion was central enough to become a subject of passionate debate.

SCHWANN: COUNTERING MATERIALISM AND REPUBLICANISM

After the formulation of his cell theory, the context of Schwann's research underwent significant changes. As mentioned above, in April of 1839, Schwann left Berlin, Müller, and his fellow students for the Belgian town of Louvain, where he had obtained a professorship of anatomy. In 1849, he was appointed professor of anatomy at the University of Liège, where he stayed until his retirement in 1879. Belgium had experienced a revolution in 1830, and thereafter became an independent state governed by a constitutional monarchy. For this reason, it was spared by the revolutions that affected many other European countries in 1848, including Schwann's home country. In the German-speaking lands, the revolutionaries failed to realize their two key demands: the creation of a united German nation and the establishment of democracy. In this post-revolutionary context, a dispute arose among German philosophers, physicians, theologians, and natural scientists over the issue of materialism (called the *Materialismusstreit*).[77] The literature on this debate does not consider Schwann's

74. See Schwann's own statements of 1878, in Commission organisatrice, *Manifestation* (ref. 56), 50, 52.

75. See Owsei Temkin, "Materialism in French and German Physiology of the Early Nineteenth century," *Bulletin of the History of Medicine* 20, No. 1 (1946), 322–27; Frederick Gregory, *Scientific Materialism in Nineteenth Century Germany* (Boston: Reidel Publishing Company, 1977), 164; John Hedley Brooke, "The Superiority of Nature's Art? Vitalism, Natural Theology and the Rise of Organic Chemistry," in *Science and Religion/Wissenschaft und Religion*, ed. Änne Bäumer and Manfred Büttner (Bochum: Brockmeyer, 1989), 38–48, on 44.

76. Timothy Lenoir, *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology* (Chicago: Chicago University Press, 1984), 4.

77. See Kurt Bayertz, Myriam Gerhard, and Walter Jaeschke, eds., *Der Materialismus-Streit* (Hamburg: Felix Meiner Verlag, 2012); Kurt Bayertz, Myriam Gerhard, and Walter Jaeschke, eds.,

position. Even though he published no explicit statement, his writings of that period indicate that his post-1839 research agenda addressed the scientific, religious, and political issues involved in this controversy.

One of the main bones of contention was the soul. In 1847, in the run-up to the revolution that broke out the following year, the zoologist Carl Vogt polemically voiced the view that consciousness was a function of the brain: "the seat of consciousness, of the will, of thought, must finally be sought in the brain alone. . . . To presume a soul that makes use of the brain like an instrument, with which it can labor as it pleases, is sheer nonsense."[78] During the revolution, Vogt was politically active on the side of the democrats. He became a member of the National Assembly in Frankfurt, advocating universal suffrage and the separation of church and state.[79] The positions he defended during the revolution revealed the political potential of his scientific claims. When in the 1850s and 1860s, scientists like Schleiden or the physiologist Rudolf Wagner launched their attacks on materialism, they certainly disapproved of the revolutionary ideas that left-wing activists and democrats like Vogt had fought for in 1848.[80] However, they also opposed materialistic scientific theories because, in their eyes, they threatened religion's stabilizing function for society. Wagner and Schleiden both argued for separate spheres of influence for religion and natural science. The division between natural science and theology was for them a necessary and irreversible historical development. But if the Christian faith no longer had any place in the investigation of nature, it followed that natural science should refrain from making any statements on the existence of a soul, free will, and God.[81] As Schleiden stated, the vocation of natural science

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Weltanschauung, Philosophie und Naturwissenschaft im 19. Jahrhundert (Hamburg: Felix Meiner Verlag, 2007).

78. Carl Vogt, "Physiologische Briefe für Gebildete aller Stände. Zwölfter Brief. Nervenkraft und Seelentätigkeit," in Bayertz et al., *Der Materialismus-Streit* (ref. 77), 1–14, here 5, 6.

