



The nexus between traditional foraging and its sustainability: a qualitative assessment among a few selected Eurasian case studies

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Abstract

Plant foraging is an important human ecological phenomenon being studied by a number of contemporary ethnobiologists as well as by a few social anthropologists among rural communities and, more recently, in urban environments. The sustainability dimension of foraging is, however, largely unexplored. We analyse a few case studies from recent field research and qualitatively assess both the environmental and social sustainability of diverse patterns of traditional foraging practices in three distinct human ecological environments (horticulturalism-, forestry-, and pastoralism-driven) located in the Eastern Mediterranean, Eastern Europe, and North Pakistan, i.e. we address the question of when does traditional foraging become unsustainable and what factors may influence this. The main findings are multidimensional. First, in all case studies, we sometimes observed competitive foraging among the gatherers of certain wild food plants potentially causing ecological degradation; such unsustainable practices seem to be linked to the market pressure on certain species. However, also customs and norms promoted by states can be detrimental (former Soviet Union), as well as climate change (Eastern Europe), and marginalisation of some minority groups (Pakistan). Second, in the Mediterranean Syrian context, wild food plant resources are largely represented by widely available weedy “wild” vegetables, normally (but not exclusively) collected by women, and usually easily accessible; only very few wild food plants seem to be threatened due to specific market demands or to disequilibria created by household economic instabilities due to the recent war. We also argue that unsustainable foraging is enhanced by the abandonment of daily practices and continuous interaction with the natural environment and by the increasingly uneven distribution of active practical knowledge on wild food plants among the middle-aged and younger population. Facilitating the transmission of sustainable foraging knowledge and practices could be therefore crucial, also for coping with food insecurity in times of crisis; but for that to occur, holistic environmental and food educational frameworks, appropriate policies for fostering community-based biodiversity conservation and also social cohesion and communal management of lands should be seriously considered as well. Moreover, future gastronomic and eco-tourism initiatives, if organised in a thoughtful manner, could

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represent a positive turning point not only for the local small-scale economies of the considered rural communities but also for helping them to dynamically preserve the entire socio-ecological system underpinned in plant foraging and ultimately to better adapt to the current global crisis.

Keywords Wild food plants · Ethnobotany · Sustainability · Traditional ecological knowledge · Social cohesion

1 Introduction

Foraging—the procurement of food from the wild (without using sophisticated technology, as in hunting and fishing, for example)—was crucial throughout human prehistory and has continued to be so among post-Neolithic societies, as it still represents an important strategy for ensuring food to the household economy in some disadvantaged rural areas of the world (e.g. Addis et al., 2005; Erskine et al., 2015; Maroyi, 2011; Ojelel et al., 2019; Shai et al., 2020; Asia: Punchay et al., 2020; Pieroni et al., 2021), while in most Western societies traditional foraging retains a marginal role and new foraging trends are globally emerging in urban environments (Arrington, 2021; Bunge et al. 2019; Garekæ & Shackleton, 2020; Landor-Yamagata et al. 2018; Łuczaj et al., 2012; Menendez-Baceta et al., 2017; Sardeshpande & Shackleton, 2020). The practice of foraging is, in fact, experiencing a remarkable resurgence in new media as well (e.g. Townsend, 2020), and these new practices have often raised some environmental concerns (e.g. Chen et al., 2019; Sarasan et al., 2011). However, in the ongoing context of global climate change, it is extremely important to assess the extent to which traditional foraging is sustainable overall. Despite the increasing number of publications on the topic of sustainability science, we too often still lack reflections linked to tangible improvements of daily human life. We need a more holistic overview of the complex relationships between humans and their environment and also within human communities (which may have very diverse levels of access to natural resources, e.g. Bunge et al., 2019). Thus, in dealing with the issue of sustainability, it is equally important to investigate the subject from an ecological and social perspective. As foraging competition is known among animals (e.g. birds: Liker & Barta, 2002; Smith et al., 2001; primates: Barrett et al., 2002; Di Bitetti & Janson, 2001), there is also deep concern regarding the competition for food resources among humans, not only in the context of famine and crisis but also in terms of the access that most socially disadvantaged groups may have to food resources for survival (Messer & Cohen, 2007). We argue that social unrests could create imbalances in sustainable use of natural resources and this would also likely create a large problem for ensuring environmental justice in certain socio-political contexts, especially towards vulnerable groups (Pellow, 2017). More importantly, in societies where socio-political/armed conflict is occurring competition for natural resources could be greater than the competition in stable societies, and thus this could bring about extreme inequality in the sharing of those resources, especially in times of conflict when the need for foraging is manifold (Sulaiman et al., 2022). In this regard, transdisciplinary research can greatly contribute to informing (environmental) policy forums about systemic sustainability; yet policymakers need to embrace its intrinsic complexity and acknowledge its uncomfotability (sensu Rayner, 2012) to finally promote transformation processes.

In this paper dedicated to the memory of Professor David Pimentel, we analyse the trajectories of plant traditional foraging in a few case studies aiming to assess these phenomena from the point of view of systemic sustainability, which involves both an environmental and a social dimension. Much of Pimentel's research focused on sustainable agriculture and related food systems to "feed the world" in the coming decades that will see increasing population pressure on local resources (Pimentel & Hall, 1989; Pimentel & Pimentel, 2007; Pimentel et al., 1997a, b). Foraging could theoretically be a possible strategy to improve food security, especially in politically and geographically remote contexts (e.g. Paoletti et al., 2011; Pimentel et al., 1997a).

In this paper, we will therefore compare some qualitative data on the sustainability of traditional foraging arising from rural field case studies the authors conducted over the past decade in diverse environments predominantly shaped by different human ecological drivers (horticulturalism, pastoralism, and forestry) in three Eurasian regions: the Mediterranean (coastal Syria), Eastern Europe (Estonia and SW Ukraine), and the Hindukush (North Pakistan). We will try in particular to analyse the possible factors affecting drawbacks and beneficial aspects of traditional foraging in relation to both environmental and social sustainability.

