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Lexical niche and sustainability: an ecolinguistic perspective

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Abstract: This paper proposes the innovative concept of *lexical niche* to analyze the ecology of vocabulary from an ecolinguistic perspective. Through the examination of niche breadth and overlap, we quantitatively assess the vitality and competition of six typical Chinese eating verbs: *shi* (食), *fan* (饭), *can* (餐), *dan* (啖), *ru* (茹), and *chi* (吃). The analysis reveals their diachronic evolution in the history of the Chinese language (temporal niche), their synchronic distribution in Chinese dialects (spatial niche), and their verb-object collocation (functional niche). The findings indicate the following: (1) *Shi*, *fan*, *can*, *dan*, and *ru* originated in Early Old Chinese, while *chi* emerged in Late Old Chinese. (2) The niche breadths of the six eating verbs are as follows: 2.585, −2.391, −2.242, −0.108, −1.734, and 3.889, respectively. *Chi* demonstrates the highest vitality, followed by *shi*; *fan*, *can*, *dan*, and *ru* exhibit extremely low vitality. (3) *Shi* originated in the Pre-Qin dynasty, serving as the dominant eating verb in ancient times with robust competition. However, in modern times, it has evolved into a morpheme for compound words, displaying weak sustainability. *Chi*, born in the Han dynasty, replaced *shi* as the dominant eating verb by the late Tang dynasty, establishing itself as the most competitive verb to date, characterized by strong sustainability.

Keywords: ecolinguistics; lexical niche; lexical vitality; sustainability of vocabulary

1 Introduction

In recent decades, linguistic research has predominantly concentrated on the internal structures of language and the intricate relationship between language, society, and culture. However, in response to the escalating environmental concerns, an increasing number of scholars have incorporated ecological theories into

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linguistic studies (Cowley 2021; He et al. 2021). This integration aims to explore the dynamic interplay between language and the environment from an ecological perspective (Ma and Stibbe 2022). Termed ecolinguistics, this field presents a fresh approach to examining linguistic phenomena. Ecolinguistics, as an interdisciplinary science amalgamating linguistics and ecology, directs attention to the interactions between language and the ecological environment. It delves into how language influences human ecological behaviors and, conversely, how the ecological environment shapes the structure and function of language (Ha 2023; Penz and Fill 2022; Zhou 2021). Research topics within ecolinguistics encompass language diversity, language contact, language endangerment, language evolution, language and ecological conservation, language and environmental cognition, and ecological discourse criticism, among others (Penz and Fill 2022). Within these topics, scholars have explored issues such as safeguarding endangered languages, leveraging language for promoting ecological protection, and understanding how language impacts people's cognition of the environment. This paper, from an ecolinguistic perspective, introduces the concept of *lexical niche* to scrutinize the ecology of vocabulary. In doing so, it provides a theoretical foundation for the sustainable development of lexis.

2 Literature review

Ecolinguistics emerged in the 1970s as an interdisciplinary science combining linguistics and ecology, aiming to investigate the dynamic interaction between the environment and language (Penz and Fill 2022). Over the past decades, ecolinguistics has undergone distinct research frameworks and theoretical systems, notably the Haugenian paradigm and the Hallidayan paradigm (Fill and Mühlhäusler 2001). The former examines the influence of the environment on language, while the latter explores the impact of language on the environment. Either of the two is complete. Haugen (1970, 1972) introduced the metaphorical concept of the ecology of language to illustrate the relationship between a language and its environment, encompassing social, natural, and psychological aspects. He asserted that linguistic ecology relies on its learners, users, and transmitters. Halliday (1990) argues that language is a form of social practice intricately linked to the ecological environment, emphasizing that language actively shapes reality rather than passively reflecting it. Li (1991) pioneered the application of niche theory from ecology to study the Chinese language, defining linguistic niche as the temporal and spatial distribution of language varieties and the environmental elements they inhabit. Dale and Lupyan (2012) proposed the "linguistic niche hypothesis", suggesting that language variation correlates with the social environment, particularly language use and learning. Their study of over

