Background of the Aṣṭādhyāyī
Keynote Speech

S. D. Joshi

Retired Prof. and Head, Department of Sanskrit and Director, CASS, Pune, India

1. I have hesitated in accepting the invitation extended to me by Amba Kulkarni on September 9. The main reason was that I am not acquainted with what is called Sanskrit Computational Linguistics, or with theories of Machine Translation, or with information theory. In fact, I know nothing about these subjects. So what can I tell you? In view of my deeply regretted lack of knowledge regarding the subjects mentioned, I have decided to deliver a talk on a subject of which I have some experience, namely, Pāṇini's linguistic analysis as shown in his method of analysis, in the development of theoretical concepts and in the composition of the Aṣṭādhyāyī. Clearly, Pāṇini, in applying his linguistic analysis of the spoken Sanskrit of his days, has developed a number of theoretical concepts which can be used for the analysis of other languages also. That is an elementary insight which proved to be fruitful already in the 19^{th} century when linguistics and especially comparative linguistics were developed as separate branches of science in Germany and France. Reading statements about information coding in which Pāṇini is hailed as an early language code information scientist, I am reminded of the situation in the early sixties, after Chomsky had published his book on Syntactic Structures in 1957. Here Chomsky introduced a type of grammar called transformational generative grammar. It earned him a great of applause, globally, I may say. Then it dawned on linguists that Pāṇini had also composed a generative grammar. So Pāṇini was hailed as the fore-runner of generative grammar. That earned him a lot of interest among linguists. Many linguists, foreign as well as Indian, joined the bandwagon, and posed as experts in Pāṇinian grammar on Chomskyan terms. Somewhat later, after Chomsky had drastically revised his ideas, and after the enthusiasm for Chomsky had subsided, it became clear that the idea of transformation is alien to Pāṇini, and that the Aṣṭādhyāyī is not a generative grammar in the Chomskyan sense. Now a new type of linguistics has come up, called Sanskrit Computational Linguistics with three capital letters. Although Chomsky is out, Pāṇini is still there, ready to be acclaimed as the fore-runner of Sanskrit Computational Linguistics. I am, of course, grateful for the interest shown in Pāṇini.
2. So what to talk about? I can, obviously, refer to the 25 volumes published by the University of Pune, and the Sahitya Akademi, one series on sections of Mahābhāṣya and another series on sections of the Aṣṭādhyāyī. From the first series I expressly mention the Samarthāhnika, the Kārakāhnika, the Anabhihitāhnika and the Paspaśāhnika. In all of these books fundamental

questions about Pāṇini's method of linguistic analysis have been discussed extensively. But references cannot make up a key-note address. So what I plan to do is to mention a number of typical features of the Aṣṭādhyāyī and some basic grammatical concepts applied in Pāṇini's analysis of the spoken Sanskrit of his days, and in the composition of the Aṣṭādhyāyī.

3. Pāṇini is short on theory, great on grammatical detail. A coherent linguistic theory can only be inferred from his detailed observations of linguistic data put in the form of rules. Questions of linguistic development, of historic sound change, and of history in general lie outside Pāṇini's interest.
4. Contrary to some Western misconceptions the starting point of Pāṇini's analysis is not meaning or the intention of the speaker, but word form elements as shown in the initial stages of the prakriyā. Here morphemic elements obtained from analysis are put side by side in an order of pūrva and para from left to right. Then by applying operations to these elements a derivation process starts. The process results in a word fit for use in vyavahāra, the every day usage of an educated brahmin .Thus we may say that Pāṇini starts from morphology to arrive at a finished word where no further rules become applicable. We have to bear in mind that Sanskrit is an inflecting language.
5. Is the Aṣṭādhyāyī rightly called a grammar? It certainly deals with the traditional parts of grammar in the West, namely, morphology, word-formation and syntax. On that account the name "grammar" is applied. It is, in fact, part of the title given by Böhtlingk to his edition of the Aṣṭādhyāyī. But the Aṣṭādhyāyī is not a grammar in this general Western sense of the word. It is a device, a derivational word-generating device. It presupposes knowledge of phonetics and it is based on morphemic analysis. It derives an infinite number of correct Sanskrit words, even though we lack the means to check whether the words derived form part of actual usage. As later grammarians put it, we are *lakṣaṇaikacakṣuṣka*, solely guided by rules. Correctness is guaranteed by the correct application of rules. For purposes of derivation as seen by Pāṇini a list of verbal bases, dhātus, is essential. That list is provided in the dhātupāṭha. It must have formed part of the Pāṇinian tradition from the very beginning.
6. Every śāstra 'branch of science' has its technical vocabulary. Technical terms require a definition of their meaning, as opposed to words in everyday speech which are characterized by free symbolization, not bound by a previous convention regarding meaning. The Aṣṭādhyāyī, being a śāstra, has its own technical vocabulary, consisting of saṁjñās 'technical terms' and pratyāhāras 'abbreviative designations.' The saṁjñās are usually, but not always, defined. The non-defined saṁjñās are borrowed from various other branches of science supposed to be generally known. I mention mantra, yajus, napuṁsaka, liṅga, kriyā, vartamāna, vibhakti, prathamā, jāti, dravya, guṇavacana, visarga, vākya, vidhi, samartha and upamāna. Use of pratyāhāras is made when the question is of enumerations of speech sounds or of suffixes. Pratyāhāras are an enumeration saving device.
7. Is semantics part of the Aṣṭādhyāyī? Or, put slightly differently, does meaning (artha) form part of Pāṇini's linguistic analysis? We have to be very care-