2 Study areas and methodology

In the current study, we mainly rely on unpublished qualitative data arising from several previous ethnobotanical case studies devoted to recording plant-related foraging practices that were conducted in coastal Syria (Sulaiman et al., 2022), Eastern Europe (Kalle, 2017; Kalle & Sõukand, 2016; Pieroni & Sõukand, 2017, 2018; Mattalia et al., 2020, 2021; Sõukand, 2016; Sõukand & Kalle, 2016; Sõukand & Pieroni, 2016; Stryamets et al., 2021; Sõukand et al., 2022), and North Pakistan (Aziz et al., 2020a, b, 2021a, b), representing three different human ecological environments as described in Table 1.

To a small extent, the data we present here were also drawn from unpublished qualitative observations accumulated in recent years in the considered areas.

The data were mainly collected via participant observation and semi-structured conversations with local (mainly elderly) community members (Fig. 1), who are still engaged in foraging. In particular, we analysed the issue of the gathered areas and access to them, the eventual occurrence of trade of certain foraged plants, and the environmental and social aspects of the foraging practices, including the their most crucial outcomes (culinary process and consumption arenas). We also thoroughly analysed the case studies via field narratives that were recorded among the selected study participants. During the interviews, the ISE Code of Ethics (ISE, 2008) was followed. Botanical identification followed national floras and was described in the aforementioned papers, from which the botanical data were extracted. We have tabulated the most culturally salient or commonly gathered plant taxa in each study area along with their social and ecological attributes.

Table 1 The case studies conducted on plant foraging in three distinct human ecological frames

Dominant activity	Study areas
Horticulturalism	Coastal Syria
Forestry	Estonia and SW Ukraine
Pastoralism	North Pakistan

Fig. 1 First author during interview with an elderly study participant showing foraged *Ferula hindukushensis*, Mastuj village, Chitral, Pakistan (Photo: Muhammad Abdul Aziz)



3 Results and discussion

3.1 Foraging patterns in diverse human ecological environments

The data show that the main characteristics of wild food plant (WFPs) foraging differ in each of the selected case study regions.

In coastal Syria, most of the gathered plant species are weeds growing in anthropogenic environments and foraging occurs mainly on communal lands; moreover, most of the plants are widely available and their social meaning is complex (Table 2).

Conversely, in Estonia and SW Ukraine, the WFPs we recorded in forest environments revealed that there are some species on the list that are particularly sensitive to human pressure. This shows that these species privilege large uncontaminated areas (i.e. forests and marshes) with sparse human settlements; moreover, there are also more wild trees and shrubs in the area that are important to people (Table 2).

In Pakistani Hindukush, we found that the researched pastoralist communities have easy access to various habitats to forage WFPs, although mountain pastures represent often the main gathered spots.

Tables 2, 3, and 4 present the environmental and social characteristics of the most commonly gathered WFPs in the three analysed study areas.

3.2 Gathering areas and access to them

In Estonia, as in Ukraine, "everyman's right" is regulated by law. This means that everyone has the right, on both state and private land (unless the land is fenced or marked with prohibition signs), to gather wild berries, mushrooms, flowers, medicinal plants, nuts, and other natural products under nature protection for personal use.

In Syria, communal land, or so-called the state land, can be accessed by everyone; however, orchards and private lands can be accessed only by their owners, while others can gain access upon agreement of the landowner.

In the case of Pakistan, people mostly collect WFPs from summer pastures (communally managed) located at higher elevations; to go there and collect plants is therefore very labour-intensive and mainly practiced by men. Most of the time, local herders go there and collect plants and then sometimes they sell them to local villagers even though they are common goods gathered from a commonly shared property. Land ownership is a complex

Table 2 Environmental and social characteristics of the traditional foraging practices of the most common and/or most culturally salient wild food plants gathered in Mediterranean Syria

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Allium ampeloprasum</i> L.; Amaryllidaceae	Communal land and orchards; no access restrictions	Moderate: gathered in large amounts with respect to its wide availability; yet habitat damaged by overharvesting and pulling up the plant with its bulb	Moderate: the plant is cooked and consumed by each family individually; however, the remaining fresh amount is shared with relatives. Prepared by steaming with other wild plants or fried with eggs	Low
<i>Anchusa strigosa</i> Banks & Sol.; Boraginaceae	Communal land and orchards; no access restrictions	Low: gathered in large amounts with no respect to its limited availability; moreover, its natural population has decreased in recent years due to overharvesting	Moderate: a trip for gathering is organised by several community members; however, it is cooked and consumed by each family individually. Consumed fried, steamed with olive oil and garlic or onion	Fair
<i>Arum maculatum</i> L.; Araceae	Communal land and orchards; no access restrictions	Low: its tuber is widely collected from the wild and planted in home gardens and orchards	High: it is gathered and used by each family individually; additionally, the prepared meal is shared with family relatives; it is prepared as a soup known for its sour astringent taste, consumed mainly by specific cultural-religious groups	High

Table 2 (continued)

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Cichorium intybus</i> L.; Asteraceae	Communal land and orchards; no access restrictions	High: gathered in large amounts with respect to its wide availability	High: it is shared between community members as a typical <i>Mazza</i> "appetiser" with alcoholic drinks. Prepared by boiling, and then olive oil, lemon juice, and garlic are added	High
<i>Eryngium creticum</i> Lam.; Apiaceae	Communal land and orchards; no access restrictions	High: gathered in large amounts with respect to its wide availability	Low: it is gathered and consumed by each family individually; it is mainly consumed as a salad	High
<i>Gundelia tournefortii</i> L.; Asteraceae	Communal land and orchards; no access restrictions	Low: its availability has significantly decreased in recent decades becoming nearly absent due to overharvesting and landscape changes. Its decrease in abundance is also a result of high community demand for the plant	Moderate: a trip to search for the plant is organised by several community members; however, when found, it is cooked and consumed by each family individually. Steamed mainly with chickpeas or/and olive oil	Nearly absent; expensive
<i>Myrtus communis</i> L.; Myrtaceae	Communal lands; no access restrictions	High: gathered in limited amounts with respect to its wide availability	High: its fruits are gathered as snacks while walking in the wild, individually or in groups. Its branches are gathered for new graves as it symbolises "the promised paradise" by many Muslim/Sufi groups	Fair

Table 2 (continued)