two thousand languages indicated a relationship between population size and language complexity: fewer speakers led to more intricate inflectional structures, or vice versa. Huang (2018) introduces the concept of harmonious discourse analysis (HDA) in the Chinese context, incorporating principles of conscience, proximity, and regulation to analyze different discourses under the philosophy of the unity of human and nature. Xiao (2021) proposes the theoretical construct of the ecolinguistic continuum, highlighting that lexical and grammatical evolution represents an eco-continuum in that the environments/contexts in which language evolves constitute an eco-continuum. In such a continuum, language interacts and aligns with environments (including natural, social, and cognitive-psychological). Language as behavior affects environments, especially cognitive and psychological ones which then influence ones' physical behavior to nature; likewise, environments also influence language. It is a dialectical process of interplay between subjective and objective variables (Xiao et al. 2023).

The ecology of language refers to the conditions under which a language survives and evolves in a given environment, encompassing the inherent nature of that language. Humboldt (1836) posited that language directly reflects human organic life in mental activity, endowing language with characteristics akin to organic life. Schleicher (1863) drew parallels between the linguistic organism and the natural organism, asserting that language undergoes a biological life process akin to birth, growth, aging, and death. This perspective aligns the law of language development with the process of biological evolution. Greenberg (1956) statistically analyzed linguistic diversity, combining elements such as linguistic diversity, population distribution, and linguistic structure to gauge the language ecology. Voegelin et al. (1967) formally introduced the term ecology to discuss the intricate relationship between languages, emphasizing the need to analyze both internal language structures and external environmental systems. Labov (1972) explored social influences on language, studying pronunciation differences among citizens of different social and economic backgrounds in New York. His research revealed the invisible and profound impact of the social environment on language change. Goatly (1996) introduced the concept of "green grammar", emphasizing the ecological factors of the language system and asserting that only harmonious grammar can construct the real world. Mufwene (2001) cited language contact examples, analyzing diachronic and synchronic language evolution. Huang (2000) established language vitality indicators based on three factors, ranking the vitality of minority languages in China. Dai and Deng (2001) addressed endangered languages, proposing core indicators for measurement. Xiao and Fan (2011) introduced a PSR assessment model of language ecology with 12 indicators, assessing language vitality comprehensively. Feng (2013) explored the relationship between language ecology and variation, resources,

planning, and education, constructing a theory on language ecology. Stibbe (2020) categorized discourse into beneficial, destructive, and neutral categories, aiming to expose growthism and consumerism and advocate for sustainable development in "the stories we live by" (Ma and Stibbe 2022).

Linguistic niche refers to the temporal and spatial position of a language and its functional relationships with other languages in the linguistic ecosystem. Distinct environments shape varied linguistic niches, resulting in diverse linguistic variants. The size of a linguistic niche dictates its vitality and competition. If the niche continually contracts in competition, reaching a point where the minimum environment for sustainable development is unavailable, the language becomes endangered or even extinct. Lewis and Frank (2016) tested the linguistic niche hypothesis by examining both the internal system (structure) and the external system (environment) of language. Their statistical results indicated that languages in colder, smaller places are more complex and less learnable for non-native speakers. Li (1991) pioneered the application of ecological niche theory to study the Chinese language, defining linguistic niche as the temporal and spatial distribution of language varieties and the environmental elements that influence them. In *Ecological Chinese*, Li (1991) introduced the ecological Chinese system, discussing the internal and external ecology of Chinese, including linguistic structure, dialects, environment, and niche. Wang (2007) explored the causes and preservation of endangered languages from the perspective of linguistic niche, defining it as the position or status of a language in a specific linguistic ecological environment and among a particular group of people. Wang (2014) studied the ecological status of Hangzhou dialects in three dimensions: function, resources, and space-time, concluding that the ecological status of a language is the sum of the resources and functions it occupies in a particular linguistic ecology during a specific historical period and geographical space. Pan (2015) investigated the sustainability of Chinese speaking and writing among college students, examining micro changes in the Chinese niche under the influence of English. The study identified subtle changes in aspects such as alphabetization of morphemes, lexicalization of words, generalization of transliteration, confusion of sound and spelling, Europeanization of grammar, and translationese. Zhang and Wei (2017) applied the theory of linguistic niche to study the emergence, status, and sustainable development of Chinese honorifics, proposing relevant protection measures. Zhang and Huang (2021) measured the niche of the Hmong language and Mandarin Chinese in Jianhe County (Guizhou, China) from the perspective of sustainable language and culture development, revealing their vitality and competition through temporal and spatial niche breadth and niche overlap.