ful here in what is understood by the word "meaning." In the Indian tradition artha is the thing-meant, the thing referred to, that to which we refer by means of words and sentences. Taking artha in this sense, the answer to my question is, no. That is clearly stated by P1.2.56, *arthasya anyapramāṇatvāt* 'because artha is decided by something else (than the Aṣṭādhyāyī).' The idea is that the Aṣṭādhyāyī is no authority to decide that word A refers to item A and that word B refers to item B. That is decided by usage in which metaphor plays a big role. Obviously, this should not be taken to mean that lexical meaning is of no interest to the Aṣṭādhyāyī. The whole of the taddhita-section testifies to the opposite.

To specify the meaning in which a nominal form is used, its lexical meaning, Pāṇini uses meaning-conditions. They are usually stated in a locative nominal form, sometimes also by means of a phrase. I quote two examples. The first is P. 3.2.134. It prescribes the following kṛt-suffixes up to P. 3.2.177 in three meanings stated as tacchīla '(an agent) having such and such a habit,' taddharma '(an agent) having such and such a duty' and tatsādhukārin '(an agent) who does something well.' The second is P. 3.3.116. It deals with the kṛt suffix LyuṬ. The rule says *yena saṁsparśāt kartuḥ śarīrasukham* 'one account of contact with which the agent experiences a feeling of physical pleasure.'

In the taddhita-section the meaning-condition is often phrased by means of a pronominal form like tasya, tena followed by a noun or participle in the nominative. The whole serves as an adhikāra. But here also phrases may be used for the same purpose. I mention P. 4.2.59, *tad adhīte tad veda*.

8. Pāṇini's operational rules are generally substitution rules. Here the distinction between the original (sthānin) and the substitute (ādeśa) is essential. As far as further rule application is concerned, the substitute is declared to be like the sthānin (P. 1.1.56). An exception is made for rules which deal with the substitution of phonemes. An ingenuous idea of Pāṇini was to extend the concept of substitution to zero-substitution (lopa) also. Lopa is defined as adarśanam "disappearance from sight" (P. 1.1.60).
9. What about rule-order application in the Aṣṭādhyāyī? As is well-known, the Aṣṭādhyāyī has been divided into two parts, the siddha-kāṇḍa and the asiddha-kāṇḍa, the latter part starting from the rule *pūrvatrāsiddham* (P. 8.2.1). The asiddha-kāṇḍa is also known as the tripādī. In the earlier part rules are applied independently of the numerical order. In the tripādī rules are applied strictly according to their numerical order. Also, with regard to the application of a rule in the siddha-kāṇḍa a rule in the tripādī-section is asiddha. A rule A can be siddha '(regarded as) effected' or asiddha '(regarded as) non-effected' with regard to rule B in the sense that rule A is regarded as having taken effect before the application of rule B or not. Accordingly, rule B may become operative or not. This is a very useful grammatical fiction in the Aṣṭādhyāyī. The tripādī-section has been established to overcome difficulties in the random application order, when this order would lead to undesired results. The majority of rules put in the asiddha-section are rules dealing with consonant-substitutions due to sandhi.