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Origanum syriacum</i> L.; Lamiaceae	Communal land; no access restrictions	Moderate: gathered in large amounts with respect to its wide availability, and it is also planted in home gardens	High: it is the main ingredient of <i>Zaatar</i> , which is a very popular dish in the region; it is shared for breakfast between family members, relatives and neighbours. Additionally, the plant is added to the Yerba Mate drink which is a social beverage in the area	Fair
<i>Rhus coriaria</i> L.; Anacardiaceae	Communal land; no access restrictions	Low to moderate: habitat was extensively damaged in the last few decade as most wild trees and shrubs, regardless of the species, were cut down for wood fuel due to the lack of fuel supply during the recent conflict	High: it is gathered and used by each family individually; additionally, it is shared as a gift between some families; the plant is mainly used as a spice, and it is the main ingredient of the popular dish <i>Zaatar</i>	Fair; expensive
<i>Thymus vulgaris</i> L.; Lamiaceae	Communal land; no access restrictions	Low: gathered in large amounts with no respect to its very limited availability and now it is nearly absent; moreover, the plant has been widely removed from the wild and planted in home gardens	Moderate: the plant is mainly used for flavouring a local cheese called " <i>Shanklish</i> ", which is commonly shared between community members and given as a gift	Low; expensive

Table 3 Environmental and social characteristics of the traditional foraging practices of the most common and/or most culturally salient wild food plants gathered in Estonia and SW Ukrainian forests

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Armoracia rusticana</i> P.Gaertn., B.Mey. & Scherb.; Brassicaceae	Estonia: grows predominantly on private land and it is found naturalised in settlements and cities; Ukraine: also native	Moderate: Estonia: tolerated; Ukraine: disappearing due to perceived consequences of climate change and pests	High: used as an additive to lacto-fermentation, in salads, for seasoning meat dishes, and ritual use	Widespread in the lacto-fermentation season
<i>Betula</i> spp.; Betulaceae	Communal land: found in diverse habitats (forests, meadows, farmsteads); no formal access restrictions	Moderate: currently gathered in limited amounts with respect to its wide availability, yet the collection of sap damages trees if not correctly done	Very high: fresh and fermented sap shared within communities, whisks dried for winter and used in the sauna on a weekly basis – in Estonia only	Some whisks (for the sauna, sold in Estonia—for therapeutic purposes) and rarely sap
<i>Carum carvi</i> L.; Apiaceae	Mostly private land: grows in disturbed human-influenced landscapes only	Low: disappearing due to changed economic activities	Moderate: used as a seasoning, tea, medicine	Only industrial crop sold
<i>Corylus avellana</i> L.; Betulaceae	Communal land: (young) forests; no formal access restrictions	High: currently gathered in limited amounts with respect to its wide availability	Low: in Estonia it was historically very high (gathered by the whole village together on specific days, used in social Christmas games)	Nearly absent (cultivated one, <i>C. maxima</i> Mill., mainly sold)
<i>Fragaria vesca</i> L.; Rosaceae	Communal land: specific forests and meadows; no access restrictions	Moderate: becoming less common due to changes in forest management	Moderate: widespread snack, the jam is also culturally important. The whole plant is prepared as a tea	Fair (very expensive)
<i>Rubus idaeus</i> L.; Rosaceae	Communal land: forest clearings, ditch banks; no access restrictions	High: currently gathered in limited amounts with respect to its wide availability, yet this is affected by changes in forest management	Moderate: important as food and medicine. Wild berries are preferred to cultivated ones	Nearly absent (cultivated one mainly sold)

Table 3 (continued)

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Rumex acetosa</i> L.; Polygonaceae	Communal land: meadows; no access restrictions	High: currently gathered in limited amounts with respect to its wide availability	High: in SW Ukraine its use in soup is widespread; winter preserves are shared within the community; in Estonia mainly used as a snack	Nearly absent (cultivated ones, <i>R. acetosa</i> var. <i>hortensis</i> or <i>R. rugosus</i> Campd., mainly sold)
<i>Urtica dioica</i> L.; Urticaceae	Communal land: human-influenced habitats; no access restrictions	Moderate: in Estonia suitable soils have partially shrunk due to the absence of animal husbandry in households	Moderate: soup cooked at least once a year as a spring delicacy. The plant is also an important medicinal plant for humans and fodder for animals	(nearly) Absent
<i>Vaccinium myrtillus</i> L.; Ericaceae	Communal land: specific forests; no access restrictions	Moderate: gathered in limited amounts with the respect to its wide availability, yet communities damaged by berry-picking devices	High: one of the most popular berries, sometimes shared fresh and cooked among community members; provides income for the most vulnerable part of the community. The whole plant is boiled to make a (medicinal) tea	Fair
<i>Vaccinium oxycoccos</i> L.; Ericaceae	Communal land: bogs; no formal access restrictions, yet difficult to access in the majority of cases	High: gathered in limited amounts with respect to its wide availability. Historically very low (gathered for income in large amounts, the collection was regulated, Estonia only)	Moderate: shared fresh among community members for food and medicinal purposes	Fair
<i>Thymus</i> spp.; Lamiaceae	Communal land: specific forests; no formal access restrictions	Moderate: in Estonia is partially shrinking due to changes in forest management	High: used as a seasoning, tea, medicine, and considered a keystone species for some Estonian minority groups	Low (only industrial crop is sold)

Table 4 Environmental and social characteristics of the traditional foraging practices of the most common and/or most culturally salient wild food plants gathered in Hindu-kush, Pakistan

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Allium carolinianum</i> DC.; Amaryllidaceae	Collected from high mountains and pastures	High: gathered in large amounts; previously it was collected for food purposes but nowadays it is largely collected for medicinal purposes	High: leaves are used as a salad, acts as a flavouring agent in many dishes; aerial parts are cooked as a vegetable by different communities	Rarely marketed
Other wild <i>Allium</i> spp.; Amaryllidaceae	Mountain pastures	Moderate: the gathering of the species is reported less compared to the past; however, in the traditional cooking system they were used instead of onion and bought from markets; in the past, the species were mostly used for food purposes but now they are used for medicinal purposes	Moderate: aerial parts, sometimes whole plants, are gathered and cooked as vegetables, some traditional communities collected their leaves and prepared local spices in their houses, but nowadays they are no longer used on a daily basis	Fair
<i>Capparis spinosa</i> L.; Capparaaceae	Foothills and found near houses in villages; no access restrictions	High: gathered in large amounts with respect to its wide availability to obtain an extract from its flowers to treat various ailments	High: the fruits are cooked as a vegetable; the flower is used in a seasoning amongst elderly community members. The entire plant is highly useful for treating various health problems	High
<i>Carum carvi</i> L.; Apiaceae	High mountains and pastures	High: gathered in large amounts with respect to its wide availability to treat various types of gastric problems	High: the consumption of both fruits and seeds as a tea and a seasoning are widespread	Fair

