

Yafeng Shan

Doing Integrated History and Philosophy of Science: A Case Study of the Origin of Genetics



Springer

Boston Studies in the Philosophy and History of Science

Volume 320

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Yafeng Shan

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 Springer

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ISSN 0068-0346 ISSN 2214-7942 (electronic)
Boston Studies in the Philosophy and History of Science
ISBN 978-3-030-50616-2 ISBN 978-3-030-50617-9 (eBook)
<https://doi.org/10.1007/978-3-030-50617-9>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Acknowledgments

Most chapters of this book were written during my IHPLS research fellowship (2018–2019) at the Cohn Institute for the History and Philosophy of Science and Ideas, Tel Aviv University. I am grateful to the Cohn Institute and Inter-University Programme in History and Philosophy of Life Sciences for the institutional and financial support. I would like to thank my colleagues at the Cohn Institute, especially Jose Brunner, Eva Jablonka, Shaul Katzir, and Ido Yavetz, and my fellows at IHPLS programme: Aya Evron, Topaz Halperin, Oren Harman, Arnon Levy, Jonathan Najenson, Nadav Rubinstein, and Ayelet Shavit. In particular, I would like to express my gratitude to Ehud Lamm and Adam Krashniak for their help during my time in Israel.

The idea of this book originated during my PhD study at University College London (UCL), while the book was completed at the University of Kent. I am very grateful to all those who have helped my thinking and writing. When I was a PhD student at UCL, I was strongly influenced and luckily nurtured by the integrated History and Philosophy of Science community in the UK. I am especially indebted to Hasok Chang and Greg Radick, who were my PhD examiners. Hasok's influence is enormous through his writings on integrated HPS and his sharp and constructive comments on my ideas. Greg's influence is also tremendous. Without Greg, Chap. 4 would have never existed. It is Greg who introduced me to Weldon's fascinating work. I am grateful to Jon Williamson for his invaluable advice and suggestions. I would like to thank Mike Buttolph for extensive discussion on Mendel and the history of genetics, his careful reading of the early drafts of the chapters in Part I, and giving me the copies of Bailey's paper and Darbirshire's paper. I would like to extend special thanks to Hugh Mackenzie for the helpful discussion and reading the chapters in Part II. I would also like to thank Jonathon Hricko for discussing the early versions of some arguments in this book.

Early versions of some arguments were presented at various conferences, including the meetings of International Society of History, Philosophy, and Social Studies

of Biology (2013, 2015, 2017, 2019); the Philosophy of Biology in the UK conference (2016); the International Congress of Logic, Methodology, and Philosophy of Science (2015); the annual UK Integrated History and Philosophy of Science Workshop (2013, 2014, 2015); and various seminars and workshops in Durham, Helsinki, Jerusalem, London, Singapore, Sofia, Tel Aviv, and Zurich. I benefited much from the discussion with the audience there. In particular, I would like to thank Garland E. Allen, Theodore Arabatzis, L. A. Callender, Lindley Darden, Michael Friedman, Jonathan Hodge, Frank James, Samir Okasha, Nils Roll-Hansen, Sahotra Sarkar, and C. Kenneth Waters for their stimulating comments and encouragement.

I am also grateful to Rafa Siodor and his colleagues at UCL Special Collections for their help when I was archiving Weldon's manuscripts there. I would also like to thank two anonymous referees for Springer, for extremely constructive and helpful comments.

I would like to thank the great team at Springer who helped to bring this book to print. In particular, I would like to thank Lucy Fleet, Silvie Demandt, Prasad Gurunadham, Christopher Wilby, and S. Keerthi Kumari for their patience and efficiency.

I also owe my thanks and formal acknowledgment to publishers for granting me permission to revise and republish parts of my own previously published work as follows: Chapter 5 incorporates material from Shan, Yafeng. 2020. "Kuhn's 'Wrong Turning' and Legacy Today." *Synthese* 197 (1): 381–406. Chapter 6 incorporates material from Shan, Yafeng. 2019. "A New Functional Approach to Scientific Progress." *Philosophy of Science* 86 (4): 739–58.

Last but not least, I would like to thank my wife, Zifei, for her support and companionship. I would also like to thank Ajiao, Kai, San, and Wendi for their moral support.

This book is financially supported by Israel Science Foundation, British Society for the History of Science, and the Leverhulme Trust.