79. See Nyhart, this issue.

80. On Wagner's political position, see Christian Jansen, "'Revolution'—'Realismus'—'Realpolitik'. Der nachrevolutionäre Paradigmenwechsel in den 1850er Jahren im deutschen oppositionellen Diskurs und sein historischer Kontext," in Bayertz et al., *Weltanschauung* (ref. 77), 223–59. On Schleiden, see Matthias Schleiden, "Ueber den Materialismus unserer Zeit. Zerstreute Gedanken" (1857) reprinted in Marianne Scholz, *Matthias Schleiden in Tartu (Dorpat) 1863–1864* (Essen: die blaue Eule, 2003), 129–37.

81. Rudolf Wagner, "Menschenschöpfung und Seelensubstanz. Ein anthropologischer Vortrag, gehalten in der ersten öffentlichen Sitzung der 31. Versammlung deutscher Naturforscher und Aerzte zu Göttingen am 18. September 1854," and "Ueber Wissen und Glauben mit besonderer Beziehung zur Zukunft der Seelen. Fortsetzung der Betrachtungen über 'Menschenschöpfung und Seelensubstanz'," in Bayertz et al., *Der Materialismus-Streit* (ref. 77), 67–103;

was exclusively to produce truths on the "bodily world." It was not competent to deal with "human society, its moral existence and religious consciousness."[82] By articulating an atheistic worldview, but more fundamentally by making claims on humanity and society, materialistic scientific theories illegitimately expanded the domain of authority of natural science. Interestingly, Schwann's attempt to counter materialism followed a different direction.

For Schwann, in contrast to Wagner and Schleiden, science, theology, and religious faith could not be kept apart. His confession in his unpublished essay "Man as he is and as he should be: Considered from a physiological standpoint" of 1864 leaves no doubt: "There is only one truth, and no serious man can accept any ideas in the special field of his work that contradict his religious convictions. . . . I am, by full conviction, Christian and Catholic, and hold the dogmas of the Catholic Church as incontrovertible truth; thus, I use them as a scientist uses facts."[83] But what did this position mean for his research and his outlook on society and politics? Schwann's diary and likewise his essay "Man" show that from the 1840s on, free will and its concomitant theological problems represented important parts of his own research agenda.[84] Yet the assumption of a soul had implications for his physiological studies, too. In his popular 1855 textbook of human anatomy, Schwann made it clear that the brain was not the first cause of thought. Nonetheless, as if responding to Vogt, he claimed that the body should not be considered merely as an instrument of the soul, either: "The body cooperates actively with all spiritual processes and modifies them."[85] Whereas Wagner and Schleiden excluded the soul from their biology, the complex interactions between body and mind became part of Schwann's physiology.[86] Moreover, in the following years, his ambition to connect his science with theology led him to formulate a new theory of the living world—a theory that entailed a significant revision of his 1838 cell theory.

In his unpublished essay "Man" of 1864, Schwann presented a theory that accounts both for the distinctiveness of humankind and for the specificity and unity of animate nature. The recourse to physical forces for thinking about physiological processes without a life-force was for him no longer an

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Matthias Schleiden, *Ueber den Materialismus der neueren deutschen Naturwissenschaft, sein Wesen und seine Geschichte* (Leipzig: Engelmann, 1863).

82. Schleiden, "Ueber den Materialismus" (ref. 80), 134.

83. Schwann, "Der Mensch" (ref. 12), 48.

84. See ibid., 32–47.

85. Theodor Schwann, *Anatomie du corps humain* (Brussels: Jamar, 1855), 83.

86. See also Watermann, *Theodor Schwann* (ref. 8), 190–98.

alternative. His basic new assumption was that the organic world rested upon a "psychic" principle. For Schwann, "psychic" did not equate to an immaterial, exclusively human principle of the soul. This concept instead referred to the world of affects, of "sensations, feelings, pleasure and displeasure."[87] If organic nature, beginning with atoms, was equipped with "psychic" qualities, then a potential new explanation of formative processes emerged. Schwann believed that, among the atoms, "a mutual solidarity of their psychic states occurs so that, when one is set into a condition of pleasure by an external effect, the other atoms belonging to the same cell partake of it. There is thus formed in each cell a higher psychic individuality. . . ."[88] This phenomenon of the "mutual solidarity of the psychic states of atoms" was, according to Schwann, responsible for the coming into being of cells, entire organisms, and species. All of these entities accordingly constituted "psychic individualities." In humankind, these "psychic individualities" were not equivalent to the soul, but were still connected to it.[89]