Table 4 (continued)

Plant taxon and botanical family	Gathering spots and access	Estimated environmental sustainability (gathered amounts with respect to ecological availability)	Estimated social meaning (including gastronomic uses and arenas)	Occurrence in local markets (and pricing)
<i>Chenopodium album</i> L.; Amaranthaceae	Commonly found in fields and gardens	Moderate: gathered in large amounts as food and medicine. A decrease is reported in its availability currently due to advancing anthropogenic activities like unsustainable agricultural practices and environmental degradation	High: almost all aerial parts, especially leaves, are cooked and consumed as vegetables by all family members of different communities	Nearly absent
<i>Eremurus</i> spp.; Xanthorrhoeaceae	Collected from high mountains and pastures	High: gathered in large amounts with respect to its wide availability for food purposes and medicine	High: all aerial parts, mostly leaves, are cooked as a vegetable by different communities across the region	Nearly absent
<i>Ferula</i> spp.; Apiaceae	High mountains and foothills	High: gathered in large amounts for medicinal and food purposes	Moderate: leaves are used as a salad, stems and latex are used as a seasoning and in pickling	Absent
<i>Portulaca quadrifida</i> L.; Portulacaceae	Commonly found in fields and home gardens	Moderate: gathered in large amounts with respect to its limited availability as compared to the past for food and economic purposes	High: both gathering and cooking, sometimes freshly used as a salad by most of the communities	High
<i>Thymus linearis</i> Benth.; Lamiaceae	Foothills	Moderate: gathered in large amounts with respect to its wide availability for different herbal sauces or chutneys, teas, seasoning, and for medicinal uses	Moderate: aerial parts are used as salads, in teas and for seasoning. The aerial parts are also used as a spice in meat and rice	Absent

issue in these areas, but foraging can be done everywhere except in fields where crops are grown and that are owned by someone. Thus far, the state has not imposed restrictions on the foraging of WFPs in the region.

Access to the most commonly used wild plant resources in all our case studies normally occurs on communal lands and this easy access only represents an obstacle for those who do not have the necessary knowledge and skills to forage or for those who have physical impediments prohibiting foraging—this is especially true in the Mediterranean where sharing wild vegetables within the rural villages is sometimes still customary and culturally important (Pieroni, 2003). However, the assignment of a particular economic value to the foraged items is highly dependent not so much upon access, but much more upon the time needed for the procurement strategy: normally plants, whose gathering requires a lot of investment in terms of time and physical labour, are more prone to be perceived as more economically valuable and therefore suitable for being marketed and meeting consumer demands (see last columns on the marketed WFPs in the tables).

3.3 The role of market pressure

Sustainability science holistically considers all the driving forces affecting social, economic, and environmental sustainability and never works in a fragmented way; therefore, it will take time to approach global sustainability (Shrivastava et al., 2020). In regard to plant foraging, we previously discussed (Pieroni et al., 2014) that in North-Eastern mountainous Albania the external pressure on certain wild plants determined by the herbal market (remarkably promoted during the Communist period) represented an important driver for shaping a distorted perception of the availability of the local resources, exacerbated by the “Albanian dilemma” of how both ancient customary (*Kanun*) and state laws should be interpreted for regulating access to common goods (communal land). The data presented in the aforementioned tables clearly show that some WFPs collected in forests and high pastures for the market are sensitive to over-foraging. In eastern European forests, foraging is mainly an activity involving families (Söukand & Kalle, 2016), while in the Pakistani context, it is principally a side activity of male pastoralism (Aziz et al., 2020a). Mediterranean foraging involves widely available weedy plants, normally gathered by women, and the pressure on plant communities seems to be very restricted—possible because the perceived economic value of WFPs is coded in gender relations as well (Pieroni, 2003).

During field observations we conducted in the Hindukush, our research group recorded some striking reflections on foraging patterns which are clearly not sustainable. In one case study, from Yasin Valley of Gilgit Baltistan, we found that people used to collect WFPs, especially *Capparis spinosus* (Aziz et al., 2020a), and sell them at high prices to the local market which later supplied other cities, thus creating huge competition among foragers in the area. It has been established that when individuals compete for access to resources using aggression (Durham, 1976), resources can be lost, or the net gain can be reduced by the physiological costs of the contest. Experimental results have demonstrated that unregulated use of a common-pool resource, such as common pastures, generates inefficient levels of use; however, there is a fundamental paradox, which we will call the spite paradox, that is in need of replication and explanation (Casari & Plott, 2003). We have observed in some areas in the remote valleys of Northern Pakistan that people, especially children, eagerly looked for the flowers of the plant to harvest, which is a very unsustainable practice and creates negative impacts on the reproduction of the plant in its natural habitat (e.g. also

