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Back-and-forth moribund ethnobotany: erosion and fragmentation of Local Ecological Knowledge among Afghan returnees in contemporary Afghanistan and perspectives for an ethnobiology of the refugees

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Abstract

Background Forced migration represents one of the most underexplored contexts in ethnobiological research. Afghan returnees, individuals recently repatriated from Pakistan following decades of exile, constitute a distinct but neglected category within refugee studies, embodying what we term "double displacement." This study investigates how this layered migration has affected Local Ecological Knowledge (LEK) related to wild food plants and herbal teas. Neither category is marginal in Afghan life: gathered greens carry the spring table and the memory of the home village. At the same time, herbal teas are the first line of domestic care for coughs, fevers, and digestive complaints, and the medium of hospitality that structures Pashtun social relations. They are also, being light, dry, and cheap, among the most portable elements of Afghan biocultural heritage - which is precisely why their disappearance is diagnostic.

Methods We conducted fieldwork over four weeks in May 2025 at the Omari Refugee Temporary Shelter Centre in Nangarhar Province, eastern Afghanistan, a high-turnover transit facility through which households pass within days of crossing the border at Torkham. We conducted semi-structured interviews with 142 returnees (61 men, 81 women) using stratified random sampling. We collected data in Pashto and Farsi/Dari in accordance with the ISE Code of Ethics. Frequency of quotation was computed for every taxon. We tested differences in the number of taxa recalled with Mann–Whitney U and Kruskal–Wallis tests and modelled them with Poisson and logistic generalised linear models; we quantified overlap with a previously published cohort of Afghan refugees still resident in Pakistan using the Jaccard index of similarity.

Results Twenty-three plant taxa, belonging to 23 genera and 18 botanical families, were listed. Nineteen (83%) were quoted only as memories of past use, one is still foraged, and three are still obtained by purchase or cultivation. The repertoire is extremely thin. Participants named an average of 0.56 taxa each; 63% named none at all, and only one taxon, *Trachyspermum ammi*, was quoted by more than 10% of the sample. The strongest predictor of retention was not gender but the character of the return itself. Returnees who came back voluntarily recalled almost twice as many taxa as those expelled ($U = 912.0$, $p = 0.008$, rank-biserial $r = 0.31$) and were far more likely to name any plant at all (64% against 33%; adjusted OR = 3.81, 95% CI 1.42–10.21, $p = 0.008$). Differences by gender were negligible and not significant. Comparison with the Pakistan-based cohort reveals a dramatic

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collapse from nine to four active genera, with *Trachyspermum ammi* as the sole common element (Jaccard index J = 0.08).

Conclusions The erosion of LEK observed among Afghan returnees exceeds patterns documented in voluntary migration contexts and reflects the compounding effects of forced mobility, prolonged urbanisation, and cultural stigmatisation of foraging. The concept of *dormant* or *inert knowledge*, culturally present but behaviourally inactive, is proposed as a framework for understanding biocultural fragmentation under forced displacement. The central empirical result is that coercion, not the individual's demographic profile, distinguishes those who have kept something from those who have kept nothing. Within a single population at a single site, the manner of return predicts retention where sex, age, and length of exile do not. Biocultural measures for returnees should therefore target displacement history rather than demographic category and should reach expelled households first.

Clinical trial number Not applicable.

Keywords Ethnobotany · Migrants' ethnobiology · Refugees · Local Ecological Knowledge (LEK) · LEK erosion · Afghanistan · Biocultural heritage · Displacement

Science highlights

Afghan returnees exhibit 83% LEK erosion, one of the highest rates documented in migrant ethnobotany, driven by forced rather than voluntary displacement.

"Double displacement" (exile plus repatriation) produces qualitatively distinct and more severe biocultural fragmentation than single-step migration.

Erosion is governed by the procurement channel rather than by the strength of the local plant knowledge. Every one of the nineteen taxa that survive as memory alone was bought at the bazaar during the exile, and the four still in use are those obtainable without access to land and for next to nothing.

Within a single returnee population, the manner of return predicts retention where demographic characteristics do not: those who came back voluntarily recalled almost twice as many taxa as those expelled, whereas differences by sex, age and length of exile were negligible.

