Preface

The present work is a study of the Aṣṭādhyāyī of Pāṇini from a new perspective and is an adapted version of my doctoral dissertation with the same title. It attempts to explore the Pāṇinian grammar from a formal point of view and investigate the possibilities of representing it in a logical, explicit and consistent manner. Such a representation requires an appropriate framework. A formal framework would facilitate adequate tools for postulating and evaluating hypotheses about the grammatical system. Moreover, it would furnish the basis for a computer implementation of the grammar. Both aspects, namely a formal representation and computer implementation of the Aṣṭādhyāyī, are objects of enquiry in the field of theoretical studies on Pāṇini as well as the emerging discipline of Sanskrit computational linguistics. This book takes on the ground-work in these areas.

The propositions that I put forward in this book are a result of my experimentations with the Aṣṭādhyāyī. Over the last few years, I tried a number of models to comprehend the content and processes of the Pāṇinian system. Beginning with the initial aim to automatize Aṣṭādhyāyī, I examined the various challenges and issues accompanying this and in the process graduated to work on the development of a formal framework for the grammar. The outcome of this ongoing process is summarized in the present work.

There are several excellent expositions of Aṣṭādhyāyī by the scholars in this field and these are evidently the chief source of my understanding on this subject. At the same time, there is hardly any significant work on Pāṇini from a formal perspective. The relatively limited writings available are largely in the nature of unproven hypotheses with few exemplary comparisons and usually with claims to show that Pāṇini has been the forerunner in matters of logic, mathematics and computer-science. The present work does not strive for any of the above objectives. It is not an attempt to compare the Pāṇinian system with modern grammatical theories. Neither is it an attempt

to establish Pāṇini as the source of the concepts and methods followed by modern computing systems. Neither does it claim that Sanskrit is the most suitable language for computers.

The present study attempts to render the Pāṇinian system of Sanskrit grammar in a framework which consists of unambiguous, consistent and explicit categories. Only then can it be conveyed to logical systems like modern day computers. Differing from the formulation of Aṣṭādhyāyī, which is composed in an artificial yet natural language and is meant to be employed by individuals who are acquainted both with the Sanskrit language and the techniques of grammar, the present rendering aims for a non verbal representation in terms of mathematical categories and logical relations which can be implemented in an algorithmic manner.

The process of formalization, however, involves determination of the underlying principles regarding the functioning of grammar. My first response was to look into the explanatory literature associated with the Aṣṭādhyāyī and on this basis to decide upon the general principles that may lead towards formalization. Although a careful study of the literature is of immense importance to enable understanding of the various issues, in my case it did not suffice to devise a solution for formalization, based only upon comparative studies of Pāṇinian literature. The reason lies primarily in the different nature of the task at hand. Later literature on Aṣṭādhyāyī is primarily explanatory.[1] Although there are significant attempts to clarify, uphold and sometimes rectify the grammatical corpus, there is hardly any effort to render it in a new formal setup. This is evident because the Aṣṭādhyāyī is (to a significant extent) a formal presentation of the grammar. And a very brilliant one indeed.[2]

The remarkable success of Aṣṭādhyāyī had the consequence that the main effort of later grammarians was directed towards keeping it intact. Apart from the attempts by grammarians like Rāmacandra (late 14th–15th century) and Bhaṭṭoji Dīkṣita (late 16th–17th century) to reorganize the rules or *sūtra*s of Aṣṭādhyāyī with process or application (*prakriyā*) as the main focus, there are hardly any works dedicated to recasting Aṣṭādhyāyī.[3]

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[1] On the explanatory nature of the literature on Aṣṭādhyāyī, see (Bhattacarya 1955 p. 123-132) and for a bibliographical note (Cardona 1980 p. 278-293).