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Chapter 1

Introduction



*Philosophy of science without history of science is empty;
history of science without philosophy of science is blind.*

(Lakatos 1970, 91)

Abstract History and philosophy of science (HPS) has been controversial since its birth. In particular, the legitimacy of its status as an academic discipline has been constantly challenged and questioned. Nevertheless, substantial hope for HPS as a productive academic discipline is not dead. Some historically-minded philosophers of science and philosophically-minded historians of science never stop making efforts to promote the dialogue across the boundaries and defend HPS against the challenges in various ways. Integrated history and philosophy of science (integrated HPS) is such an attempt. It aims at a balanced inquiry from which both history of science and philosophy of science can benefit. In a nutshell, integrated HPS maintains that HPS should be both a good philosophy of science and a good history of science at the same time.

Keywords HPS · Integrated HPS · Anti-anachronistic reading

1.1 History and Philosophy of Science

In the late 1950s, more and more philosophers of science, including Norwood Russell Hanson, Mary Hesse, and Stephen Toulmin, recognised the significance of history of science in the philosophical examination of science. It does not mean that pre-1950 philosophy of science work is history-free. Rather in the 1950s philosophers of science became more careful and serious in using historical cases to philosophise. This tendency was greatly reinforced by the works of Thomas Kuhn, Imre Lakatos, Paul Feyerabend, Larry Laudan and others in the following decades. Consequently, as Ronald Giere (1973, 291) observed, “[T]hose philosophers of science who make serious use of the history of science form a loosely connected

school within the philosophy of science.” This is what is later called “the historical turn” in the twentieth century philosophy of science (Bird 2008).

Concurrently, new postgraduate programmes and departments with an interdisciplinary focus on the historical and philosophical studies of science were founded in the United Kingdom and the United States. The Division of History and Philosophy of Science within the Department of Philosophy at University of Leeds was established in 1956,¹ while the Department of History and Philosophy of Science at Indiana University, the first department of its kind in the United States, was founded in 1960,² quickly followed by the establishment of similar departments in North America.³ In 1970, *Studies in History and Philosophy of Science*, a new interdisciplinary journal that “devoted to the study of the conceptual history and foundations of science”, was established by Gerd Buchdahl and Laudan. The historical turn, as well as the creation of new programmes, departments, and journals, advances the formation of history and philosophy of science (HPS) as a new academic discipline.

However, HPS has been controversial since its birth. In particular, the legitimacy of its status as an academic discipline has been constantly challenged and questioned. For modest sceptics, “[w]hether [a marriage of convenience between history of science and philosophy of science] will prove to be relatively permanent or only transitional remains to be seen” (Giere 1973, 296). For radical sceptics, “the failure of HPS” is simply a fact (Kuukkanen 2016, 3). To some extent, such scepticism seems to be justified in various ways. Institutionally, HPS is not very well developed in general, despite that there are still a number of HPS departments and postgraduate programmes worldwide. After a quick development in the 1970s, the institutionalisation of HPS slowed down. As Laudan (1989, 11) noted, “[HPS] slowly atrophied, and was finally officially pronounced dead at Princeton and Pennsylvania. It flickered briefly at numerous other places (e.g. Minnesota, MIT, Brandeis, Oxford, Oklahoma, Sussex, Melbourne, John Hopkins) but only occasionally became more than a rocky marriage of convenience at any of the latter.” Thus, it is no wonder that Steven Shapin and Simon Schaffer (2011, xxi) regard the creation of HPS departments as “a largely unsuccessful experiment.”

Axiologically, HPS is not easily viable, especially from a historian’s viewpoint. It is commonly held that history of science and philosophy of science have distinct aims and problems (Giere 1973; Cohen 1977; Pinnick and Gale 2000; Steinle and

¹Although it is often claimed that the Division of History and Philosophy of Science at Leeds is one of the oldest institutions of its kind in the world, the oldest HPS department in the UK was founded at University College London (UCL) much earlier. It was established in 1921 under the name “Department of History and Method of science”, though it was renamed twice later (“Department of History and Philosophy of science” in 1938, and “Department of Science and Technology Studies” in 1994).

²Facing the resistance from the philosophy department, HPS department at Indiana was initially named “the department of history and logic of science” by Hanson (Grau 1999, S302).

³The HPS graduate program was launched at Princeton University in 1961 and at University of Pennsylvania in 1962. HPS department at Pittsburgh was established in 1970 while the HPS graduate program was introduced 1 year earlier.