Most of the above researches are static, synchronic, qualitative, and internal, lacking extensive data for scientific results. For a holistic study, this paper introduces the novel concept of *lexical niche*. Lexical niche refers to the temporal and spatial distribution of words in the lexical system and the functional relationships between

words, allowing for the quantification of language ecology. This study utilizes four corpora for lexical statistics, aiming to investigate the ecology of words in terms of temporal, spatial, and functional niches. By employing niche breadth and niche overlap indices, the paper quantifies the vitality and competition of six Chinese eating verbs: *shi* (食), *fan* (饭), *can* (餐), *dan* (啖), *ru* (茹), and *chi* (吃). The study seeks to answer the questions below: (1) When were the six eating verbs originated? (2) Which among them exhibits the highest vitality? (3) What kind of competition do they undergo during their diachronic evolution?

3 Research methodology

In this section, we introduce the novel concept of *lexical niche*, focusing on the temporal and spatial distribution of words in the lexical system and the functional relationships between words. The aim is to digitize the ecology of vocabulary and unveil the driving factors behind lexical metabolism.

3.1 Research object

This study centers on the concept of eating, excluding drinking. Six typical eating verbs are selected to quantify the lexical ecology: *shi*, *fan*, *can*, *dan*, *ru*, and *chi*. Noun, quantifier, or other parts of speech that share the same words in the corpora are excluded from the statistics.

3.2 Data source

Data for this study are sourced from historical literature and modern dialects, collected from various corpora and dictionaries, including the Chinese Classics Retrieval System by Shaanxi Normal University,[1] CCL corpus by Peking University (http://ccl.pku.edu.cn:8080/ccl_corpus/index.jsp), BCC corpus by Beijing Language and Culture University (http://bcc.blcu.edu.cn/), *Modern Chinese Dialects Dictionary* (Li 2002), *Dictionary of Chinese Dialects* (Xu and Gongtian 2020), *Chinese Dialect Vocabulary* (Wang 1995), *Atlas of Chinese Dialects* (Cao 2008), and *Language Atlas of China* (Xiong and Zhang 2012).

1 This retrieval system is a paid software developed by Professor Lin Yuan at Shaanxi Normal University (see https://his.snnu.edu.cn/info/1091/8988.htm), containing 1.54 billion words.

The history of Chinese is categorized into four periods: Early Old Chinese, Middle Old Chinese, Late Old Chinese, and Modern Chinese (Table 1). Correspondingly, four corpora (T1/T2/T3/T4) are constructed to record the frequency of eating verbs across the history of Chinese, which indicates the temporal niche breadth of the eating verbs. To ensure scientific results, colloquial books are selected for each stage, considering that oral language has been a primary driving force for word evolution (Li 2011). Each corpus comprises six books, with balanced sizes, resulting in a total of 24 books. The size of each corpus is 1.568, 1.543, 1.592, and 1.574 million words, respectively.

Table 1: Diachronic corpus for temporal niche.