[2] Patañjali considers Pāṇini to be an "embodiment of authority" प्रमाणभूत आचार्यः। (MB on 1.1.1) regards "the *sūtra*s of Pāṇini as beautiful" शोभना खलु पाणिनेः सूत्रस्य कृतिः। (MB on 2.3.66) and postulates that "just because of doubtful appearance of a rule, it should not be rejected, but should be made precise on the basis of reasoned explanation" व्याख्यानतो विशेषप्रतिपत्तिर्नहि संदेहादलक्षणम्। (PB. 68). The Pāṇinīyas or the scholarly followers of Pāṇini formulate a number of conventions to keep intact the systematic coherence of Aṣṭādhyāyī, see (Wujastyk 1993).

[3] Bhaṭṭoji Dīkṣita's Siddhāntakaumudī is a reorganization of the Pāṇinian rules. Compared to the earlier attempt of Rāmacandra in his Prakriyākaumudī, Bhaṭṭoji Dīkṣita sticks to the

The question of formalization, in terms of a logical language which a computer program without any knowledge of Sanskrit could understand, was naturally not a requirement at that time either. Formal representational techniques that are being evolved today and increasingly being employed to develop machines and computers were missing, and it would be anachronistic and wrong to expect Pāṇini (or anyone) to anticipate the requirements and expectations of a computer program trying to implement it two-and-a-half millenia later. It should be noted here that I am neither denying the formal nature of Aṣṭādhyāyī, nor examples of precursors of several modern techniques in it.[4] However, what is certain is that Aṣṭādhyāyī, as we have it today, would require considerable additional information organized in a suitable manner in order to make it executable as a computer program.[5]

As a consequence, a new methodological approach becomes necessary—the scientific method of observation, hypothesis and testing in order to develop a new formal representation of the Aṣṭādhyāyī.[6] The present work is primarily based on this methodological approach. Unlike most of the publications on Pāṇinian grammar, I do not attempt to comment upon an issue by collecting and analyzing the views of the traditional scholars or the Pāṇinīyas. Although an important task, this is hardly fruitful in my case. The reason for this is that I am confronted with a challenge of our time and the Pāṇinian tradition, because of its antiquity, had no occasion to comment on it. On the other hand, my investigations are directly based on the corpus of Aṣṭādhyāyī. My use of later Pāṇinīyas is in order to understand the tradition and to relate them to important premises of my hypotheses.

It could be asked here: how justified I am in proposing systematic frameworks that are not directly supported and employed by the Pāṇinīyas? I feel that Aṣṭādhyāyī is a text which not only allows but invites such an approach. Its composition is the result of an empirical observation and systematic organization of the linguistic features. It is an appropriate case for studying the methods of comprehending linguistic phenomena through developing systematic structures.

Another ground for formalization is that it has both theoretical and practical relevance in the field of Pāṇinian studies. Practically speaking, it facilitates better access to the content and processes of the Pāṇinian system, not just to experts in this field, but to non-Sanskritists as well. Theoretically speaking, it

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Pāṇinian rules only. He also covers all the rules of the Aṣṭādhyāyī. See (Cardona 1980 p. 285-288) for bibliographical notes and (Houben 2008 p. 563-574) for the reasons for the tremendous success of Bhaṭṭoji Dīkṣita.

[4] See section 1.1 for recent works on the formal character of Pāṇinian rules.

[5] I will discuss this in section 3.2.

[6] On the scientific approach, see (Wilson 1952) and (Popper 1959).

prompts us to look at the Aṣṭādhyāyī from a formal perspective. This entails a critical examination of the content and processes of the grammatical system. Strategies for evolving such a representation involve a reworking of the oral framework in which Aṣṭādhyāyī is composed. This leads to identification, analysis and determination of issues related to organization and application of Pāṇinian rules. A formal representation also facilitates precise formulation and testing of hypotheses regarding some of the fundamental issues of the Pāṇinian system—meta-linguistic conventions (*paribhāṣā*s), brevity (*lāghava*), rule organization (*adhikāra* and *anuvṛtti*), ordering and application of grammar (*prakriyā*), functioning of the system etc. In short, it opens up a new paradigm for Pāṇinian studies.