But how exactly did the interaction of atoms, molecules, and cells shape itself into a whole, into the organism? To visualize his conception, Schwann employed the model of the army. Molecules resembled "an irregular mass of soldiers." The process of the unification of molecules into cells paralleled the organization of these soldiers into a "company in rank and file." Cells, in Schwann's theory, were akin to military units subordinated to other, higher organizational units. Schwann pictured the organism as "a whole army corps, with infantry, cavalry, artillery."[90] Already in his textbook of human anatomy from 1855, Schwann had drawn analogies between corporeal and military organization. Both organizational forms were characterized by hierarchical structures, in which information was transmitted from bottom to top and commands issued from top to bottom. "One can compare this organization to that of an army: the sense-organs are the sentinels; the sensitive nervous fibers are the patrols who transmit the impressions received to the general quarter. The latter, in turn, decides what movements shall be made and transmits its orders, via the sergeant major (the motor nerve-fibers), to the active organs of movements, that is to say the body of troops, and to the muscles."[91] It is remarkable that the social world,

87. Schwann, "Der Mensch" (ref. 12), 54.

88. Ibid. Interestingly, in the 1830s–1850s, Auguste Comte introduced the concept of solidarity in his analysis of organism and society. On Comte and Charles Robin's use of this concept, see Thomas, this issue.

89. Schwann, "Der Mensch" (ref. 12), 54.

90. Ibid., 56.

91. Schwann, *Anatomie* (ref. 85), 82.

which had been absent from Schwann's physiology of the 1830s, now entered his descriptions of the body. To be sure, the use of social and political metaphors in general increased in biology from the 1850s onward.[92] Nevertheless, what makes Schwann's physiology of the early 1860s peculiar is that he explicitly equated society with the body and used the authority of nature to vindicate monarchy.

More precisely, Schwann's new law of formation suspended the division between organic nature and society. According to his theory, the formation of "psychic individualities" did not cease at individual organisms. Groups of organisms, in animal and human society equally, arose through the principle of "psychic solidarity." In human societies, members of a family were linked to one another through "a common psychic bond." Families, in turn, were united into "communes." Put together, the communes formed the "nation." Schwann approved of the idea of a nation. However, he did not think of this entity as the result of historical and political processes of formation, but rather as a "product of nature." As such, he claimed, it should have "an organization provided by nature." That, in his eyes, was the "moderate monarchy." He rejected the "republic" on that grounds that it was "a product of rationalism, which takes no account of instinctive feelings, but constructs the organization of nations a priori, on the principle of the general equality of mankind."[93] Whereas Raspail associated the idea of the commune with the radical decentralization of political power relations and the overcoming of nationalism, Schwann by no means conceived of the commune as an autonomous political unit. It was much more an organic component of a vertical national community, with the monarch at its summit.

Schwann did not merely draw on the model of a hierarchically structured institution, like the army, for visualizing the interaction of elementary parts and organs in the body. He was convinced that an organizational form based on inequality and the subordination of its individual parts conformed to a natural order, and was moreover compatible with religious faith. With this outlook, interestingly, he turned away from the decentralized model of the body that had undergirded his cell theory in 1838. In his treatise of 1839, Schwann had used the expression "autocracy of the organism" in connection with his critique of life-force.[94] At that time, he had rejected the idea of any central, superordinate principle in the body that guides all formative and

92. See the introduction by Nyhart and Vienne, this issue; and Andrew Reynolds, "Ernst Haeckel and the Theory of the Cell State: Remarks on the History of a Bio-Political Metapher," *History of Science* 46 (2008): 123–52.

