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A FEATURE-BASED ANALYSIS OF GREEK NOMINAL INFLECTION*

ANGELA RALLI

This paper deals with the structure and the morpho-syntactic information of Greek nominal inflection. It argues that nouns are binary-branching combinations of stems and affixes, and features characterizing inflected words follow a bottom-up procedure according to a well-defined set of percolation principles. Lexical entries that participate in inflectional processes are assumed to be listed as feature-bundle sets, and categories such as gender, case, number and inflection class are reexamined within the framework of a feature-based approach to morphology. As opposed to traditional approaches to inflection, the proposed analysis has serious consequences to the distribution of nouns in inflectional paradigms, the well-known declinations.

0. Introduction

A major issue in the study of morphologically complex words is the location of inflectional morphology. Anderson (1982) defends the hypothesis that inflectional processes are triggered by syntactic information and must, therefore, be handled within a post-lexical component. This point of view differs from a strong lexicalist position according to which the lexicon generates inflected forms independently of syntactic requirements (cf., among others, Halle 1973 and Jensen 1990).

In this paper, I follow the framework of lexical morphology. I believe that inflection should be performed in the lexicon, which is conceived as a component consisting of a morpheme list and a word formation part (cf. Lieber 1980, Kiparsky 1982, etc.)[1]. I propose a theory which accounts for the special behav-

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1. The word formation part may be stratal ordered (cf. Kiparsky 1982, Mohanan 1986), but this issue is peripheral to the main purpose of this paper.

ior of inflectional morphemes and the structures into which they participate. The major aim of the paper is to put forward an analysis which accommodates a full range of nominal inflected forms in Modern Greek (henceforth simply Greek). However, one effect of the proposal is to force a consideration of how a rich inflectional system, such as Greek inflection, may be treated within a component independent of syntax in an efficient manner. In this approach, the morphological entities involved in every inflectional process of word formation (i.e., stems and inflectional endings) are formulated in terms of feature bundles and inflectional structures appear as feature bundle representations[2]. Inflection, then, becomes a morphological process of feature-matching and feature-passing between feature bundles in feature bundle representations.

The organization of the paper is as follows: the first section is devoted to Greek nominal inflection and its major characteristics, followed by some general remarks about a lexical treatment of inflection. The theoretical approach of features is presented in the second section, which serves as a general framework to the analysis of Greek nouns. I hope that the discussion will lead into a better understanding of the importance of an approach based on features and feature manipulations to the study of inflection.

1. Greek nominal inflection

1.1. General characteristics

The main features characterizing Greek nominal inflection are grammatical category, gender, case, number and inflection class[3]. Grammatical category is

2. My approach to inflection is based on the driving idea that there is a structure intervening between a stem and a word which is generated by a word formation rule (cf. § 2.2). As it will become clear below (sections 2 and 3), I keep the notions of morpheme and morpheme-based morphology although I do not consider morphemes to be the traditionally postulated non-separable meaningful units, since they can be represented as sets of features. This approach differs from a procedural theory of morphology according to which no structure intercedes between a stem and a word and inflectional operations apply to a pair involving a phonological form and a fully specified morphosyntactic feature operation (cf. Anderson 1992).
3. By the term "feature" I refer to the properties of a word that may have a role in morphology and syntax. It will be clear below why I prefer using this term instead of 'morphosyntactic category' and 'morphosyntactic property' (cf. section 2).

realized as [noun], [adjective], [determiner] and [pronoun][4]. With respect to gender, Greek nouns are inflected according to three gender types, [masculine], [feminine] and [neuter].

Case has four distinct values, [nominative], [genitive], [accusative] and [vocative] and the number marking feature has the values of [singular] and [plural]. Nominal inflection in Greek is carried out through affixation. Inflectional affixes are generally added to stems in order to form words[5]. For example, a stem like 'kip-' "garden" gives rise to eight paradigmatic types (only seven of them are distinct in form) depending on the addition of the appropriate inflectional affixes:

1.

	Singular	*Plural*[6]
Nominative	kipos	kipi
Genitive	kipu	kipon
Accusative	kipo(n)	kipus
Vocative	kipe	kipi

4. Adjectives are not different from nouns with respect to inflection. However, adjectival stems are underspecified for specific gender values. See Ralli (1996) for a detailed account of gender underspecification in Greek adjectives. Moreover, determiners and pronouns will not be treated here because most of these items cannot be segmented into a stem and an inflectional part (e.g., the personal pronoun 'egho' "I"). Note, however, that inflected determiners (e.g., the demonstrative 'aftos' "this") and pronouns (e.g., 'kapoios' "somebody") behave morphologically like adjectives.
5. It should be noted that in a number of cases, items of Ancient Greek origin (cf. 'ktitor' "foundator" below) seem not to take any inflectional endings for nominative and vocative singular even though they are regularly inflected through the rest of the paradigm. It could be said, however, that these forms are submitted to a ∅ affixation process, where a ∅ affix assumes the role of an inflectional affix:

	Singular	*Plural*
Nominative	ktitor	ktitores
Genitive	ktitoros	ktitoron
Accusative	ktitora	ktitores
Vocative	ktitor	ktitores

Actually, there is a tendency to submit paradigms like the one given above to analogic levelling. In particular, 'ktitoras' and 'ktitora' are forms appearing quite often in nominative singular and genitive singular respectively.
6. In the paper, Greek examples will be given phonologically according to the transcription offered by the International Phonetic Alphabet. Although I have chosen not to examine stress, it should be noted that stress placement and stress shift phenomena in Greek inflected forms constitute a case of morphology-phonology interaction. For more information concerning stress in Greek, the reader is referred to Nespor and Vogel (1986), Ralli (1988), Malikouti-Drachman and Drachman (1988) and Touratzidis and Ralli (1992).