see Aziz et al., 2020a). Such an unsustainable ecological practice not only damages the population density of the species but also has a significant impact on species richness, as in some cases other associated plants can also be affected (Schunko et al., 2021). Therefore, we can also perceive the growing issue of biotic homogenisation (Olden et al., 2004), while intraspecific variation and individual diet specialisation (IDS) have also emerged as key drivers of ecological functions (Lunghi et al., 2020). The niche variation hypothesis predicts that when a population is released from interspecific competition (i.e. “ecological release”), intraspecific competition will promote resource niche expansion and IDS. It then follows that if biotic homogenisation reduces taxonomic diversity and *interspecific* competition, *intraspecific* competition within the remaining taxa should expand population resource niches and increase the prevalence of IDS (Manlick & Newsome, 2021). Similarly, there were other WFPs that were foraged in the remote mountains of North Pakistan and brought home, without taking into account the negative impacts of extensive collection; for instance, *Eremurus* spp. and certain species of *Allium* were frequently collected by herders (see Aziz et al., 2021b). Local interviewees from North Pakistan confirmed that in the past most of the WFPs could be found also in the vicinity of villages but now they only grow in places far from villages and people that graze animals in pastures and high mountains are likely to forage them. It is also interesting to note that the pastures are generally communal property which could provoke serious concerns over the exploitation of the rights of local communities in the Hindukush mountains. Field observations have confirmed that in the Kalash Valley of the Hindukush the minority group of Kalasha has been pushed back by their Chitrali neighbours and several parts of the valley have been sold to their neighbours. The Kalasha have been facing some problems since they cannot forage freely on communal lands due to security issues, as a few years ago they were targeted by Islamist militant groups in the remotest part of the surrounding mountain pastures, which are considered the best places to forage plant resources. It is crucial to link the issues of minority groups to the fact that meta-power has often reduced their local ecological practices, as clearly explained by Baumgartner et al. (1975).

Among our case studies in coastal Syria, we investigated the abundance of WFPs over the last decade. Local informants reported a significant decrease in the availability of some wild plant species during the recent conflict compared to pre-conflict times (Sulaiman et al., 2022). This can be attributed to several factors, including the overharvesting of species with no respect to its limited availability, landscape changes due to human displacement from non-secure regions to the very few safe areas, and the absence of governmental control over the widespread use of some non-selective pesticides. Herbaceous species such as *Gundelia tournefortii*, *Anchusa strigosa*, *Arum maculatum*, and *Thymus vulgaris*, in all likelihood, have been affected in their natural habitat by the uncontrolled use of herbicides. This is especially the case for some species such as *Gundelia tournefortii* which at the flowering and fruiting stage are considered by some locals as weeds that need to be pulled out of the ground or treated with chemicals. Wild food plants have shifted from a complementary food before the conflict to a main source of food in recent years, resulting in increased demand and subsequent pressure on the species and their habitats. Informants reported that several wild food species (e.g. thyme, *Thymus vulgaris*) have been largely overharvested in an unsustainable way, including the uprooting of whole plants from the wild and planting in home gardens, and, as a consequence, such species have become nearly absent. On the other hand, several other species were collected in order to be sold in local markets. The natural populations of these species, including *Gundelia tournefortii*, have significantly decreased in recent years due to high demand and market value. *Rhus coriaria*, also known as “the sour of the Phoenicians” referring to its ancient cultural value

for the local people of coastal Syria, has been affected by the current conflict in the country. Local inhabitants have been forced to cut down these trees for wood fuel, and this, along with its market value as a main ingredient of the traditional food *Zaatar* (Fig. 2) has resulted in high pressure on its habitat. Of the species listed from Syria, *Myrtus communis*, *Thymus vulgaris*, *Cichorium intybus*, and *Rhus coriaria* were classified by the IUCN with the conservation status “least concern” (IUCN Red List, 2022), which is not indicative of some degree of threat. However, the reported assessment by local people could generate greater concern regarding its abundance in the region, especially with the reported availability of *Thymus vulgaris* and *Rhus coriaria*. The social meaning of some species such as *Arum maculatum* is complex: besides its use as a winter soup and as a medicinal plant for digestive disorders, it serves as a hidden part of the cultural identity of the Alawites and Ismaili cultural-religious groups, as they used to eat this soup while they were persecuted and isolated in the mountains during the Ottoman Empire.

Forest plants are often keystone species for forest-dependent communities. Across our case studies in Estonia and the Ukrainian Carpathians, we identified some of the most important species for assessing their social and ecological sustainability. While we acknowledge a shift from wild to cultivated forest plants (especially for raspberries and strawberries which are now commonly grown in gardens), we also recorded a clear preference for the taste of wild fruits, as well as a recognition of the importance of the practice of foraging (e.g. direct contact with the forest).

In Eastern Europe, the blueberry is probably the most important forest berry across different areas, as it is a major source of livelihood for forest-dependent communities living in the Ukrainian Carpathians (see also Mattalia et al., 2020). On the one hand, blueberry (*Vaccinium myrtillus*) holds a high social meaning being a keystone species and serving as food, medicine, and a shared recreational activity (Fig. 3). On the other hand, this berry represents a crucial economic resource for local communities, which sometimes undermines its ecological sustainability due to overharvesting and forest mismanagement. The

Fig. 2 *Zaatar* (*Origanum syriacum*): one of the culturally salient plants in coastal Syria (Photo: Naji Sulaiman)



Fig. 3 Blueberry (*Vaccinium myrtillus*) drink, SW Ukraine (Photo: Nataliya Stryamets)



fresh berries of *Vaccinium myrtillus* last only a few days after picking. Thus, smaller quantities are gathered for personal use and immediately stored in cans or frozen. In the food industry, blueberries are used to make food colouring. Thus, it does not matter whether the blueberry is spoiled or not, the dye is still obtained. Picking berries with special mechanical aids damages both the berries (those picked in this way spoil quickly) and berry bushes (shrubs do not produce berries for many years), but at the same time, one can quickly collect a large number of berries. In Estonia, these berries are sold to a middleman who usually takes them to the large food industry in Finland. There they are be made into natural food colouring. Large-scale berry-picking with mechanical tools for commercial purposes is not sustainable and should be discouraged, while the hand-picking of berries, being sustainable, should be encouraged.

Wild raspberry is another important forest species in Eastern Europe, yet its value is partially substituted by cultivated ones which are bigger, easier to harvest, and less susceptible to transportation damage. As with blueberries, (wild) raspberries are widely recognised as an important local food and medicinal resource, yet its ecological sustainability is being challenged by the current changes in forest management—raspberry (*Rubus idaeus*) is one of the first species that appears after forest disturbance) and by the perceived consequences of climate change (Ukrainian interviews reported prolonged rains affecting the productivity of raspberries). Similarly, wild strawberries are socially important, yet their ecological sustainability is being challenged by management and climatic changes. From the beginning of the twentieth century until World War II, the harvesting of *Rubus idaeus* and *Fragaria vesca* berries was banned in young forests on Estonian state lands (Kalle & Sõukand, 2012). The reason for the ban was that the foresters feared that berry pickers would trample young trees; violators of the ban were fined. This ban indicates that there were fears that people could pick berries unsustainably. However, there was no known scientific study behind this ban and thus there is no basis for this preconception.