Burian 2002; Kuukkanen 2016). And these differences are still growing. As Friedrich Steinle and Richard Burian (2002, 392) indicate, “there is a growing gulf between philosophical studies of conceptual change on the one hand, and cultural studies of scientific practices (which have recently helped to reshape the history of science) on the other.” Today, historians of science tend to view science as a social phenomenon and thus focuses more on the issues of social histories, cultural histories, and histories of materials. In contrast, contemporary philosophers of science are fundamentally interested in the epistemic content of science. Accordingly, it is more and more difficult for philosophers of science and historians of science to find the works of each other that are relevant to their own concerns. In other words, it seems that “history and philosophy of science do not have much to say to one another.” (Arabatzis and Schickore 2012, 396) Therefore, for many, the axiological parallel dooms a pessimistic prospect of HPS.

Methodologically, HPS has been heavily criticised. Most of the HPS works in the past four decades (e.g. the historicist approach to the scientific realism debate) can be characterised as the instances of the confrontation model, of which the basic idea is to test philosophical theories against historical data.⁴ However, this confrontation model is shown to be problematic. Firstly, it implicitly assumes that there is an objective or neutral historiography which is capable of producing historical data that can be used in a straightforward manner to test philosophical theories. However, as Hans Radder (1997, 638) indicates, this assumption is highly implausible. It is doubtful that there is only one proper approach to the history of science, and even if so, more is to be said about which is the proper one and why. Secondly, the confrontation model oversimplifies the ways of understanding scientific practice. Jutta Schickore (2011, 471–74), for example, famously argues that the study of science, whether historical or philosophical, results from a hermeneutic analysis, “in which preliminary concepts and frameworks and initial case judgments are modified and adjusted until a cogent account is obtained, and this procedure should be reflected in our writing about science.” Clearly, the confrontation model fails to follow this procedure. Thus, it is in this sense, Schickore (2011, 477) argues, that the confrontation model is “misleading.”

Practically, the interaction between historians and philosophers of science is unbalanced or asymmetrical. Despite its name, HPS, as a product resulting from the historical turn in the twentieth century philosophy of science, has been fundamentally philosophically-oriented since the very beginning. Philosophers of science not only have contributed to the most of HPS work, but also have shown great interest in studying and writing the history of science. In contrast, many historians of science have been uninterested in philosophy of science and even sceptical of the

⁴Of course, there are alternative ways of analysing the methods of HPS. Some (e.g. Pinnick and Gale 2000; Scholl and Räs 2016) summarise the typical method of HPS as the case-study method, while others (e.g. Burian 2002) distinguish a top-down approach with a bottom-up approach in HPS. Nevertheless, I think that all of the case-study method, the top-down approach, and the bottom-up approach can be construed as instances of the confrontation model, since each follows the rationale that history serves evidence for philosophising.

interaction of history and philosophy of science. As Giere (2011) points out, “the presumption that what philosophers say is irrelevant to the work of historians of science seems still strong.”

What is more, recent citation analyses also question that there is an academic discipline called HPS. According to K. Brad Wray’s analysis (2010), no history of science journals is listed in the top journals cited in the major philosophy of science works. Wray (2010, 428), thus, argues that “if there were such a field as history and philosophy of science, one would expect scholars in that field to be citing publications in the leading history of science journal. But, it appears that philosophy of science is largely independent of the history of science.”

1.2 Integrated History and Philosophy of Science

Nevertheless, substantial hope for HPS as a productive academic discipline is not dead. Some historically-minded philosophers of science and philosophically-minded historians of science never stop making efforts to promote the dialogue across the boundaries and defend HPS against the challenges in various ways. Institutionally, HPS conferences are regularly organised.⁵ Axiologically, the necessity of history-philosophy engagement has been defended (e.g. Chang 2012a; Arabatzis 2017). A common ground has also been explored. For example, Michael Friedman (2008) and Alan Richardson (2008) actively promote the history of the philosophy of science (HOPOS) as a new variant of HPS which they believe may interest both historians of science and philosophers of science and “provides further ground for hope that a new kind of productive relationship between the two fields may now be possible.” Methodologically, the confrontation model has been defended (e.g. Pinnick and Gale 2000; Scholl and Räs 2016; McAllister 2018; Scholl 2018). New HPS methods have been introduced and developed (e.g. Chang 2004, 2012a, b; Schickore 2009, 2011). In the recent development of HPS, I find a new movement called integrated history and philosophy of science (integrated HPS) most promising. Its manifesto is spelt out as follows.

&HPS is distinctive in that it is both historical and philosophical at the same time.

Good history and philosophy of science is not just history of science into which some philosophy of science may enter, or philosophy of science into which some history of science may enter. It is work that is both historical and philosophical at the same time.