Traditionally, gender is considered to be realized on the inflectional part of a word (cf. Triantaphyllides 1941). However, it has been proposed by Ralli (1986, 1988) that gender in nouns belongs to the features of the stem. The main argument of this proposal relies on the fact that nouns with different gender values are inflected with the same set of inflectional affixes. For example, the feminine noun 'psifos' "vote" is inflected in the same way as the masculine noun 'kipos'[7]:

2.

	Singular		*Plural*	
Nominative	kipos	psifos	kipi	psifi
Genitive	kipu	psifu	kipon	psifon
Accusative	kipo(n)	psifo(n)	kipus	psifus
Vocative	kipe	psife	kipi	psifi

In traditional grammatical descriptions, nouns are distributed into three inflection classes (term used here instead of declensions). It is not the case, however, that the old declensions have a real classification value because they do not reflect the actual division of nouns in inflection classes. According to the form of their inflectional endings, nouns can be said to belong to eight different paradigms, i.e., inflectional classes. Members of the same paradigm show the same inflectional ending for any given proper morphosyntactic combination. Table 1 below contains a representative example of each inflection class in each form. The use of a special diacritic feature marking both the stem and the ending in order to ensure the right matching between them has already been proposed in some of my previous studies of Greek inflection (see, for example, Ralli 1986, 1988) as a replacement for the use of old declensions. I have claimed that membership of a given inflection class is indicated by a special marker, the ic feature, the specific value of which triggers a particular inflectional ending for a stem bearing the same marker. Distinct values of this feature assume the classificatory role of distinct nominal inflection classes and their number depends on the number of different nominal paradigms. In this paper, I will refer to the feature of inflection class with the abbreviation 'ic' and I will use Arabic numerals for the specific classes:

3.

[[kip$_{ic:\ 1}$]- os$_{ic:\ 1}$] "garden, masculine, nominative, singular"
[[maxiti$_{ic:\ 1}$]- s$_{ic:1}$] "fighter, masculine, nominative, singular"

7. Conventionally, nouns will be cited in the text in their nominative singular form.

I say, for example, that for masculine nouns, a stem like 'kip-' belongs to inflection class [1], another stem such as 'maxiti-' (with its allomorph 'maxit-') "fighter" is inflected according to the paradigm of inflection class [2], etc[8]. Nominal stems sharing the same 'ic' value belong to the same paradigm, that is, to the same set of inflectional forms. In Greek, more than one inflection class corresponds to a single gender. Moreover, distinct gender values do not imply different 'ic' values (cf. (2) above).

Replacement of old declensions by the ic feature with values ranging from [1] to [8] has no effect on the system of other nominal features, such as gender, case, etc.. As a matter of fact, Meillet (1934) and Ernout (1953) had already observed that inflection classes are not direct carriers of morphosyntactic properties. For these authors, inflection classes have a classificatory role and exist as independent parts of the grammar. The same claim was further explored by Aronoff (1991) who pointed out that the classification system of inflection classes is motivated by an inherent human desire for order. Gender, case and number refer to both morphology and syntax and they are involved in agreement, while inflection class is a purely morphological property.

In Greek nominal inflection, we do not find distinct affixes for every inflectional feature. As for most Indo European languages, inflectional affixes are portmanteau morphemes. Moreover, for each paradigm there is a certain amount of syncretism. Nevertheless, for one class of nouns, i.e., nouns with the nominative case ending in '-os' (cf. (1)), all cases are realized by distinct affixes (with the exception of vocative plural). As Joseph and Warburton (1986) point out, syncretism is often disambiguated syntactically by the use of different articles. For example, with the masculine noun 'patera' "father" and the feminine noun 'mitera' "mother" we find the use of different articles:

4.
Nominative singular: i mitera
Vocative singular: - mitera
Genitive, singular: tu patera
Accusative, singular: ton patera, ti mitera

8. In Ralli (1986, 1988), masculine nouns in -is and -as (e.g., maxitis "fighter", tamias "cashier") and feminine nouns in -i and -a (e.g., tixi "chance, fortune", xara "joy") are considered to have two allomorphs, depending on the particular site in the inflectional paradigm: one ending in i/a (e.g., maxiti, xara) and one without the final stem vowel (e.g., maxit-, xar-). Allomorphy is assumed to be handled in the lexicon along the lines of Lieber (1982), that is, morphematic variants which share lexical information, such as semantic representation, but which differ unpredictably and arbitrarily in their phonological form and in the morphological environments in which they occur, are considered to be occurences of the same entry and are related by morpholexical rules.

There are cases though (e.g., nominative, accusative and vocative neuter forms) which are non-distinct even when accompanied by an article:

5.
Nomin. /acc., singular: to vuno "the mountain"
Nomin. /acc., plural: ta vuna "the mountains"

In this paper, I do not try to offer an explanation of syncretism. However, as we will see below (cf. § 2.1), the feature approach I propose can account for all cases of syncretism[9].

1.2. Towards a lexical morphological treatment: some remarks

As I have already said, inflection in Greek is based on affixation. This places it very close to derivation which is another word formation process mostly based on affixation. Nevertheless, the two processes have a number of different properties[10]. For example, it is usually stated that inflection provides forms of lexemes, while derivation provides new lexemes (cf. Bauer 1988: 73).