Stinging nettle is a very common species that grows at the edge of Eastern European forests, especially areas that are grazed. While it is not used much for most of the year, it is considered a “must eat” in springtime when it is considered to be full of properties able to “clean the blood”. Although the abandonment of animal husbandry has partially reduced the abundance of *Urtica dioica*, it is still foraged in a sustainable way from both ecological and social points of view.

In the 19th and beginning of the twentieth centuries, there were restrictions on picking *Corylus avellana* nuts in Estonia and there were national statute dates for harvesting them (Kalle & Sõukand, 2012). The reason for the ban was that the nuts that were picked too early went bad (mouldy) but were still sold at a high price. In the

middle of the twentieth century, the commercial harvesting of nuts in the forest declined so much that restrictions were lifted. There are practically no wild nuts in the market today. Now the market is filled with cultivated, mainly non-native nut species (e.g. *C. maxima*).

In the 1970s, the price of *Oxycoccus palustris* berries in Estonia became very high because the USSR began to export them. Thus, the mass harvesting of those berries that damaged the bog surface began in Estonia (people trampled the bogs too intensively). Unripe berries (white) were also picked. To prevent this, harvesting periods were imposed, which allowed the berries to be picked in the wild at the correct time. The time-restriction on collecting cranberries lasted until the 1980s. There is no mass harvesting of cranberries today.

The collection of caraway (*Carum carvi*) fruits (most commonly and erroneously called seeds) has historically been a source of income for rural people in Estonia; caraway fruits were sold in urban markets or country manors. For *Carum carvi* plants to grow, their habitat needs human care. Thus, the natural survival of a plant depends on human activity. However, due to the import of cheap cumin seeds at the end of the twentieth century and changes in land use, the collection of seeds from wild *Carum carvi* has practically disappeared today. Thus, when the commercial need disappeared, the interest in caring for this plant also decreased drastically and today this plant has nearly disappeared from the immediate vicinity of humans.

Finally, we analyse here the socio-ecological sustainability of beech trees (*Betula* spp.), an extremely important tree in the Eastern European milieu (Svanberg et al., 2012). The collection of *Betula* sap and whisks (in Estonia for the sauna and in SW Ukraine for ritual purposes) needs to be done carefully to prevent plant damage which can compromise future collection. Socially, birch can be considered a keystone species, being crucial for essential aspects of forest-dependent communities. During the Soviet era, forest industries in Estonia were obligated to collect *Betula* sap. It was sold to the food industry, where it was bottled. Due to the transition to a market economy in the 1990s, the purchase of industrial birch sap also disappeared. Today, the production of birch sap has become profitable again, and both forest companies and the food industry have started bottling sap. Currently, due to the high cost of pure birch sap, many mixed drinks have entered the market using birch sap as one of the ingredients.

During the time of the Soviet Union (until three decades ago), people in Estonia had a duty to pick medicinal and tea plants and wild berries. The norms of procurement were controlled by specific procurement offices. Schoolchildren were also obligated to pick medicinal plants, wild berries, and, in some areas, wild mushrooms. Although lists of the procured plants were provided, the so-called norms (by weight) were predominantly met by gathering the heavier plant (parts) (e.g. *Rubus idaeus* stems). Such forced picking of certain plants created a situation in which some of the species were not consumed by people at home, but rather were picked only for sale or as a state norm. The whole issue of the role played by the market in shaping cross-spatial and cross-temporal dynamics of foraging would need however to be addressed more in-depth with ad-hoc surveys. Our field observations of the last two decades suggest in fact that small-scale and farmers' markets, for example, not only represent crucial arenas for the livelihood of local communities and sometimes - especially in the Mediterranean and in Eastern Europe - of women (Sõukand et al., 2020), but can also act as virtuous drivers for training old foraging practices and developing new ones, thus allowing WFPs gathering to evolve and to even become more resilient.

3.4 The fading appeal of traditional foraging among rural younger generations

Traditional foraging among the considered groups has revealed interesting insights into how each culture has conceptualised the local environment and how they instrumentalised the value of nature. The study presented an overview of the diverse patterns of WFP-centred foraging, historically shaped by certain human-ecological relationships among the different cultural groups living in the studied regions. Our previous findings have shown that the local communities that have remained in close contact with nature have maintained considerable peculiarities regarding plant foraging (e.g. Mattalia et al., 2021), although in Estonia foraging practices are fading away within the lifetime of one generation due to changes in land management and social changes (Kalle & Sõukand, 2016; Kalle et al., 2020; Sõukand et al., 2022). However, there still exists a remarkable store of traditional/local environmental knowledge (TEK) on foraging, as recorded in each of the case studies.

Despite this important cultural heritage documented in these case studies, it is worth mentioning that the longstanding ecological practices linked to foraging are now being influenced by a wide variety of socio-cultural and political factors (e.g. Aziz et al., 2020b). These either have a direct impact on foraging practices (restricting access, prohibiting sale, promoting collection through procurement) or indirectly affect the social life of local communities, which in turn has influenced the foraging behaviours of different individuals or groups of individuals and consequently many cultures have to re-orientate human ecological relationships in the changing socio-political landscape. For instance, in the studies conducted in Southern Italy among ethnic Albanians during the past two decades, we found that the collection of non-domesticated vegetables (locally called *liakra*) gathering during the spring season was a common practice until the recent past, but nowadays foraging is no longer practiced among younger generations and TEK is only retained by elderly women (Pieroni, 2003; Pieroni et al., 2002). During the field survey, we observed that the ethnic minority settled in the area have inevitably been indirectly forced to Italianise, which has seriously threatened both language and human ecology. Similarly, the results of a study conducted by our research group in Vulcano Isle, Sicily (Cucinotta & Pieroni, 2018) found that traditional plant foraging practices are vanishing; local narratives confirmed that in the past foraging was a crucial part of food procurement strategies, whereas now it is recognised solely as a recreational activity for some people, who often link wild plant ingredients to a healthier diet. On the island, the increase in touristic activities since many decades has created opportunities for entrepreneurs to open supermarkets, and people have started working for external enterprises, preferring to serve holiday resorts, and thus the link between foraging practices and daily agro-pastoral activities have almost disappeared and wild vegetables seem to be no longer known and maybe even appreciated by the younger generations. Similar perceptions were recorded in coastal Syria (Sulaiman et al., 2022) in recent decades where interest in wild plant-based food has decreased; however, the opposite situation has been associated with the conflict in the country that started in 2011. The conflict has left millions of people in poverty, and as a result wild plants have evolved from being complementary to essential food in many households.