⁵International conferences on integrated HPS take place every 2 years, while the UK integrated HPS workshop is held annually. Other major HPS-related conferences include the biennial meetings of International Society of History, Philosophy, and Social Studies of Biology (ISHPSSB), International Society of History of Philosophy of Science (HOPOS), and Society of Philosophy of Science in Practice (SPSP). In addition, there are regular HPS symposia in general philosophy of science conferences like the biennial meetings of Philosophy of Science Association (PSA) and the International Congress of Logic, Methodology, and Philosophy of Science (CLMPS).

The founding insight of the modern discipline of HPS is that history and philosophy have a special affinity and one can effectively advance both simultaneously.

What gives HPS its distinctive character is the conviction that the common goal of understanding of science can be pursued by dual, interdependent means. This duality may be localized in a single work. Or it may be distributed across many works and many scholars, with parts locally devoted just to historical or philosophical analysis. Intellectual history, for example, serves this purpose. What unifies this local scholarship into an HPS community is the broader expectation that all the work will ultimately contribute to the common goal.

There is no distinct methodology that is HPS. Doing HPS does not confer a free pass to suspend the standards of one field to advance the other. It must be good history of science and philosophy, in that its claims are based on a solid grounding in appropriate sources and are located in the relevant context. And it must be good philosophy of science, in that it is cognizant of the literature in modern philosophy of science and its claims are, without compromise, articulated simply and clearly and supported by cogent argumentation. (Arabatzis and Howard 2015, 1–2)

The most distinctive feature of integrated HPS is integratedness. Unlike the other methodologies of HPS, integrated HPS is not overwhelmingly philosophically-driven. Too much attention has been paid to how philosophy of science can unbiasedly and wisely use history of science (see Burian 1977; Nickles 1995; Pinnick and Gale 2000; Scholl and Räs 2016; McAllister 2018; Scholl 2018). In contrast, integrated HPS aims at a more balanced inquiry from which both history of science and philosophy of science can benefit. Therefore, HPS should not be identical with a good historically-informed philosophy of science. Nor should it be merely a good philosophically-driven history of science. HPS should be both a good philosophy of science and a good history of science at the same time.

Another distinctive feature of integrated HPS is plurality. Axiologically, integrated HPS encourages a plurality of approaches to its aim. Methodologically, “let a hundred flower bloom” as long as a better history and philosophy of science is aimed at. There is no such a thing as the only correct method of integrated HPS.

This book defends and develops integrated HPS. More precisely speaking, I aim at a practical defence of integrated HPS in this book. Rather than providing a full-fledged methodological defence (see Scholl and Räs 2016; McAllister 2018), I would be defending integrated HPS by practising integrated HPS in a concrete historical case study, namely, the case of the origin of genetics. It should be noted that I am not trying to downplay the significance of any methodological defence of integrated HPS, which I do believe is of great importance. However, I contend that a mere methodological defence is not complete or strong enough. An adequate defence should show not only what a good integrated HPS is methodologically, but also how it can be applied in concrete cases. To this end, I argue that the best way to defend integrated HPS is to do it (or practise it). Ultimately, I wish to show how an integrated HPS study helps us to have a better understanding of an historical episode, the origin of genetics, and sheds light on some general issues in the philosophy of science in this book.

Before delving into my integrated HPS work, I would like to say a bit more on my methodology. Although, as I have just emphasised, I am not aiming at a methodological defence, it is necessary to articulate the basics in order to ward off some

potential worries. Hasok Chang (2012a, 121–22) proposes two methods of integrated HPS.⁶ Method 1 begins with some historiographical puzzle (say, there is a historical episode which is difficult to understand), followed by a search for a new philosophical framework, which provides a better understanding of that episode. Then the new philosophical framework is further developed in order to apply it to other historical episodes. Method 2 begins with a philosophical puzzle, say, a set of putative actions/decisions by past scientists that does not make sense, followed by a search for better historiography, which resolves the philosophical puzzle. Then the new historical account is completed based on empirical work and sheds new light on other related history.

Some chapters in the book will reflect the use of these methods. Nevertheless, there is still something important missing. In Method 1, the integrated HPS analysis begins with a historiographical puzzle, while in Method 2, a search for a better historiography is indispensable. But where are the historiographical puzzles from? And how should we search a better historiography? Typically, both the historiographical puzzles and the better historiographies come from contemporary historical literature. So, shall we start with a review of state of the art of the relevant historical literature? It seems to me not a very satisfactory starting point. Since an integrated HPS work aims at both a good history and a good philosophy, any integrated HPS work should make its own contribution to a good history of science, even for the presentation of a historiographical puzzle. A good integrated HPS work should not assume a particular historical account without argument. Therefore, I argue that, for anyone who plans to use Method 1, he or she should begin writing a historiographical puzzle. Similarly, for anyone who plans to use Method 2, he or she should work on a better historiography.