Generally speaking, a morphological process can be defined as one that simultaneously alters the form of an item, i.e., a morpheme or a morphologically complex element, and adds an element of meaning to that item (cf. Aronoff 1976, Jensen 1990, etc.). Greek inflection may, therefore, be defined as a morphological process because by joining an ending to a morphologically simple or complex stem the new form that occurs is followed by an addition of a certain amount of information to the basic semantic interpretation of the stem. What is unique to inflection though is that the piece of new information added to a stem by the addition of inflectional material is already predicted from the

9. Syncretism, that is the occurence of formally identical inflectional forms at different sites of the paradigm, is extensively discussed by Carstairs (1987) who formulates general conditions for systematic homonymies in inflection. Although Carstairs' theoretical claims are extremely interesting and should by given a serious consideration with respect to Greek data, syncretism does not constitute the main issue of this paper. Therefore, I will restrict myself to a rather formal account of syncretism within the system of features and feature-passing operations proposed for Greek inflection.

10. Contrary to the claim that independently of their differences, derivation and inflection should be accounted for by the same formal mechanism (see, for example, Halle 1973), I believe that it is possible to handle a distinction between inflection and derivation inside the lexicon by using different feature representations and different conventions applied to these representations. Therefore, I agree with Scalise (1988a) who has already observed that a clear distinction between inflection and derivation is to be seen in the kind of structures representing these processes.

grammatical category of the stem itself. For example, information concerning the features of number and case seems to be preassociated with Greek noun stems. This is not true for derived items, where the information added to the base through the addition of a derivational affix cannot be predicted by the case itself. A certain "preassociation" of features with word bases has already been noticed by Scalise (1988a: 578) who points out that any word can be inflected for a closed set of features, as for example, in Romance languages, nouns are inflected for number. My position here differs from Scalise's position in that I accept a closed set of features to be inherently associated with stems, but I claim that these features are underspecified with respect to particular values[11]. I propose that stem bases acquire these values by the appropriate inflectional endings the presence of which is necessary not only to contribute to the formation of full forms of words but also to solve feature underspecification of stems. Consider, for example, an inflected word like 'kipi' "garden, masculine, nominative plural" (cf. (1)). What I maintain is that the lexical entry of the stem 'kip-' inherently asks for number and case, but the specific values of plural and nominative are given by the inflectional ending carrying these values, i.e., '-i'. Note, however, that underspecification does not apply to all features characterizing stems. According to what have been said in the preceding section, gender should mark stems as a fully specified feature, that is a feature which already contains a specific value. For example, the lexical entry of 'kip-' should bear the feature [gender: masculine]. Thus, gender is excluded from the information characterizing inflectional endings. This seems to be the right decision of handling gender since inflected nouns of different gender values may display the same inflectional endings (cf. (2) above).

In what follows, I will try to develop an approach, based on a theory of features, which accounts for the special behavior of inflectional morphemes and the way with which percolation of morphosyntactic information is achieved by the use of specific conventions applied to inflectional structures. I will show that inflection can be handled in the lexicon by using feature representations and a number of conventions applied to these representations. By considering inflection to be a lexical morphological process, I follow the generalized lexicalist hypothesis (Lapointe 1980), according to which no syntactic rule has the power to affect word internal structures. This approach prohibits the appearance of bound morphemes, i.e., stems, as terminal items of syntactic represen-

11. By underspecification I mean absence of a specific value for a feature given as an attribute-value pair. My approach of underspecification here does not imply that a certain value is unmarked and hence not specified or filled by default.

tations[12]. I propose, then, that fully inflected words are inserted into appropriate syntactic representations. These items are selected from the lexicon with a number of features representing their morphological specifications. In such a framework, syntactic mechanisms, e.g., agreement, check the features of constituents selected from the lexicon and ensure the correct matching of these constituents to appropriate syntactic structures[13].

2. A feature representation approach to inflectional structures and constituents

It has been claimed by Matthews (1972) (and later by Anderson 1989, 1992 and Aronoff 1991) that inflectional endings are simple formatives without any morphematic status. Their features simply mark stems (or lexemes) and these features are the input to a series of realization rules which determine the word-forms. It seems to me that there is a major problem with the notion of formative here, which has not been sufficiently discussed. In most of the cases related to Greek inflection, the formatives concerned bear a form and a meaning although this meaning is mainly of a grammatical nature. Following Hockett's (1954) definition of the morpheme as the smallest meaningful element, inflectional endings may be considered as morphemes and treated as affixes.

As Jensen (1990: 43) notes, a given morpheme has either a lexical meaning or a grammatical one, but some morphemes can have both types of meaning. According to this, nominal inflectional affixes are associated with a grammatical meaning, taken as the meaning that relates the sense to grammatical concepts such as number and case. On the other hand, stems generally have a lexical meaning but they are also associated to category and gender (i.e., with respect to Greek and maybe other inflectional languages) which are pieces of grammatical information. It has often been proposed that grammatical meanings are represented by features (cf. Jensen 1990 and Aronoff 1991 for featurized grammatical information in inflection). Following this proposal, constituents of a morphological structure can be formulated in terms of features (at least as far as their grammatical meaning is concerned, since there is no agreement yet on a system of features representing their sense). Assuming that nominal stems and inflectional affixes appear as feature bundles, we deal, then, with feature bundle constituents in every inflectional process.

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12. A stem is taken to be here as a morphological entity which constitutes the basis of a word when an inflectional affix is joined to it. As Ralli (1988) has shown, in Modern Greek, a possible distinction between a root and a stem is of no synchronic value.
13. A rather similar approach to inflected items has been adopted by Chomsky (1992).

Most theories in linguistics use some type of feature notation in their phonological, morphological, syntactic and semantic descriptions. For example, in generative phonology, features are binary and a 'plus-minus' symbolism is commonly used for their representation (cf. Chomsky and Halle 1968). Feature binarity though seems to be unsufficient for the representation of Greek inflectional affixes most of which may assume several values depending on the case[14]. On the basis that in Greek there is a need for a system of multi-valued features, I will proceed to the description of features by adopting a rather simple solution under which features are thought of as attribute-value pairs:

6.
[number: sg]
[case: nom]
etc.