History	Books	Size/million	
T1 Early Old Chinese (14th century BC–7th century AD)	*Zhuangzi* (‘*Sir Zhuang*’)	0.078	1.568
	Guoyu (‘*Discourses of the States*’)	0.088	
	Lüshi Chunqiu (‘*Master Lü’s Spring and Autumn Annals*’)	0.123	
	Hanfeizi (‘*Sir Hanfei*’)	0.106	
	Shiji (‘*Historical Records*’)	0.526	
	Shisanjing Zhushu (‘*Annotations of the Thirteen Classics*’)	0.647	
T2 Middle Old Chinese (7th–14th century AD)	*Soushen Ji* (‘*Anecdotes about Spirits and Immortals*’)	0.071	1.543
	Lunheng (‘*On Balance*’)	0.246	
	Qimin Yaoshu (‘*Essential Techniques for the Welfare of the People*’)	0.141	
	Shishuo Xinyu (‘*A New Account of the Tales of the World*’)	0.140	
	Yanshi Jiaxun (‘*Family instructions of Master Yan*’)	0.042	
	Hanshu (‘*History of the Han Dynasty*’)	0.903	
T3 Late Old Chinese (17th–early 20th century)	*Xinwudai Shi* (‘*New History of the Five Dynasties*’)	0.348	1.592
	Wangfanzhi Shi (‘*Poems by Wang Fanzhi*’)	0.020	
	Dunhuang Bianwenji Xinshu (‘*Ballads and Stories from Dunhuang*’)	0.194	
	Rutang Qiufa Xunli Xingji (‘*The Record of a Pilgrimage to China in Search of the Law*’)	0.082	
	Zutang Ji (‘*Collection of the Patriarchal Hall*’)	0.249	
	Wudeng Huiyuan (‘*Compendium of Five Lamps*’)	0.699	
T4 Modern Chinese (early 20th century – now)	*Yuanchao Mishi* (‘*The Secret History of the Mongols*’)	0.048	1.574
	Fusheng Liuji (‘*Six Records of a Floating Life*’)	0.036	
	Qingpingshantang Huaben (‘*Novellas Printed by the Qingping Mountain Pavilion*’)	0.137	
	Yuankan Zajv Sanshi Zhong (‘*The Thirty Zaju Plays in Yuan Printings*’)	0.130	
	Chuke Paian Jingqi (‘*Amazing Tales-First Series*’)	0.362	
	Hongloumeng (‘*A Dream of Red Mansions*’)	0.861	

The spatial niche breadth of eating verbs is determined by their distribution across various dialectal regions. In the context of Chinese dialects, different dictionaries and atlases propose varying classifications, such as seven dialects, eight dialects, and ten dialects. These differences stem primarily from the subdivision of larger dialectal groups. For instance, the Guanhua area can be further categorized into eight sub-regions, including Northeast, Southwest, Jiaoliao, Beijing, Jilu, Zhongyuan, Jianghuai, and Lanyi dialects. Given their proximity to Mandarin/Putonghua (the official Chinese language), these eight dialects generally do not pose significant communication barriers and can be regarded as a cohesive dialectal family. In our data collection process, we adhere to the categorization outlined in the *Modern Chinese Dialect Dictionary* (Li 2002), which classifies Chinese dialects into ten distinct groups: Guanhua, Jinyu, Huiyu, Wuyu, Minyu, Xiangyu, Ganyu, Hakka, Cantonese, and Pinghua, as illustrated in Table 2.

Table 2: Division of Chinese dialects (according to Li 2002).

Division of Chinese dialects															
D1								D2	D3	D4	D5	D6	D7	D8	D9	D10
D1	D1	D1	D1	D1	D1	D1	D1									
I	II	III	IV	V	VI	VII	VIII									

Note: D1, Guanhua; I, Dongbei Guanhua; II, Jiaoliao Guanhua; III, Beijing Guanhua; IV, Jilu Guanhua; V, Zhongyuan Guanhua; VI, Jianghuai Guanhua; VII, Lanyin Guanhua; VIII, Xi'an Guanhua; D2, Jinyu; D3, Huiyu; D4, Wuyu; D5, Xiangyu; D6, Ganyu; D7, Hakka; D8, Minyu; D9, Cantonese; D10, Pinghua.

The functional niche breadth is delineated by the collocative objects associated with the six eating verbs. In this study, the collocations of eating verbs were extracted from a corpus constructed for this purpose and pertinent Chinese dialect dictionaries. Fourteen categories of objects were identified, including meal, cake, meat, fruit, vegetable, grass, porridge, sauce, tea, wine, water, milk, cigarette, and gas, as presented in Table 3.

Table 3: Object categories of the six eating verbs.

Eating verbs	Objects
Shi *Fan* *Can* *Dan* *Ru* *Chi*	Meal, cake, meat, fruit, vegetable, grass, porridge, sauce, tea, wine, water, milk, cigarette, gas

3.3 Research method

This study delves into the ecological position and evolution of six eating verbs, exploring these aspects in three dimensions: temporal, spatial, and functional. The temporal dimension investigates the diachronic evolution of the verbs, the spatial dimension examines their synchronic distribution, and the functional dimension explores their collocation. The study exclusively focuses on eating verbs, necessitating data tagging to precisely identify the verbs. Natural Language Processing & Information Retrieval Sharing Platform (NLPIR) (http://www.nlpir.org) is employed for lexical segmentation and tagging, followed by manual proofreading to ensure accuracy. R 4.2.2 is utilized for computing the lexical niche, while Python 3.1.1 is applied for data visualization.