Surely, there has been a persistent worry concerning philosophers writing history among historians. L. Pearce Williams (1975), for example, famously argues that philosophers should not “be allowed to write history”.

Philosophers tend to be interested in ideas, their logical connections and their logical consequences. They do not seem to find it very interesting to ask where ideas came from, how they developed and how they were interpreted by others who claim to have been influenced by them. They are, therefore, at their best when analysing a system; as we have seen, they are at their worst when trying to account for the evolution of one. (Williams 1975, 252)

Another leading historian of science, I. Bernard Cohen (1977), though having some sympathy to HPS, is concerned with a history written by non-historians, including philosophers.

Indeed, to many historians, the major danger in the writing of history by nonhistorians (and even by some members of the profession) is the anachronistic application of our present canons of logic and mathematics and of scientific knowledge to prior experiments, laws, and theories. To view the concepts, laws, and theories of a Galileo, a Kepler, and a Newton as

⁶Note that Chang is not only proposing these methods, but also extensively uses these two methods in his integrated HPS study of the chemical revolution (2012b).

‘approximations’ to some later ideal creations of critical or philosophically minded scientists will block us from a meaningful understanding of the creative processes of any scientist we may be studying, including the interaction of the individual and his social and intellectual environment. (Cohen 1977, 345)

No doubt I oppose Williams’ conclusion, but I do think that there is an important lesson from the historians’ worry. A good history of science must be holistic and anti-anachronistic. When writing a historical episode, one should not isolate it from its context or understand it in an anachronistic way. Thus, a good way to achieve this is to begin with an anti-anachronistic reading of original texts, correspondences, and relevant published and unpublished writings like a historian would do. Then it is also necessary to examine the relevant secondary literature and scholarly reflections. If a philosopher is writing a good history like a good historian, there is no reason to prevent philosophers from writing history. Therefore, I argue that any serious integrated HPS should begin with an anti-anachronistic reading of history.⁷

There are some obvious benefits of an anti-anachronistic reading of history. For example, it helps to understand the historiographical puzzle in Method 1. In addition, it helps to search for a better historiography in Method 2. And it may also help to inspire a new philosophical framework or a resolution to a philosophical puzzle. It should be noted that an anti-anachronistic reading of history does not guarantee a brand-new historiography. Sometimes it just turns out to confirm the existing historiography. Sometimes it provides a better interpretation in an existing historiographical framework. That said, the significance and the necessity of an anti-anachronistic reading of history should not be overlooked. As I have emphasised, a good integrated HPS work should be a good philosophy of science and a good history of science at the same time. I contend that an anti-anachronistic reading of history provides a good starting point for writing a good history of science as well as doing integrated HPS.

1.3 Integrated HPS in Practice: The Case of the Origin of Genetics

This book will focus on an episode of the history of genetics: the origin of genetics. The origin of genetics is such a mysterious and fascinating topic for both historians of science and philosophers of science, as there are many unsolved puzzles in that period. The traditional narrative of the origin of genetics typically begins with a story of a nineteenth century Austrian monk, Gregor Mendel (1822–1884): Mendel undertook the experiments on *Pisum* (peas) in his garden in Brünn (now Brno, Czech Republic) and discovered the laws of heredity. Mendel presented his discovery at a local scientific society in 1865, and published a paper, entitled *Versuche über Pflanzen-Hybriden* (Experiments on Plant Hybridisation), in a local journal

⁷This is not completely a new idea, but it is often overlooked by philosophers unfortunately.

Verhandlungen Des Naturforschenden Vereins Brünn (Proceedings of the Natural History Society of Brno) in 1866. Unfortunately, Mendel's paper was completely neglected until 1900 when the Dutch biologist Hugo de Vries (1848–1935), the German botanist Carl Correns (1864–1933), and the Austrian agronomist Erich von Tschermak (1871–1962) independently rediscovered it. The rediscovery of Mendel's paper inspired the Cambridge biologist William Bateson (1861–1926) and his associates to develop a Mendelian theory of heredity. However, the Mendelian theory of heredity was immediately resisted by the Biometric School, who advocated a statistical theory of heredity. The leading proponents of Biometry were the UCL statistician Karl Pearson (1857–1936) and the Oxford biologist W. F. R. Weldon (1860–1906). The Mendelian-Biometrician controversy ended soon after the sudden death of Weldon in 1906. Thereafter, the Mendelian theory was developed in great depth and at a rapid speed and eventually incorporated into a highly successful theory of inheritance, classical genetics, by the efforts of the Morgan School in the 1910s and 1920s.