The attribute part defines the kind of the feature we deal with and the value part specifies its content. The idea of features being attribute-value pairs is widely used in unification based formalisms (cf. Unification Grammar (UG), Shieber 1986). Several related grammar formalisms, e.g., Generalized Phrase Structure Grammar (GPSG, Gazdar et al. 1985), Lexical Functional Grammar (LFG, Bresnan 1982), etc. are based on the same concept of features, that is, they view them as associations of attributes and values. Most of these grammar formalisms have certain inbuilt limitations on features. One of these limitations is not allowing disjunctive specifications which rules out the following representation:

7. [case: {nom acc}][15]

(7) describes the values of case as being "either nominative or accusative". However, as Karttunen (1986: 24) correctly notes, this restriction is completely without motivation. In Greek morphology, there are many cases in which feature specifications are disjunctive. An example arises in the paradigm of neuter words like 'vuno' "mountain". Such words have the same form in nominative, accusative and vocative, [[vun]-o]. If we accept the view that there should be just one rather than three homonymous entries for the inflectional

14. Note that other languages with a rich case system may also need multi-valued feature representations.
15. Following Karttunen, (1986: 23-24), I indicate disjunction by enclosing the alternative values in { }.

suffix '-o', we have the following feature specification:

8. o: [case: {nom acc voc}]

The genitive case of all paradigms in plural provides another example that calls for a disjunctive feature specification. The suffix '-on' is used in all nouns independently of the inflection class to which they belong[16]. By taking into consideration the fact that the number of inflection classes amounts to eight, the entry given below encodes exactly this fact:

9. on: nb: pl
cs: gen
ic: {1 2 3 ... 8}

As Karttunen (1986: 25) says, "there are many cases where disjunctive specifications seem necessary for reasons other than descriptive elegance". Thus, I accept disjunctiveness in the description of the feature values. However, I think that disjunctive values should be allowed only to features which do not have a distinct semantic interpretation, that is, to inflection class, case and gender which has lost its relation to sex and animacy. The features of category and number should be excluded from any disjunctive specifications for their values. The reason for this choice is obvious: a form denoting an object could not be either a noun or a verb and express either the notion of singularity or that of plurality. Note now that several cases of syncretism in Greek inflectional morphology are better taken into account if we assume that there is a single form which has a disjunctive value specification, instead of postulating several fully specified, homonymous forms[17]. By multiplying the different values of number (two), case (four) and inflection class (eight), Greek inflectional paradigms should contain sixty four different forms. This is not really the case, since syncretism drastically reduces the number of possible forms. In this paper, I am not offering an explanation of this phenomenon. What I try to show is how this model allows us to represent syncretism by admitting disjunctive value specifications to feature representations.

An important advantage of the attribute-value representation of features is that it allows us to present an underspecified feature, by giving only its at-

16. Another solution would be to describe the 'ic' attribute as having no value at all. However, this would be problematic to our feature-matching convention described in sections 2.3 and 3.

17. In computational linguistics, disjunctive values in features are not impossible to treat as Johnson (1991) has recently shown.

tribute part and not the value specification. As I have already mentioned in the previous section, the simple existence of a nominal stem predicts its relation to the features of number and case independently of any concatenation process related to inflectional affixation. Since these features cannot bear specific values before the stems are combined with the proper endings, number and case may constitute pure attributes without specific values[18]. In inflection, the terms 'attribute' and 'value' cover the notions of 'morphosyntactic category' and 'morphosyntactic property' (formulated in Matthews 1974), referring to the properties of a word which has a role in both morphology and syntax and the categories of these properties. In this paper, I am concerned only with the morphological aspect of the features. Following Aronoff (1991), I consider morphological features to be directly traceable to the form of the morphological object while in syntax, properties formulated in terms of morphosyntactic features are rather abstract syntactic elements. As mentioned by Aronoff, it is possible for some morphological features to have syntactic counterparts (e.g., number) and also semantic counterparts (e.g., the notion of plurality). Not all morphological features, however, are relevant to syntax and semantics. Consider for instance, the feature of inflection class which determines the right kind of inflectional affixes to be combined with the stem. There is no way that this feature could have reference to syntax and semantics. However, syntactic and semantic counterparts for some morphological features may be considered to represent a kind of correlation between levels of grammatical description[19]. I believe that morphology, (i.e., lexical morphology in this paper) must be viewed as an autonomous level of grammatical description but interactions like the one cited above are perfectly legitimate. I agree with Aronoff on the question that morphology follows certain principles of its own besides broader principles that may also apply to other levels.

2.1. Stems and affixes as feature bundles

In the light of the remarks made above, let us see now how entries of stems and inflectional affixes can be formulated. As far as Greek nominal inflectional affixes are concerned, the features relating their morphological representation to grammatical concepts are number and case. Inflection class is another piece of featurized information characterizing these affixes from the morphological point of view. Contrary to what has been proposed by a certain number of lin-

18. The way these values are obtained constitutes the subject of the next section.
19. Kinds of partial mappings between levels are defined by Aronoff (1991), in terms of implicational rules.

guists (cf. Jensen 1990, among them), I believe that information about the grammatical category (e.g., noun, adjective) does not characterize the inflectional affix; rather it belongs only to the stem, otherwise, we could not explain why nouns and adjectives generally share the same inflectional endings[20]. The features I propose for inflectional affixes are universal in the sense that they belong to a range of universal features. Other languages, however, may use additional features and different combinations of features in their morphology, in the same way as they do not share the same features in phonology. As we have already seen, there are two specific values for number, [singular] and [plural], and four values for the feature of case, [nominative], [genitive], [accusative] and [vocative]. With respect to inflection class, eight different paradigms can be represented by eight attribute value pairs. Combinations of features referring to number, case and inflection class form the feature bundles representing the nominal inflectional affixes of Greek. Examples of these affixes are given below.