The study employs the niche metric to quantitatively describe the ecological niches of the selected verbs and explore interspecific relationships. This metric is typically measured using two indicators: niche breadth and niche overlap. Niche breadth represents the sum of various resources available to an organism, indicating its adaptation to the environment and resource utilization. A wider niche suggests a generalist species, while a narrower niche signifies specialization. Specialized species with low vitality face disadvantages in resource competition, whereas generalized species with high vitality exhibit strong competitive abilities. Niche overlap reflects the efficiency and degree of resource sharing among species. According to the principle of competitive exclusion, greater overlap leads to more potential competition, influencing community structure and distribution. Potential competition may not necessarily occur, and the intensity of competition can be reflected by the increase or decrease of data. The lexical niche breadth (Bi) is determined by the standardized number of resources occupied by verb i. Temporal niche breadth is denoted by the frequency of eating verbs across different historical periods of the Chinese language. Spatial niche breadth is characterized by the number of dialectal regions where the eating verb is distributed. Functional niche breadth is indicated by the categories of the eating verb's collocative objects. Lexical niche overlap (O_{ij}) is quantified by the ratio of the number of resources shared by verb i and verb j to the total number of resources (periods of Chinese language, dialectal regions, collocative objects). The niche overlap index ranges from 0 to 1. A value of 1 signifies complete overlap between verb i and verb j, indicating potential competition. Conversely, a value of 0 indicates no overlap between the two verbs, signifying no competition. A higher niche overlap index suggests a greater potential for competition.

4 Result and discussion

4.1 Niche breadth and vitality of eating verbs

Based on the mean value of three-dimensional niche breadth (Table 4), the eating verbs could be categorized into three categories: narrow niche ($Bi < 0$), medium niche ($0 \leq Bi < 1$), and wide niche ($Bi \geq 1$). The mean values of three-dimensional niche breadth for the eating verbs are as follows: *chi* (3.889), *shi* (2.585), *dan* (−0.108), *ru* (−1.734), *can* (−2.242), *fan* (−2.391). *Dan*, *ru*, *can*, and *fan* fall into the category of narrow niche verbs, exhibiting low vitality and sustainability. *Chi* and *shi* are classified as wide niche verbs, showcasing high vitality and sustainability.

Table 4: Niche breadth of six eating verbs.

Niche breadth	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Temporal	1.563	−0.634	−0.640	−0.595	−0.666	0.972
Spatial	0.063	−0.695	−0.695	−0.316	−0.316	1.957
Functional	0.959	−1.062	−0.907	0.803	−0.751	0.959
Mean value	2.585	−2.391	−2.242	−0.108	−1.734	3.889

4.1.1 Temporal niche breadth and vitality

In terms of temporal niche (Figure 1), *shi* demonstrates the widest niche breadth (1.563) and exhibits high vitality. Being an ancient word transmitted from antiquity to the present, *shi* is utilized in Cantonese, Min, and Hakka dialects, resulting in a high frequency across temporal corpora. The assessment of vocabulary niche breadth should consider two factors: richness and evenness of distribution. *Ru* exhibits the lowest temporal niche breadth (−0.666) due to its relatively low richness (occurring 5, 7, 7, and 3 times in T1/T2/T3/T4, respectively). *Chi* ranks second in temporal niche breadth (0.972) owing to its high frequency (2,542 occurrences in total). Born in the history of Middle Old Chinese, *chi* is a relatively new word compared to the ancient *shi*. In Modern Mandarin Chinese, *chi* has dominated the semantic field of eating, while *shi* has undergone degradation into a morpheme, persisting in compound words and idioms such as ***shi****yan* (食盐, 'table salt'), *mei****shi*** (美食, 'delicious food'), and *ruorou qiang****shi*** (弱肉强食, 'if you are weak, you are the meat; if you are strong, you eat the meat'). This shift highlights *chi*'s ascendancy in modern usage, contrasting with *shi*'s historical prominence.