10. Another situation in which the order of application of rules becomes vital is that of conflict (vipratiṣedha). The term vipratiṣedha has not been defined in the Aṣṭādhyāyī, but it was taken up by Kātyāyana for explanation (vārtika I on P. 1.4.2). In the prakriyā a conflict may arise in the sense that two rules become applicable at the same stage. Here the question is of determining the stronger rule which is to prevail. Tradition, as embodied in Nāgeśa's Paribhāṣenduśekhara, has formulated a number of principles to solve a conflict. I may point out that recently a considerable amount of work has been done on conflict-procedure, leading to the formulation by myself and P. Kiparsky of the siddha-principle. I won't bother you with further details on this intricate subject, but refer you to Vol. IV in the Aṣṭādhyāyī of Pāṇini Series, 1995, Introduction, p. viii-xi, Here the new ideas on the subject have been explained.
11. Kātyāyana, in the opening vārtika of the Mahābhāṣya, says *atha śābdānuśāsanam* 'now starts the instruction in words.' But what are words? Patañjali explains in his bhāṣya that words may belong to ordinary speech or the Veda. They are laukika or vaidika. Examples for both categories are quoted. Then he asks the question, in gauḥ what is the word (śabda)? The answer is that from this word we understand an object with a dewlap, a hump, hoofs and horns. Apparently, a word is that from which we understand a meaning in the sense of a thing-meant.
    Pāṇini's answer to the question what is a word is rather different and rather more linguistically precise. First of all, for "word" he does not use the word śabda, but he uses the term pada. Then he defines that term as *suptiṅantam* 'ending in a suP-suffix or in a tiṄ-suffix' (P. 1.4.14). Thus pada does not just mean "word". It means a fully derived word according to Pāṇinian standards. Clearly here Pāṇini does not enter into questions of meaning, but talks in terms of word form categories. The suffixes mentioned are listed by P 3.4.78 and P. 4.1.2. We further note that the endings called tiṄ are excluded from the designation kṛt (P. 3.1.93).
12. The derivational process, prakriyā, starts from a dhātu, a verbal base, a list of which is provided in the dhātupāṭha. What comes next in the derivation are suffixes (pratyayas), divided into kṛt and taddhita. The section dealing with the addition of suffixes starts from P 3.1.92, dhātoḥ. This is the central rule in the Aṣṭādhyāyī for purposes of derivation. The order of dhātu and pratyaya is fixed by P. 3.1.2, which says that a suffix is a following element. The derivational base of a subanta pada is either a dhātu + a kṛt suffix, which forms a nominal base, or a nominal base + a taddhita suffix, or a combination of nominal bases called samāsa. All of these derivational nominal bases are called prātipadika (P. 1.2.46). Thereafter a feminine suffix may be added to indicate feminine gender, and the suP-suffix comes to take care of gender other than the feminine and of number, and of case. The last two general stages of the derivation are reserved for the application of sandhi-rules and of accent-rules. We have to bear in mind that Sanskrit is a pitch-accented language, although, unlike in the Vedas, accent in Sanskrit is not indicated. Accent is treated by Pāṇini in great detail; from P. 6.1.158 to 6.2.199, in

all 263 sūtras, with two isolated rules at the end of pāda 8.4. That is in short how the derivation of a nominal form goes, the whole process being regulated by rules. As everybody knows, for some Sanskrit subanta words a derivational base is not reasonably available. They are declared to be avyutpanna 'underivable,' or they may be still be derived with the help of an ad hoc invented suffix.

One more point about prakriyā which may be of interest to you being computer-linguists. The Aṣṭādhyāyī is not just an analysis of what he calls bhāśā, and what was called Sanskrit later on. It is also a generative calculus, which is actually the main thrust of the Aṣṭādhyāyī. Whereas the type of grammar developed in Greece and Rome is paradigmatic, the Aṣṭādhyāyī is a generative calculus known as prakriyā for which Bhaṭṭojī Dīkṣita composed the authoritative handbook known as the Siddhāntakaumudī. Mastery of Pāṇini is shown in mastery of prakriyā, and the rest is silence. The prakriyā evolves by means of rule operations in successive stages. This is strongly reminiscent of a mathematical procedure known as algorithm. Here the answer to a problem belonging to a class which has an infinite number of members is produced in a finite number of steps. As you undoubtedly know, in principle the calculus can be produced by a machine provided with a tape. That was shown already in 1937 by Turing. Thus, I think, we may say that Pāṇini whom I date around 350 B.C. has intuitively used this idea of calculus.

13. What about case, one may ask. The technical term in the Aṣṭādhyāyī is kāraka, literally "one who or that which brings about", introduced by P. 1.4.23. A satisfactory English translation is not found. Kāraka is a syntactic category, since it deals with the formal characteristics of word meaning combination according to the speaker's intention, whether in a word group or in a sentence. Kāraka is not a semantic category, nor a semantic-syntactic category which merely confuses the issue. For an exhaustive discussion of the grammatical points involved I may refer to the Kārakāhnika, published by the University of Poona in 1975.
14. Finally, I want to say something very briefly about Pāṇini's idea of vākya. The term is not defined in the Aṣṭādhyāyī. Literally the term means "what can be spoken", in distinction from vācya. The term is used in the sense of "utterance" whose end is marked by a pause (avasāna, P 1.4.110), but also in the sense of what we call a word group or sentence. Since Pāṇini uses the term *vākyādeḥ* 'at the beginning of a vākya' in P. 8.1.8, he must have had an idea where the vākya starts. In fact, it starts after a pause in speech. That is why Pāṇini need not define vākya and that has saved him a lot of trouble. The first attempts to formally define vākya stem from Kātyāyana. He has provided two definitions in the vārtikas. IX and X on P. 2.1.1.

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