10.

os:	cs: nom	es: cs: {nom acc voc}[21]
	nb: sg	nb: pl
	ic: 1	ic: {2, 3}

'os' and 'es' may be added to stems such as 'kip-' "garden" and 'miter-' "mother" respectively. Based on the grammatical information these stems carry, we can formulate the following entries:

11.

kip:	cat: n	miter: cat: n
	gd: masc	gd: fem
	cs: X	cs: X
	nb: Y	nb: Y
	ic: 1	ic: 3

20. The driving idea that inflectional affixes are not carriers of categorial information is put forward in one of my previous works, namely in Ralli (1988). The same idea is also suggested by Lieber (1989, 1992) who claims that contrary to derivational affixes which bear complete sets of morphosyntactic features (given by the term of "categorial signatures"), inflectional affixes are not marked for a given category.
21. Attributes and values concerning features of Greek inflection are used in abbreviated forms: cat (category), gd (gender), cs (case), nb (number), ic (inflectional class), n (noun), masc (masculine), fem (feminine), neut (neuter), nom (nominative), gen (genitive), acc (accusative), voc (vocative), sg (singular), pl (plural).

where, X, Y are variables and denote underspecification of the features of case and number.

All stems are listed in the lexicon in the form of feature bundles, containing idiosyncratic information about their phonological, morphological, syntactic and semantic content. Since we are concerned with featurized information relevant to inflection, entries such as the ones given above appear with a relatively limited number of features. As seen in the previous section, not all features for stems are fully specified: the underspecified feautures of case and number will receive their specific values during the word formation process which is responsible for the combination of stems with the proper affixes bearing these values. It is already assumed that category and gender are characteristics of stems and that inflection class is a feature assigned to both stems and inflectional affixes in order to achieve the perfect matching between them. The latter (i.e., the ic feature), marks both stem and affix and acts as a valid predictor of the correct inflectional combinations.

2.2. Formation of inflected nominal words

According to Ralli (1988), Greek morphological constructions are analyzed and generated by a context-free rewriting rule of the following type:

12. X →Y Z

This is Lieber's (1980) general rule pattern. Values for X, Y and Z depend on the morphological operation. For example, X has the value of a word in inflection and the value of a stem in derivation. Y corresponds to a stem for both processes and Z can either be a derivational affix or an inflectional one depending on the process. The rule in 12 is generally subject to a number of well-known conventions such as headedness and percolation (cf. Lieber 1980, Williams 1981, Selkirk 1982 and Scalise 1988b for a detailed account of these notions). However, both rule and conventions are not sufficient to account for inflection and its major characteristics.

The notion of head has a long history in syntax but the application of a similar notion in morphology is relatively new and has been prompted by the development of the lexicalist theory. Williams (1981) states that the rightmost constituent in a binary word structure will always be the head. This view has been criticized by a number of linguists (see, for example, Joseph and Wallace 1984). More specifically, Scalise (1988a, 1988b) challenges the assumption that, in morphology, we can define the head of a construction X as the right-

hand member of that construction. He shows that while this assumption seems to hold true for derivational suffixation, in inflection, it seems reasonable to accept that inflectional morphemes are not heads of their constructions[22]. I will not discuss here this assumption but I think that Scalise is right to make such a strong claim: in Greek, the distributional properties of an inflected word are always determined by the stem and not by the inflectional part. However, percolation seems to be carried out from both constituents, the stem and the inflectional affix: in general, the category and the gender of a nominal form are determined by the stem and the values of number and case percolate from the affix.

Lieber's (1989, 1992) recent work constitutes an important contribution to the elaboration of a theory of feature percolation, independently of the position of the head in a word. Lieber puts forward the idea that only syntactically relevant features for a given category (what she terms the categorial signature of the category) percolate from heads to mother nodes (head percolation). In case that the node dominating the head remains unmarked for some features after head percolation, then, values for these features percolate from the closest nonhead branch marked for the features (back up percolation). Lieber's approach may apply to the study of percolation in Greek inflection. However, this theory has also a number of shortcomings. Firstly, the system lacks a principled method of representing features. For instance, by adopting a system of binary feature representations, it is hard to represent multi-valued features (cf. Lieber 1989: 99). Secondly, according to Lieber, only pure morphosyntactic features are involved in percolation and diacritic features do not percolate. However, she does not provide any clear definition of what she considers to be a morphosyntactic feature and what convention prohibits diacritics to percolate to mother nodes[23].

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22. Because of arguments used against the notion of "head" in morphology, Di Sciullo and Williams (1987) proposed the notion of "relativized head", according to which words may have two heads, both of them determining the features of mother nodes. In an earlier work, Selkirk (1982) had also proposed a kind of revised percolation principle which allows the percolation of a feature from a non-head if the head is unmarked for that feature. Both these approaches to headedness and percolation may find an application to Greek morphology (cf. Ralli 1988). However, they do not resolve the problem of feature percolation in inflection where not only both constituents contribute to the featurized representation of the inflected words, but also information brought to an inflected word by its inflectional affix is not entirely unpredictable with respect to information brought by the stem (cf. section 2.1).
23. Note also that the treatment of prefixation is missing from Lieber's system. Since most prefixes do not change the category of the base and are not usually characterized by inflectional features, then, one has to reach the undesirable conclusion that prefixes, contrary to all other affixes, do not participate in percolation at all. However, as Bisetto et al. (1989) have proposed, percolation in prefixation may be accounted for by adopting the so-called "interactionist approach".