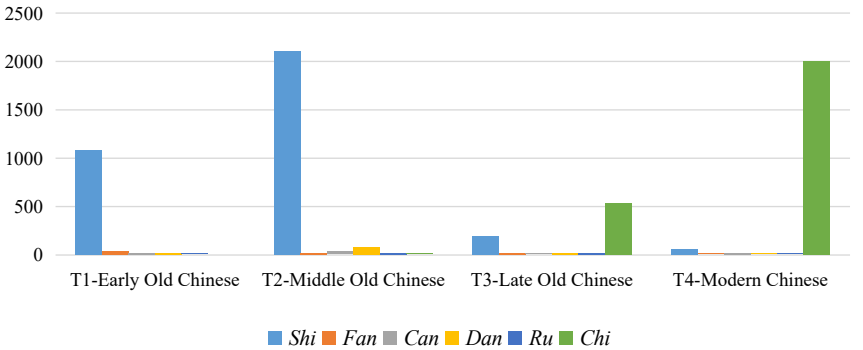

Figure 1: Temporal distribution of six eating verbs.

4.1.2 Spatial niche breadth and vitality

In terms of spatial niche (Figure 2), *chi* distinguishes itself with the widest niche breadth (1.957), indicating exceptional vitality attributed to its prevalence across eight Chinese dialects. Notably, modern Cantonese encompasses not only *shi* in Guangzhou but also *chi* in Yangjiang. While *shi* would be traced back to Early Old Chinese, *chi* derives from Middle Old Chinese. In contrast, *fan* and *can* exhibit the narrowest spatial niche breadth (–0.695), stemming from their unique presence in the Guanhua area. *Dan* and *ru* rank second to last in spatial niche breadth (–0.316), representing small regional dialect words, with *dan* used in Minyu (Xiamen in Fujian Province, Leizhou in Zhejiang province) and Huiyu (Jixi in Anhui province), and *ru* in Guanhua and Wuyu.

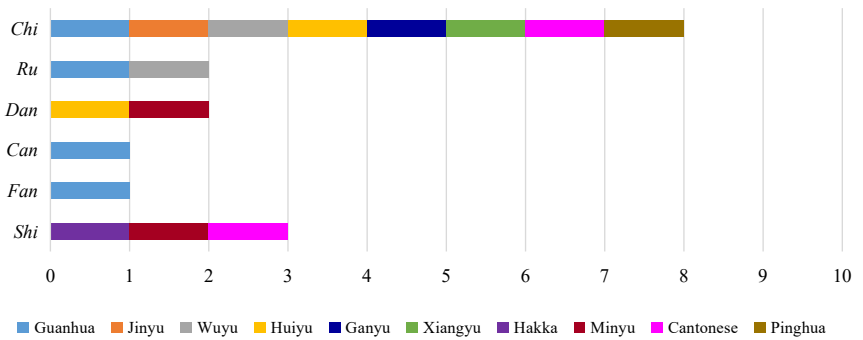

Figure 2: Spatial distribution of six eating verbs.

4.1.3 Functional niche breadth vitality

In terms of functional niche (Figure 3), *shi* and *chi* exhibit the widest niche breadth (0.959), both of which collocate with fourteen categories of objects: meal, cake, meat,

fruit, vegetable, grass, porridge, sauce, tea, wine, water, milk, cigarette, and gas. *Fan* possesses the smallest functional niche breadth (–1.062), as it solely pertains to dining a specific meal, with cereal as the object. *Can* encompasses two categories of objects (meal and gas) with a functional niche breadth of –0.907. *Ru*'s objects span meat, grass, and gas, resulting in a functional niche breadth of –0.751. *Dan* displays greater versatility, with a functional niche breadth of 0.803, encompassing objects from all categories except meal.