In North Pakistan, traditional foraging has been significantly affected by remarkable social changes (Aziz et al., 2020a). It is important to mention that foraging is a socio-ecological process; therefore, the social attributes linked directly or indirectly to foraging have been crucial in the temporal dynamics affecting foraging. For instance,

the folk nomenclatural knowledge of the foraged plants has been lost by few minority groups, which reveal the impact that acculturation to the mainstream of the majority populations may have on the foraging behaviours (Aziz et al., 2021a; Pieroni et al., 2002). It is also important to note that local communities have shaped across centuries various social beliefs, which are attached to the foraging of certain plants. In Pakistani Hindukush, local people perceived for example the wild plant *Saussurea lappa* as taboo, or morally unacceptable, and thus they are not allowed to forage for it; this indicates that foraging patterns are not only linked to the local food system, but certain plants are also associated with cultural and religious beliefs (Aziz et al., 2020a). Moreover, during previous research investigations, we could find in diverse Middle Eastern and Caucasian contexts that a strong impact of a dominant language or even religious affiliation affects not only the language/religion of minorities as practiced by the youngest generations, but also their folk plant nomenclature and taxonomy, thus in turn affecting the ability to recognise and use certain plants, and ultimately both the local ecology and attached cultural practices (see for example Pieroni et al., 2018, 2020, 2021). On the other hand, beyond our considered case studies, which all concern rural traditional foraging practices, new foraging trends are clearly emerging in urban environments, sometimes enhanced during the COVID-19 pandemic and the literature on these phenomena has exponentially increased in the past two years (Łuczaj et al., 2012, 2021; Hare & Peña del Valle Isla, 2021; Sardeshpande et al., 2021; Shortly & Kepe, 2021; Somesh et al., 2021); it could be therefore worth to carefully compare in the future these practices with more “traditional” rural foraging practices or their hybridised forms, also for what concerning the holistic sustainability. A few preliminary exploratory studies that our groups conducted in various European locations suggest that the “new foragers” act in a much more utilitarian manner and have a much less contextual knowledge of the environment than their “rural grandparents”, possibly since a continuous, daily exposure to nature is often missing.

3.5 Challenges for environmental and food education and policies

Several measures have been adopted to counter the impacts of human-made disturbances on ecosystems both on the national and international level. There are also increasing efforts to ensure integrity among the social, cultural, and biological components of the living planet (Maffi, 2001). Even though a large number of resources have been utilised in different parts of the globe to achieve sustainable goals, there is still a long way to go. Sustainability is often a buzzword that is mentioned because of the anthropogenic pressures that are overwhelming the planet and ultimately affecting each pillar of life every single day. Looking at the preamble of the 2030 Agenda for Sustainable Development (UNESCO, 2015), we can observe highly appreciable phrases, i.e. “This Agenda is a plan of action for people, planet and prosperity. It seeks to strengthen universal peace in larger freedom”, but there are certain crucial gaps that need to be filled in this regard. Looking through the lens of foraging practices, our field research has shown that certain minority groups are striving to extract benefits from local natural resources (e.g. the Pakistani case we discussed in the previous section). Similarly, in the Vulture area in Southern Italy, the Italianisation of former Albanian minorities may have affected the loss of language as well as part of their cultural heritage and some traditional foraging practices too (Pieroni, 2003). In other Mediterranean case studies—i.e. Vulcano Isle, Southern Italy (Cucinotta & Pieroni, 2018)—the increase in inconsiderate tourist activities has displaced local agro-pastoral activities

and many fields have been replaced by concrete, which possibly came at the expense of foraging as locals also believe that the a few WFPs that were readily available have now disappeared. Having looked through these examples, policies should be devised and implemented. We have also found that inappropriate policies of local authorities sometimes undermine the rights of local inhabitants to access local natural resources.

It is also worth mentioning that, on the one hand, unsustainable ecological practices are threatening ecosystem stability, while on the other hand, in certain contexts, states are designing unjust policies regarding the protection of nature and putting pressure on local communities without offering them an alternate solution. As an example, in a recent field study in the Wakhan area of Pakistan, we found that the growth of legal restrictions is also creating several challenges for these agro-pastoralist societies; for instance, Broghil has been given the status of a national park and local inhabitants are facing problems in grazing their animals. Similar problems confront traditional pastoralists in the Carpathian Mountains. Therefore, political changes, such as collectivisation and central planning, are having an impact on long-established patterns of local landscape management (see also Mattalia et al., 2021). Authorities should respect the rights of local people and there should be an equitable sharing of benefits from natural resources as the local inhabitants are not content with these legal restrictions. During some field surveys, some local community members refused to share their folk knowledge as they considered us staff members or somehow affiliated with a national park nearby or otherwise related to nature conservation.