In the next section, the special behavior of inflection will be accounted for by the use of a device which could explain percolation of featurized information and resolution of feature underspecification within a system of well-elaborated feature representations[24]. For the purposes of this paper, I will not take any position on Lieber's claim that only syntactically relevant features are generally allowed to percolate in morphology. While I will keep the idea of head percolation, I will show that the fact that both types of constituents, heads and nonheads, seem to contribute to feature percolation in inflection depends on the special underspecified featurized content of the head.

Following Steele (1990), I claim that feature percolation from a nonhead is triggered by underspecification of the head which, for some features, may contain attributes without any specific values. That is, a given value of an attribute-value pair of a nonhead (inflectional affix) is allowed to percolate to the mother node only if the head (stem) is marked with the same attribute for which there is not any specific value. Moreover, in the approach I propose, the fact that diacritics are not involved in percolation may be accounted for in a principled manner, as opposed to Lieber who attributes this special behavior of diacritics to the absence of any syntactic relevance. It will be shown below that when a head and a nonhead share the same attribute-value pair this feature gets cancelled and, consequently, does not percolate to the mother node. An example of such a feature could be the morphological feature of inflection class which may be considered as a kind of diacritic. As already noted, inflectional affixes are added to stems by the application of the word formation rule **Word → Stem infl.** Thus, application of this rule seems to be obligatory not only because it generates full forms of words but also because it contributes to the resolution of feature underspecification related to stems[25].

2.3 Nominal inflection as a featurized word formation process

In well-known syntactic theories dealing with structured representations (e.g., the X-bar theory, Jackendoff 1977), one member of a dominating phrasal category has a privileged status. This member supplies the basic properties of the

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24. The need for a different sort of mechanism of percolation according to which the relevant features can percolate from non-head constituents has also been pointed out by Scalise (1988b).
25. Obligatoriness does not seem to hold true in joining a derivational affix to a stem because derivational affixes are only optionally required by stems. As a matter of fact, Scalise (1988a: 563) has already observed that one of the differences between inflection and derivation is that inflectional rules are obligatory while derivational rules are optional.

phrasal category. This idea has been challenged by Steele, who states clearly in her model that the properties of non privileged daughters must be accessible as well, since they can play a role in the combinatory properties of the mother (1990: 2)[26]. This issue is of crucial importance to Greek inflection because properties such as number and case (morphological features in our model) characterize both stems and affixes, but values of these particular features are only provided by the affixes in the way that I will explain below.

In this section of the paper, I will show that by applying Steele's approach to morphology, we can build an efficient system of computing inflectional information in Greek inflectional structures. I must specify, though, that Steele's ideas have been developed within the framework of what is called 'Extended Functional Application', a framework which relies on the notions of 'functor' and 'argument'[27]. My approach is developed instead within the framework of lexical morphology. The basic principles of Steele's model which underlie the formation of Greek inflected words are the following:

– Stems and affixes participating in word formation processes are non-atomic. They constitute feature bundles built on a feature system that considers features as attribute-values pairs.

– A feature bundle may contain an underspecified feature, that is a feature lacking a specified value part which can be represented by a variable[28].

– Words are created out of the features of their daughters, not by simply collecting these features, but rather through a process which selects from among the features and reorganizes them. In such a process, the features of the privileged member (i.e., the head or the functor in Steele's terms) have priority over the features of the non-privileged member (the non-head or the argument in Steele's terms). It is important to note that given a construction where some features of the privileged member are underdetermined (i.e., features without specific values), the non-privileged member is allowed to contribute to the result only those values which are underspecified. Moreover, the privileged

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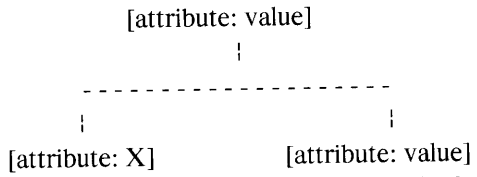
26. Accessibility to the features of non-privileged members of constructions constitute a major concern of other linguistic theories too (e. g., the idea of 'foot features' in GPSG). Proposals shifting the burden of accessibility to the non-privileged member of a construction can be found in the categorial systems used by Karttunen (1989) and Zeevat (1988). For a criticism of these proposals, see Steele (1990: 21-25).
27. According to Steele (1990: 4), Extended Functional Application is mainly a proposal concerned with the general issue of how the featurized properties of a containing unit are constructed from its members.
28. Steele's approach to Extended Functional Application requires a variable in the domain of the functor. In our system of Greek inflection, variables may appear within the feature bundle representing the stem. Variables are given with the capital letters X, Y and Z.

member may preclude a property of the non-privileged one from appearing in the mother node by ignoring or by cancelling it. In fact, in inflectional structures, the underspecification of the domain of the privileged member yields three combinatorial situations:

Situation 1. The privileged member of the construction identifies a feature but not the associated value. Then, the feature of the non-privileged member contributes to the mother node. This property is available to the grammar for further manipulation above the level of the mother node.

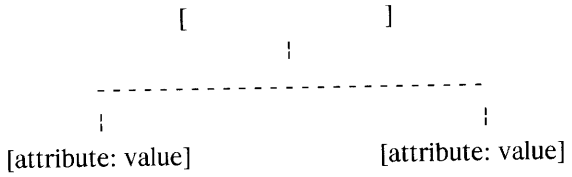
13.



where, the variable X represents underspecification of the feature.

Situation 2. A feature of the non-privileged member and its associated value is required by the privileged member for reasons that have to do with the well-formedness of the construction. This feature is not available for further manipulation above the level of the mother node.

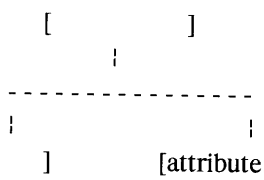
14.



Situation 3. The privileged member does not identify a certain feature and, therefore, it is insensitive to this feature if it belongs to the domain of the non-privileged member. The feature is prevented from contributing to the resulting node and it is not available for further manipulation above the level of the mother node[29].