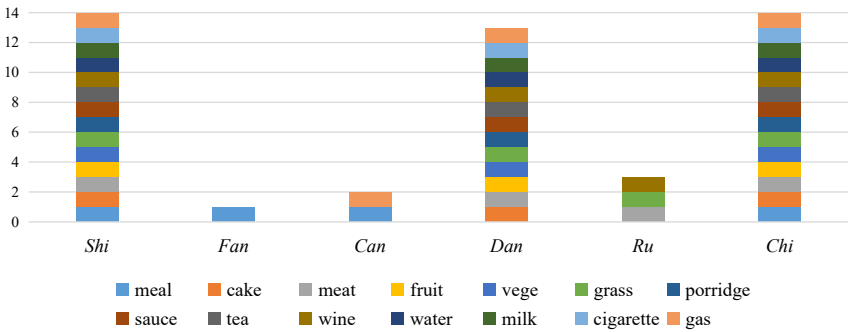

Figure 3: Collocation (objects) of six eating verbs.

4.2 Niche overlap and competition of eating verbs

4.2.1 Temporal niche overlap and competition

In the temporal dimension (Table 5), the niche overlap indexes between *shi* and *fan*, *can*, *dan*, *ru* are all 1.000. This is because they are archaic words originating from ancient times and spanning the four periods of the Chinese language, from Early Old Chinese to Modern Chinese. In contrast, *chi* shares a temporal niche overlap index of 0.500 with *fan*, *can*, *dan*, and *ru*. This discrepancy is attributed to *chi* being a Middle Old Chinese verb, while the other four are Early Old Chinese verbs, resulting in a significant temporal gap between them. As shown in Table 6, *shi*, born in ancient times, dominates the eating domain in Early Old Chinese and Middle Old Chinese. In contrast, *chi*, a comparatively newer term, asserts its dominance in Late Old Chinese and Modern Chinese. The frequency of *shi* diminishes over time, dropping from 1,085 occurrences in corpus T1 to 63 times in T4, indicating a continual decline. Conversely, *chi* emerges victorious from T3 to T4, with its frequency increasing from 0 to 2003. *chi* initiates competition with *shi* after its inception, gradually establishing itself as the predominant eating verb. According to Jia and Wu (2017), by the late Tang

dynasty, *chi* had successfully replaced *shi*, maintaining its dominance ever since. Archaic words such as *fan*, *can*, *dan*, and *ru* appear sporadically in the corpus throughout history, experiencing minimal competition.

Table 5: Temporal niche overlap index of six eating verbs.

Niche overlap	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Shi	/					
Fan	1.000	/				
Can	1.000	1.000	/			
Dan	1.000	1.000	1.000	/		
Ru	1.000	1.000	1.000	1.000	/	
Chi	0.500	0.500	0.500	0.500	0.500	/

Table 6: Frequency of six eating verbs.

History of Chinese	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Early Old Chinese	1,085	38	3	6	5	0
Middle Old Chinese	2,107	18	24	85	7	2
Late Old Chinese	196	10	23	19	7	537
Modern Chinese	63	6	12	21	3	2,003
Total	3,451	72	62	131	22	2,542

4.2.2 Spatial niche overlap and competition

In the spatial dimension (Table 7), the highest overlap index is observed between *ru* and *chi* (0.200). Both verbs are distributed in Guanhua and Wuyu dialects, indicating

Table 7: Spatial niche overlap index of six eating verbs.

Niche overlap	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Shi	/					
Fan	0.000	/				
Can	0.000	0.100	/			
Dan	0.100	0.000	0.000	/		
Ru	0.000	0.100	0.100	0.000	/	
Chi	0.100	0.100	0.100	0.100	0.200	/

some potential competition. The overlap indexes of *shi* and *fan*, *shi* and *can*, *shi* and *ru*, *fan* and *can*, *dan* and *can*, *dan* and *ru* are all 0.000, signifying no overlapping at all and therefore no competition. This is because they belong to different dialects: *shi* appears in Cantonese, Minyu, and Hakka; *fan* and *can* appear in Guanhua; *dan* appears in Minyu (Xiamen in Fujian Province, Leizhou in Zhejiang province) and Huiyu (Jixi in Anhui province); *ru* appears in the Wuyu and Guanhua, as shown in Table 8.

Table 8: Dialectal distribution of six eating verbs.