We strongly believe in the need to include local communities, especially minority voices, in planning and formulating conservation strategies in any regard. We also recommend exploring the influence of power on environmental justice; for instance, in our case to identify foraging patterns and access to natural resources by minorities in their respective areas when they are struggling to sustain their economic and social life within multicultural societies. We hope that putting forward these recommendations for policymakers can act as a road map to devise strategies and challenge the consolidated power that denies minorities their rights of inclusion, self-determination, and access to natural resources. It is also not encouraging to know that in some cases non-locals forage and in other cases people working for enterprises collect wild food and medicinal plants without respecting private property or local people's property, thus exploiting their common rights to natural resources. In this regard, policymakers should plan certain measures to prevent the destructive practices of both internal and external foragers, and a local community-based committee should be established to provide them the opportunity to impose decentralised sanctions on destructive foraging; for instance, if we look at the Italian case where foraging is free to locals, this could lead to unsustainable consequences (Sardeshpande & Shackleton, 2020). Moreover, it is worth mentioning that there is a large space to develop gastronomic-based tourism initiatives and local gastronomic practices should be promoted to achieve economic stability among the isolated, marginalised, and minority groups in their respective communities (*sensu* Derek, 2021), and this could even have a positive impact on the protection of natural ecosystems in a more informed way (see e.g. Corvo & Fontefrancesco, 2019). Lastly we can observe different kinds of practices, some of which are a threat to ecology while others are very dangerous. On the one hand, biodiversity is under threat, while on the other hand, cultural diversity needs support as well, as Maffi (2001) emphasised two decades ago in her pioneering volume that focuses on the links between linguistic/cultural diversity and biological diversity. In both cases, policymakers are the main pillars that must be involved, and merely presenting folk wild plant uses is maybe not anymore sufficient for scholars to compel or help society in implementing sustainable practices. We need to divert the attention of policymakers

towards the holistic issue of economic, environmental, and social sustainability of various groups in a broader context in order to understand them. Recent efforts to incorporate restorative and recognition justice, alongside procedural equity, have provided important models for progress as well. For instance, granting legal and protective rights to river sheds and other ecosystems provides one promising way forward, as do the efforts to incorporate TEK in our attempts to mitigate and develop more sustainable socio-economic systems (see Fernández-Llamazares et al., 2021). In particular, we would advise putting forward policy measures to build participatory educational platforms aimed at co-creating foraging knowledge and at preventing extensive and destructive foraging, especially among younger generations. It could be crucial also to focus on and discuss the value chain of foraged food ingredients (Epanda et al., 2020), in the case that it is commercialised, in order to obtain a reasonable share for each member of the community.

It is worth mentioning that the current contribution is aimed at supporting policymakers, as the possible environmental threats caused by unsustainable foraging practiced for commercial purposes are somewhat intuitive and have a long, tragic history in human society (see the example of the extinction of the possible seasoning plant *Silphion* in ancient Greece, Miski, 2021), unquestionably restricting human rights and going against the 2030 Agenda for Sustainability (UNESCO, 2015). In particular, developing countries need to revise their relative policies and have greater opportunity to implement measures regarding socio-environmental protection. It has frequently been seen that policy frameworks are generally not very effective in rural areas, which may result in threatening the integrity of socio-ecological systems. It is unfortunate that besides unsustainable local foraging practices, the invasion of non-local foragers is also a phenomenon that should be critically considered in framing sanctions of harmful foraging practices. In this critical situation, solid narratives are needed to define sustainable foraging practices (Pontius, 2020), which might be possible after having undertaken an in-depth analysis of the foraging practices among groups under different socio-political contexts, and to discuss the nature of challenges that are constantly threatening and affecting sustainable foraging. However, environmental education alone in the context of foraging would not match the ambitious Agenda 2030 objectives, without (re)considering the link between environment and foodways and therefore promoting not only local food educational platforms in the schools (Weitkamp et al., 2013), but integrative approaches linking both the ecological and food dimension.

3.6 The importance of revitalising sustainable foraging practices

Researchers in ethnobiology have often stressed the importance of implementing frameworks for revitalising plant foraging knowledge and its transmission through possible comprehensive educational tools (Zarger, 2011; Baptista & Araujo, 2019; Carvalho et al. 2021). For establishing socio-ecological sustainability, the revitalisation of folk nature and food knowledge and practices is crucial because, on the one hand, the waves of social change that rural communities face are maybe unstoppable, and, on the other hand, the cultural homogenisation of food systems (often driven by urbanisation and the spread of industrial agriculture and food) is enhancing the disappearance of local food practises. To proceed with concrete tools, TEK recorded in different field studies could provide a better understanding and set a baseline for future planning in this regard. It should be noted that the involvement of ethnobiologists should be highly encouraged because they are the main academic actors that articulate the interactions of people with their nature

and they should often have the needed skills to articulate the issue on different policy platforms and engaging the community as well. We also believe that it may be crucial to introduce *place-based* biological teaching (Pontius, 2020), in school curricula and it would be very encouraging to compare the local/folk knowledge with the scientific knowledge in order to get students involved in the process of co-creating/fostering sustainability. We believe that one of the most effective tools that could work in the future is to incorporate traditional foraging knowledge into the modern educational curriculum; this could provide students the opportunity to cultivate their comprehension of both the natural and cultural spheres and to connect them to their socio-ecological environment in an imaginative way. Comprehensive nature-bound field experiences that enhance relatedness with the natural world through “*contact, meaning, emotion, compassion and beauty*” (Lumber et al., 2017) could for example represent an important step along this trajectory. Learning about foraging would therefore need to involve comprehensive, reflective, and multilateral strategies, including the practice and belief dimensions of TEK. Our research groups have proposed some perspectives on how to bring local ecological knowledge into educational platforms (i.e. in local schools, Aziz et al. in press).

4 Conclusion

We highlighted some of the important drawbacks and advantages of foraging practices among the different cultural groups subjected to distinct human ecological environments and socio-political factors. Our findings show the need to formulate crucial policy measures to prevent ecological and social damage and ensure environmental and social justice in particular contexts. However, policy forums need to be not only informed but also pushed to transform complex and uncomfortable knowledge on systemic sustainability into practice. Future (possibly also quantitative) investigations are also needed to complement the social, ethnobotanical, and ecological studies to obtain a clearer pattern of the existing foraging practices and their impacts in the studied areas. We also suggest the replication of some of the studies conducted in various regions decades ago in order to have a look at the current situation and to identify changes and interpret them with current knowledge, evaluating different drivers. A strong focus from both national and international organisations is needed to better ensure the integrity of the whole socio-ecological system and prevent unsustainable activities from emerging in societies and being incorporated by them. Looking at the overall situation, both social and ecological implications could be derived from these scientific facts. We hope that this work could have some useful implications for courageous policy makers to help design projects for socio-ecological sustainability in the considered regions in the near future.

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Declarations

Conflict of interest The authors have no conflict of interest.

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