29. Note that this situation is not represented in Greek inflection.

15.



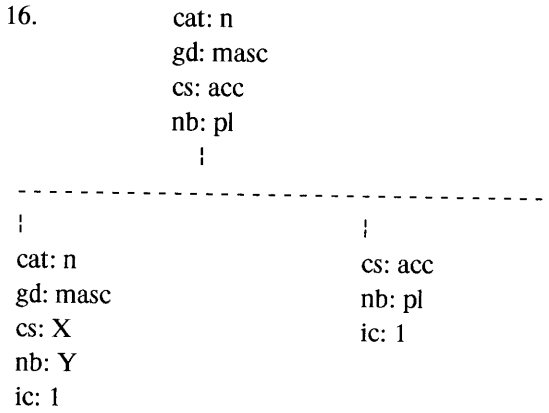
(cf. Steele, 1990 for further details on these three situations)

Let us now begin exploring the application of these ideas to Greek nominal inflection.

3. An analysis of Greek nouns

Consider first an inflected form such as 'kipus' "garden, masculine, accusative plural". It contains a stem, 'kip-' and an affix '-us' which is obligatorily required by the stem. The stem may be defined as the privileged member of the construction and the affix as the non-privileged one the features of which are by no means ignored. Thus, the basic principles of Steele's model may apply to 'kipus', and account for the computation of information characterizing the structure.

16.



In 16, fully specified features of the privileged member, i.e., the stem, percolate to the topmost node. Note that the stem contains the features of case and number as underspecified, that is, characterized only as far as the attribute part is concerned. The values which will give these features a full specification are provided by the feature bundle representing the inflectional affix. This is done by application of the first convention of Steele's model according to which, in situations similar to our case, values of non-privileged members are allowed to

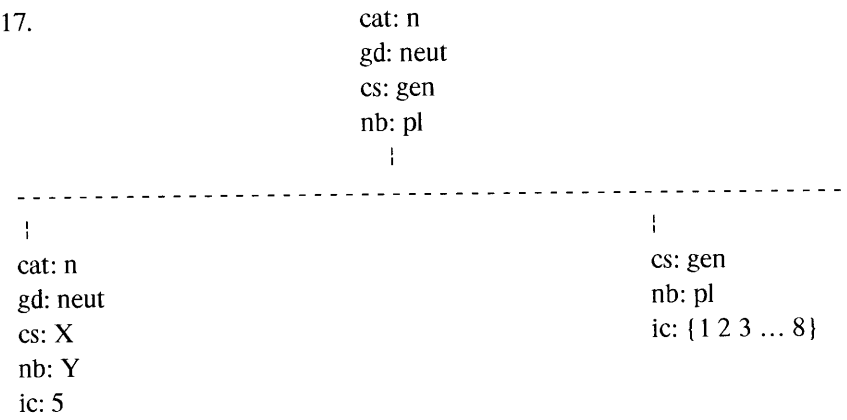
be supplied to underspecified features of feature bundles acting as privileged members of constructions.

The use of the feature of inflection class ('ic') is covered by the second convention of Steele's approach described in 14. According to this, both stem and affix can share the same fully specified feature, that is, a feature that has a given attribute with a specific value part. In our case, the feature of inflection class acts as a matching device associating a particular stem to an appropriate inflectional affix. This feature though is not allowed to percolate to an upper level of the structure, i.e., to the word feature bundle, because it appears in the feature bundles of both constituent parts. As a result to this, the 'ic' feature is not open for further manipulation above the word level. As such, it cannot be seen by rules manipulating words and cannot be relevant to syntax.

Therefore, information related to inflection class can be characterized as word internal. This is to be expected from an analysis dealing with a purely morphological feature such as inflection class. Having defined morphology in terms of what is relevant to word internal processes, features referring only to word internal constituents should not be seen by syntactic rules. On the other hand, features characterizing words as whole entities must be available for further manipulation by rules dealing with words in syntactic structures. Thus, our analysis correctly predicts that the morphological features of category, case, number and gender are open to syntactic manipulation since they percolate from word-internal constituents to the topmost feature bundles which constitute phrasal elements. These features are used by syntactic mechanisms such as phrase structure rules (feature of category), case assignment and agreement. Syntactic relevance of these features is taken into consideration although their morphological status is maintained. Moreover, we can also explain why these features are prevented from being erased or changed during syntactic manipulation: by being morphological, these features may get altered only within morphology while for syntax, they are like frozen objects.

It is necessary now to take another glance at the feature of inflection class, which allows the correct matching between stems and inflectional affixes. Within the framework just described, it is possible to have a case where a stem marked by an 'ic' bearing one value combines with an affix containing an 'ic' bearing several disjunctive values. Such an example arises in genitive plural, where nouns of all three genders, and independently of their inflection class, end in the same form, '-on'. '-on' has already been indentified as an inflectional affix and its lexical entry has been listed under (9). When '-on' is combined with a noun stem, for example 'vun-' "mountain", an inflected wordform is obtained and the 'ic' feature is cancelled:

17.



As we see in 17, the mapping between the 'ic' of the stem and that of the affix is not perfect because the 'ic' of the affix has a choice of values, but only one can be chosen by the stem. Therefore, Steele's second convention needs to be slightly modified in the sense that a feature may be cancelled when the value of a feature of the non-privileged member, mapped with the value of a feature of the privileged member, is part of a set of disjunctive values.

It is worth noting that in inflection, there is no application of Steele's third convention according to which, some properties of the non-head not identified by the head are precluded from appearing in the mother node. The non-application of this convention is justified by the fact that inflectional affixes have no other properties than the ones obligatorily required by stems in inflectional structures. In this sense, inflectional affixes are different from derivational affixes the properties of which are not generally predicted by the properties of stems.