The concept of "dormant" or "inert knowledge" remembered but no longer practised provides a novel theoretical lens for refugee ethnobiology, and one with an expiry date: it lapses when the last generation that practised the knowledge dies.

Policy and Practice Recommendations

Integrate biocultural LEK documentation and seed distribution into UNHCR and FAO emergency response frameworks for refugee returnees, restricting distributed material to taxa native or long naturalised in the receiving region and screening it against the national invasive-species list.

Establish community pharmacopoeia gardens at returnee transit shelters as low-cost health and knowledge revitalisation tools.

Design programmes to restore access to wild plant environments through safe mobility networks and home garden schemes, targeting expelled households first, since displacement history and not demographic category is what separates those who have retained something from those who have retained nothing.

Embed ethnobotanical knowledge transmission in school-based programmes in returnee settlement areas.

Commission longitudinal ethnobiological monitoring of LEK dynamics across forced displacement cycles in conflict-affected regions.

Prioritise the nineteen taxa recorded here as dormant, and the households that still name them, in any documentation or revitalisation effort: they are the only remaining source of the practical detail – season, habitat, processing, dosage – that names alone do not preserve.

Introduction

Forced migration has emerged as a defining humanitarian and ecological challenge of the twenty-first century, affecting over 120 million people globally [1, 2]. While the socio-political and economic consequences of displacement have received considerable scholarly attention, the biocultural dimensions of forced mobility and, in particular, the fate of Local Ecological Knowledge (LEK) embedded in human-plant relationships remain critically understudied [3–5]. This gap is especially pronounced in conflict-induced displacement contexts, where environmental disconnection, trauma, and social fragmentation intersect to produce distinctive patterns of knowledge erosion and transformation.

Within ethnobiology, research on migrant plant knowledge has grown substantially over the past two decades, documenting patterns of adaptation, substitution, and partial retention across diverse voluntary migration contexts in the Americas [6–12], Europe [13–19], and Africa [20]. The seminal framework proposed by Pieroni and Vandebroek [4] established migration as a productive lens for studying ethnobotanical dynamics, revealing how displaced communities rebuild, hybridise, and sometimes lose their relationships with plants. However, this body of literature has focused predominantly on voluntary, economically motivated migrants in stable resettlement contexts, leaving displaced people, particularly refugees, internally displaced persons, and returnees largely invisible in the ethnobiological record [5, 21].

Migration, however, does not only subtract from a group's plant repertoire. The literature on cross-cultural adaptation in urban ethnobotany describes a recurring sequence of substitution, hybridisation and, occasionally, genuine acquisition. Colombian and Andean households in London replace unavailable home-country species with functionally analogous plants sold in Latin American shops, keeping the therapeutic logic while changing the species that carries it [14, 22]. Turkish families in Cologne maintain a core of imported dried herbs for chronic and culturally salient complaints while turning to German pharmacy products for acute ones [16]. Albanian and Moroccan migrants in north-western Italy split their repertoire along a clear line, retaining home-country herbal teas, which travel well and can be bought, and abandoning wild vegetables, which require access to land and time [19]. Vandebroek and Balick [23] have argued on this basis that apparent erosion frequently masks a reorganisation of knowledge around new procurement channels rather than its outright disappearance, and that the two must be distinguished empirically rather than assumed. Two mechanisms recur across these studies: what is lost first depends on the landscape, and what survives longest can be bought, carried, and prepared indoors. We take both directions of change seriously in what follows, and we return in the Discussion to the two taxa in our dataset that appear to have been acquired, rather than lost, during the Pakistani exile.

Afghanistan provides an exceptional and urgent case for examining these dynamics. Four decades of protracted conflict have generated one of the world's largest and most enduring displaced populations, primarily in Pakistan and Iran [24, 25]. Since 2023, Pakistan's intensified deportation policies have triggered mass repatriation, returning hundreds of thousands of Afghans to a country fundamentally altered by conflict, changes in governance, and economic hardship [1]. These returnees constitute a category that has received scant attention in both migration studies and ethnobiology: individuals who have undergone what we term "double displacement," first uprooted from their homeland, then forced repatriation to a context they may no longer recognise as home.