This traditional historiography has been challenged. It has been shown that Mendel's laws were, literally speaking, not about heredity and his concern is no longer simply regarded as an attempt to study the mechanism of heredity (e.g. Olby 1979, 1985; Brannigan 1979; Callender 1988; Monaghan and Corcos 1990). The allegedly rediscovery story is shown to be false. De Vries, Correns, and Tschermak all read Mendel's paper before they wrote their papers (e.g. Rheinberger 1995; Stamhuis et al. 1999; Harwood 2000; Simunek et al. 2011). The significance of Weldon has been recently reassessed (e.g. Radick 2005, 2016; Pence 2011). In short, the historiography of early genetics has been radically revised for the past 50 years. Nevertheless, there is still a lack of consensus on many issues among the historians of science. For example, it is unclear whether Mendel's work could be understood as a study of heredity (e.g. Orel 1996; Olby 1997; Müller-Wille and Orel 2007). It is under debate whether de Vries had discovered the 3:1 ratio independently from his experiments before reading Mendel's paper (e.g. van der Pas 1976; Heimans 1978; Darden 1985; Zevenhuizen 2000). It is puzzling how the history of genetics would have changed if Weldon had not died in 1906 (e.g. Radick 2005). Moreover, the origin of genetics is such a rich historical episode that it may provide many interesting cases for philosophers to examine various issues in general philosophy of science such as conceptual change, confirmation, scientific progress, and theory choice.

In this book, I start my integrated HPS study with a review of the history of genetics from Mendel to Weldon with an anti-anachronistic reading of the original papers, correspondence, and unpublished writings, and a critical examination of the secondary literature. Chapter 2 revisits Mendel's concepts of *Entwicklung* (development) and of *Entwicklungsreihe* (developmental series) in order to re-examine Mendel's work. Chapter 3 examines Mendel's legacy in 1900 and evaluates the significance of de Vries' work in the origin of genetics. Chapter 4 reassesses the historiography of Weldon by focusing on Weldon's late work (1904–1906), especially his unpublished manuscript *Theory of Inheritance*.

Then I move on to two integrated HPS problems: Based on my historical work in Chaps. 2, 3, and 4, what is the best way to analyse and interpret the origin of genetics? What is a best way to understand the progress in the history of genetics if there is any? I call these two problems integrated HPS problems for two reasons. One is that both problems may interest historians of science and philosophers of science. The other is that neither of the problems has been taken seriously by historians of science or philosophers of science today. Many historians of science today are not so interested in the analysis of the pattern of the development of genetics. This sort of work seems a bit too “internal.” And philosophers of science are not as interested in developing a philosophical account of the development of science as they were in the 1970s. Nevertheless, I still find both problems worth exploring. A careful analysis of the development and the progress in early genetics will not only provide us a better understanding of the history, but also shed light on the philosophy of science in general. Chapter 5 introduces a new integrated HPS method, the exemplar-based approach, and applies it to analyse and interpret the origin of genetics. Chapter 6 develops a functional approach to the progress in early genetics, motivated by the exemplar-based approach. Chapter 7 offers an exemplar-based explanation of the problem of the long neglect.

Finally, I discuss some general issues in the philosophy of science with my case studies in the history of genetics. Chapter 8 introduces a new mode of conceptual continuity, illustrated by the case of the evolution of the dominance concept. Chapter 9 argues for a practice-based solution to the gap problem in hypothetico-deductivism with the case study of Mendel’s evidence for the law of composition of hybrid fertilising cells. Chapter 10 proposes a new criterion of theory choice, illustrated by the case of the Mendelian-Biometrician controversy.

Thus, this book is structured by three parts. Part I consists of three chapters on historical problems. Part II consists of three chapters on integrated HPS problems. Part III consists of three chapters on philosophical problems. Part I provides the historical basis for the discussions in Part II and Part III. Part II offers an integrated HPS method to analyse and interpret the historiography in Part I and to shed new light on the philosophical issues in Part III. Part III develops new philosophical accounts which will in turn make a better sense of the history of sciences more generally.

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