To sum up, it is maintained here that in nominal inflectional structures, percolation of featurized information is achieved though a principled method of feature-passing from daughters to mother nodes. This method is applied to feature bundle representations the privileged member of which is a feature bundle underdetermined for the features of case and number. It is showed that stems, i.e., the privileged members of inflectional structures, require specific values for their underspecified features from inflectional affixes, i.e., the non-privileged members, which are added to them by an obligatory application of a context free word structure rule. By adopting this method of feature passing, we do not need to look for a kind of revised percolation principle (such as the one formulated by Selkirk 1982), in order to account for feature percolation in inflection. Furthermore, in this approach, Lieber's distinction between head percolation and back up percolation seems to be an unnecessary device to adopt,

at least for inflection, where percolation of featurized information characterizing inflected items is triggered by value underspecification of heads.

4. Conclusions

In the above, we have seen how a rich inflectional system such as that of Greek nominal inflection may be encoded and analysed within a framework dealing with features given as attribute-value pairs. In developing such a framework, it is argued that the main issue of percolation of information to inflectional structures can be accounted for by adopting a principled method of feature-matching and feature-passing applied to constituents of feature bundle representations. Moreover, syncretism in inflectional forms finds a way to be taken into consideration by using a featurized representation of morphemes and the possibility to have several disjunctively specified values for the same attribute. Finally, to a certain extent, we have also seen how such an approach may help to clarify the relationship between inflection and morphology in general and the interaction of syntax and morphology as far as nominal inflection is concerned. All the evidence in this paper has been taken from Greek. Nonetheless, other rich inflectional systems (e.g., Latin) may be treated in a similar manner. I hope that I have at least offered further incentives for the investigation of feature structures in morphological descriptions.

A. Ralli
University of Patras

TABLE 1: GREEK INFLECTION CLASSES

Inflection class 1: Stems *anθrop* "man" (masculine)
psif "vote" (feminine)

	Singular	Plural
Nominative	anθropos	anθropi
Genitive	anθropu	anθropon
Accusative	anθropo(n)	anθropus
Vocative	anθrope	anθropi

Inflection class 2: Stems (all masculine):*

tamia	~	*tami*	"cashier"
maxiti	~	*maxit*	"fighter"
papa	~	*papað*	"priest"
papu	~	*papuð*	"grand father"
kafe	~	*kafeð*	"coffee"
bakali	~	*bakalið*	"grocer"

	Singular	Plural
Nominative	maxitis	maxites
Genitive	maxiti	maxiton
Accusative	maxiti	maxites
Vocative	maxiti	maxites

Inflection class 3: Stems (all feminine):

mitera	~	*miter*	"mother"
avli	~	*avl*	"yard"
alepu	~	*alepuð*	"fox"
mama	~	*mamað*	"mummy

* Stems separated by '~' are considered to be allomorphs of the same lexical entry (cf. note 8). Note also that a number of stems of an Ancient Greek origin (e.g., *pritani(s)* "Principal", *sinγrafea(s)* "writer") are inflected according to the second inflection class in singular, but they follow the fourth inflection class in plural.

	Singular	Plural
Nominative	avli	avles
Genitive	avlis	avlon
Accusative	avli	avles
Vocative	avli	avles

Inflection class 4: Stem: *poli ~ pole* "city" (feminine)**

	Singular	Plural
Nominative	poli	polis
Genitive	polis/poleos	poleon
Accusative	poli	polis
Vocative	poli	polis

Inflection class 5: Stems (all neuter): *vun* "mountain"
6: *spiti* "house"
7: *kratos* "state"
8: *soma ~ somat* "body"
plisimo ~ plisimat "washing"

	Singular				Plural			
Nom.	vuno	spiti	kratos	soma	vuna	spitia	krati	somata
Gen.	vunu	spitju	kratus	somatos	vunon	spitjon	kraton	somaton
Acc.	vuno	spiti	kratos	soma	vuna	spitja	krati	somata
Voc.	vuno	spiti	kratos	soma	vuna	spitja	krati	somata

(i-> j / ---- vowel
[- stress]

** In genitive plural nouns of the fourth inflection class end in '-eon'. We may consider this '-eon' as an inflectional ending or suppose that the ending is no other than the '-on' and that the initial vowel /e/ belongs to an allomorphic variation of the stem (e.g., *pole*). I opt for the latter considering the fact that the same allomorphic variation of the stem also appears in genitive singular in a rather litterary style of language.

TABLE 2: GREEK INFLECTIONAL AFFIXES

os	u	o(n)	e
cs: nom	cs: gen	cs: acc	cs: voc
nb: sg	nb: sg	nb: sg	nb: sg
ic: 1	ic: {1 5 7}	ic: 1	ic: 1

i	on	us	s
cs: {nom voc}	cs: gen	cs: acc	cs: nom
nb: pl	nb: pl	nb: pl	nb: sg
ic: 1	ic: {1 2 ... 8}	ic: 1	ic: 2

∅	es	∅
cs: {acc gen voc}	cs: {nom acc voc}	cs: {nom acc voc}
nb: sg	nb: pl	nb: sg
ic: 2	ic: {2 3}	ic: {3 4 7 8}

s	o	a
cs: gen	cs: {nom acc voc}	cs: {nom acc voc}
nb: sg	nb: sg	nb: pl
ic: {3,4}	ic: 5	ic: {5 7 8}

os	us	i
cs: {nom acc voc}	cs: gen	cs: {nom acc voc}
nb: sg	nb: sg	nb: pl
ic: 6	ic: 6	ic: 6

os	is
cs: nom	cs: {nom acc voc}
nb: gen	nb: pl
ic: {4 8}	ic: 4

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