The concept of double displacement builds on forced migration theory [2, 21] and extends it into the biocultural domain. Unlike voluntary migrants who may maintain transnational connections to home environments, or internally displaced persons who retain proximity to familiar ecosystems, doubly displaced returnees face a compounded ecological estrangement. Exile disrupted their LEK, and decades of urban refugee life in Pakistan shaped it; return does not restore the conditions under which that knowledge was produced and transmitted. This makes them a theoretically significant but empirically neglected group for understanding the limits of biocultural resilience under extreme structural constraint.

Prior ethnobotanical research on Afghan communities is limited but illuminating. Manduzai et al. [26] documented wild plant use among Afghan refugees in Mansehra, Pakistan, finding a diverse pharmacopoeia of nine

genera actively used in camp settings, maintained through market access and community networks. Shah et al. [27] showed that stricter border enforcement and economic marginalisation further constrained plant access even among Pakistan-based refugees. No study has, however, examined what happens to LEK upon return to Afghanistan, particularly given the recent mass repatriation and the radically altered socio-ecological context of contemporary Afghanistan.

This study addresses this gap through the following research questions: (1) Which wild food plants and herbal teas are remembered or currently used by Afghan returnees? (2) How has double displacement affected the retention, erosion, and transformation of LEK? (3) What cultural, social, and gendered factors explain differential knowledge retention? (4) How does the returnees' knowledge compare with that of Afghan refugees who remained in Pakistan?

Our objectives were to document returnees' ethnobotanical knowledge, assess erosion patterns through comparative analysis, examine gendered dimensions of knowledge loss, and propose a theoretical framework centred on the concept of "dormant" or "inert knowledge" to advance refugee ethnobiology as a distinct research trajectory. A further aim is to test the socio-demographic correlates of retention formally rather than to describe them, and to ask whether the *manner* of return – expulsion against voluntary repatriation – leaves a measurable trace on what people have kept.

Materials and methods

Study site and participants

Fieldwork was conducted in May 2025, over 26 consecutive working days, at the Omari Refugee Temporary Shelter Centre in eastern Afghanistan, a transit facility for Afghans recently repatriated from Pakistan, in the case of the households interviewed here from the Islamabad Capital Territory, Punjab and Khyber Pakhtunkhwa, and, among the returnees passing through the centre more generally, also from Balochistan (Fig. 1). Eastern Afghanistan spans diverse ecological zones from mountain terrain to lowland semi-arid plains. Still, the returnees' immediate context, a peri-urban shelter, offers minimal opportunities for foraging or engagement with wild plant resources. This environmental constraint is analytically central to our findings.

The centre lies in Nangarhar Province, some 15 km west of Torkham, the busiest single point of entry for Afghans deported or pressed into "voluntary" return from Pakistan since the announcement of the Illegal Foreigners' Repatriation Plan in late 2023 [1, 28]. The households we interviewed spent their exile in three settings: the Islamabad–Rawalpindi conurbation, which accounted for just under half; the industrial and agricultural districts of Punjab; and the peri-urban belts of Peshawar, Nowshera and Mardan in Khyber Pakhtunkhwa. Returnees from Quetta and its satellite settlements in Balochistan also pass through the centre via the Spin Boldak–Chaman crossing, but none were included in the sample analysed here (Fig. 1).

Some background on why these households were at the border in May 2025 is needed, since it bears directly on the analysis that follows. The Illegal Foreigners' Repatriation Plan announced by the Government of Pakistan in October 2023 set out three phases. The first gave undocumented Afghan nationals thirty days to leave, and more than 468,000 crossed in the closing months of that year. The second was announced in March 2025 and took effect on 1 April, when holders of the Afghan Citizen Card, a document issued by the Pakistani authorities themselves between 2017 and 2019, were told to depart or face removal. The third concerns holders of the Proof of Registration card issued by UNHCR, whose validity was set to lapse on 30 June 2025. By late April 2025, shortly before our fieldwork began, close to a million people had crossed since the plan was announced, and United Nations agencies were planning for daily arrivals of up to twenty thousand at Torkham and Spin Boldak [1, 28].