Chinese dialects	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Guanhua	0	1	1	0	1	1
Jinyu	0	0	0	0	0	1
Wuyu	0	0	0	0	1	1
Huiyu	0	0	0	1	0	1
Ganyu	0	0	0	0	0	1
Xiangyu	0	0	0	0	0	1
Hakka	1	0	0	0	0	0
Minyu	1	0	0	1	0	0
Cantonese	1	0	0	0	0	1
Pinghua	0	0	0	0	0	1
Total	3	1	1	2	2	8

4.2.3 Functional niche overlap and competition

In the functional dimension (Table 9), the highest overlap index is observed between *shi* and *chi* (1.000), indicating intense potential competition. Both *shi* and *chi* belong to generalized species, encompassing objects from all 14 categories: meal, cake, meat, fruit, vegetable, grass, porridge, sauce, tea, wine, water, milk, cigarette, and gas, as shown in Table 10. *Dan* covers 13 categories of objects, displaying high functional niche overlap indexes with *shi*, and *chi* (0.929 in both pairs), suggesting fierce potential competition. In contrast, the functional niche overlap indexes of *ru* and *fan*, *ru* and *can*, *fan* and *dan* are all zero, signifying no overlapping and therefore no competition. *Ru* implies eating greedily, with objects primarily related to meat, grass, and wine. *Fan* refers to consuming a specific meal, primarily involving grains and food. *Can* is quite formal and refers to dining, with objects including meal and wind (metaphor). *Dan* signifies gulping, with objects mainly related to fruit and meat. *Chi* and *shi*, being relatively civilized in terms of eating, exhibit a more elegant and diverse coverage of various objects.

Table 9: Functional niche overlap index of six eating verbs.

Niche overlap	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Shi	/					
Fan	0.071	/				
Can	0.143	0.071	/			
Dan	0.929	0.000	0.071	/		
Ru	0.214	0.000	0.000	0.214	/	
Chi	1.000	0.071	0.143	0.929	0.214	/

Table 10: Collocative objects of six eating verbs.

Objects	*Shi*	*Fan*	*Can*	*Dan*	*Ru*	*Chi*
Meal	1	1	1	0	0	1
Cake	1	0	0	1	0	1
Meat	1	0	0	1	1	1
Fruit	1	0	0	1	0	1
Vegetable	1	0	0	1	0	1
Grass	1	0	0	1	1	1
Porridge	1	0	0	1	0	1
Sauce	1	0	0	1	0	1
Tea	1	0	0	1	0	1
Wine	1	0	0	1	1	1
Water	1	0	0	1	0	1
Milk	1	0	0	1	0	1
Cigarette	1	0	0	1	0	1
Gas	1	0	1	1	0	1
Total	14	1	2	13	3	14

5 Conclusion

Words compete, survival of the fittest. This study delves into the lexical ecology of six Chinese eating verbs, tracing their journey from ancient to modern sounds, from southern to northern accents, and from elegant to vulgar expressions. Our exploration quantifies the vitality and competition of these verbs through two key metrics: lexical niche breadth and overlap. The findings reveal a nuanced linguistic landscape: *shi* and *chi* inhabit a wide lexical niche, showcasing high vitality and sustainability. However, *shi*, once the dominant eating verb in ancient times, has evolved into a morpheme for compound words, displaying weakened sustainability

in modern times. In contrast, *chi*, born in the Han dynasty and replacing *shi* as the dominant eating verb by the late Tang dynasty, stands as the most competitive and sustainable to date; *dan* and *ru*, occupying a narrow lexical niche, demonstrate very low vitality and sustainability. Rooted in Early Old Chinese, they contribute to the linguistic continuum with their distinct characteristics; *can* and *fan*, confined to a super narrow lexical niche, exhibit little vitality and sustainability. Born in Early Old Chinese, their limited competitive edge reflects in their diminished presence in modern linguistic contexts.

This study pioneers an ecolinguistic perspective, conducting a pilot test to measure the lexical niche and unveil the sustainability of vocabulary: a novel application within quantitative linguistics. The significance of understanding vocabulary sustainability extends to its implications for teaching and learning. It is crucial to acknowledge the limitations of this study, notably the absence of a comparative analysis with English eating verbs. In envisioning an exceptional Eco-Project of Vocabulary, visualizing the DNA of each word – tracing its birth, prototype, family, and history – holds immense potential for unraveling the intricate dynamics of linguistic evolution.

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