93. Schwann, "Der Mensch" (ref. 12), 57.

94. Schwann, *Mikroskopische Untersuchungen* (ref. 69), 223.

developmental processes. Schwann's religiously motivated search for an alternative to vitalism had led him to place the principle of cellular autonomy at the center of his theory. "Every cell," he wrote, "is within a certain limit an individual, an independent whole."[95] In the 1850s, Virchow would take this idea in a republican direction, describing the organism as a "state" made up of cells he compared to equal and autonomous individuals or "citizens."[96] By the 1860s, Schwann had taken up a different tack.

Schwann's example illustrates how a dualistic position could go together with a naturalization of society and humankind. His cell theory of the 1860s elevated society to an object of physiology. With respect to his material existence—which in Schwann's theory included his affective, social, and political existence—the human resembled an animal. As for Raspail, his cell research had inspired some of his proposals for social and political reform of the 1830s. Yet maintaining the difference between society and nature, human and animal, was central to his political thinking. Precisely his interest in the *homme matériel* had driven Raspail to dedicate more of his attention to political economy and social medicine. These, and not biology, were for him the fields of knowledge that ought to have pride of place in the study of man.

CONCLUSION: AN ENCOUNTER THAT NEVER HAPPENED

In his treatise *Microscopic Researches*, Schwann claimed to be the first to have derived a common developmental principle from the comparison of plant and animal cells.[97] Neither that paper, nor any later accounts of his discovery of cells, mentions Raspail's name.[98] Conversely, I could find no reference to Schwann's cell theory in Raspail's post-1839 scientific publications. Raspail and

95. Ibid., 2.

96. See, e.g., Johach, *Krebszellen* (ref. 1); Renato G. Mazzolini, *Politisch-biologische Analogien im Frühwerk Rudolf Virchows* (Marburg: Basiliken-Presse, 1988); Andrew Reynolds, "The Theory of the Cell State and the Question of Cell Autonomy in Nineteenth and Early Twentieth-Century Biology," *Science in Context* 20, no. 1 (2007): 71–95.

97. See Schwann, *Mikroskopische Untersuchungen* (ref. 69), 13.

98. Russel C. Maulitz, however, refers to an exchange of letters between Raspail and the French biologist Jacques Coste concerning Coste's study *Ovologie du kangourou* (1838) and preserved in Schwann's unpublished papers; see Russel C. Maulitz, "Schwann's Way: Cells and Crystals," *Journal of the History of Medicine and Allied Sciences* 26 (1971): 422–37. So far, I have been unable to find this source in the Archives of the University of Liège and the Archives of the Medizinische Historische Museum der Charité in Berlin, where most of Schwann's papers are kept.

Schwann most likely never met, although they lived within a short geographical distance from one another in the 1850s. Raspail stayed in Belgium from 1853 to 1862 as a political refugee, as a consequence of his post-1848 political activities. As we have seen, Raspail and Schwann had good reasons to ignore each other's existence. Their worldviews and life courses stood diametrically opposed to one another. This antithesis revealed itself particularly clearly in their conceptions of time. For Raspail, the passage of time meant change. The future could not and should not be "the servile prolongation or reproduction of the past."[99] His cell theory delivered an explanation for the continuous and contingent transformations of organic nature over the course of time. Politically, he fought for the dawn of a new era, in which all people could live in equality and free from poverty. The focus of Schwann's work and thought, by contrast, was that which is not subject to time. One year before his death, he wrote in his diary: "Nature as a side issue . . . time as a side issue." The main issue, for him, was "eternity"—by which he meant the eternal, spiritual life of humankind.[100]

This case study demonstrates that cell theory, contrary to the prevailing historical narrative, was not exclusively connected with materialism, liberalism, and revolutionary politics. The idea of a unifying principle of organic development did not emerge from a coherent philosophical and political position, but encompassed different and even antagonistic visions of nature, humankind, society, and the role of religion in science. Raspail and Schwann represented opposite worldviews that remained in conflict with each other throughout the nineteenth century, but which nevertheless articulated a very similar concept of the basic principles of life.

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99. Raspail, *Réformes* (ref. 43), 152.
100. Schwann, "Tagebuch" (ref. 12), 20, see also 7.