Two features of this process shape our data. First, the people arriving are not returning from a short absence. Many were born in Pakistan, and among those who were not, the median stay in our sample was 32 years. Households were leaving homes, tenancies, businesses, and schools built up over decades, and doing so on a few weeks'

Fig. 1 Study area and repatriation routes. Areas of prior residence in Pakistan recorded for the participants – Islamabad Capital Territory, Punjab and Khyber Pakhtunkhwa – are shown in ochre, together with Balochistan, from which returnees also pass through the centre; Nangarhar Province, where the Omari Refugee Temporary Shelter Centre is located, is in green. Arrows indicate the principal return corridors used between 2023 and 2025, through the crossings at Torkham and Spin Boldak–Chaman

notice or less. Second, the administrative distinction between deportation and voluntary return reflects a procedural difference rather than a choice. Agency monitoring of crossing records shows fear of arrest as the reason most returnees give for leaving. It applies to those who departed ahead of enforcement rather than under escort [28]. We keep the distinction because our participants themselves made it and because, as the analysis below shows, it predicts what they have retained. The term is used here descriptively, in this restricted administrative sense.

The two ends of that trajectory differ sharply in ecological terms, and the difference matters for what follows. The Peshawar Valley and the Punjab plains are irrigated, intensively farmed and densely populated. Uncultivated ground is scarce there, and for tenants and daily labourers without land rights it is effectively inaccessible. Islamabad and Rawalpindi form a metropolitan conurbation in which no household we met had any access to open ground at all, and it is from there that the thinnest repertoires came. Nangarhar is a different landscape altogether: a warm semi-arid lowland basin at 500–700 m along the Kabul River, framed to the south by the Spin Ghar range. Its flora still contains much of what our participants remembered, including *Mentha longifolia* along the irrigation channels and *Descurainia sophia*, *Peganum harmala* and *Zygophyllum indicum* on disturbed ground near the settlements. The plants, in other words, are largely present. The social and economic conditions for gathering them are not.

Households at the centre depend almost entirely on humanitarian assistance. On arrival, they receive a cash grant and dry rations of wheat flour, pulses, fortified oil, and salt, distributed through IOM and WFP partners. They then remain at the shelter for anything from two days to three weeks before moving on to relatives or informal settlements [28]. None of the households interviewed held cultivable land, and only a small minority reported growing anything at all, generally a few pots of mint or coriander. Food therefore reaches them through rations and, where cash allows, through the bazaars at Torkham and Jalalabad; gathering plays no measurable part in provisioning. That dependency is not background detail but part of the explanation for the erosion we document.

The population passing through the centre is overwhelmingly Pashtun, with smaller numbers of Tajiks and a few Pashai and Uzbek households. Virtually all participants were Sunni Muslims, and the languages of everyday use were Pashto and, less frequently, Farsi/Dari. The staple diet is wheat-based. *Naan* is baked at home or bought from a tandoor, and it is accompanied by rice (*Pulao*), pulses, potato and okra dishes, yoghurt and *Qurut*, and green tea (*Chai sabz*). Green tea is the vehicle through which most of the aromatic taxa listed in Table 2 would traditionally be taken. Meat is infrequent. Against this starch-dominated, aid-dependent diet, the disappearance of wild leafy vegetables carries nutritional and cultural weight, since these plants were the principal seasonal source of micronutrients and dietary diversity in the rural diet these households left behind.

The brevity of the fieldwork window follows from the setting rather than from a design decision. The Omari centre is a transit facility where residents stay for days. The population we needed to reach was, by definition, only briefly reachable. A study spread over six months would not have produced a longer relationship with any single participant, only a different set of participants arriving under the same conditions. Three circumstances made four weeks workable. First, the first author is a Pashtun ethnobotanist from the region who conducted every interview himself, in the participants' first language and without an interpreter, which removes the extended rapport-building phase that fieldwork in an unfamiliar community requires. Second, he was already working at the centre in a clinical capacity, so interviews took place inside an established relationship of trust and in a space that participants had come to of their own accord. Third, the instrument was deliberately narrow – two use categories, no free-listing of the entire pharmacopoeia – so that a single conversation of 25–40 min was sufficient. Daily interviewing over 26 working days produced the 142 interviews reported here. We nonetheless regard this as a rapid appraisal of an acute moment, not a substitute for long-term ethnography.

A total of 142 returnees participated (61 men, 81 women), selected through stratified random sampling to ensure representation across gender, age groups, and duration of prior stay in Pakistan. Participants ranged in age from 4 to 77 years (median 30, IQR 23–45) and had spent a median of 32 years in Pakistan (IQR 12–40, range 1–65); fourteen were under 18, and we interviewed them in the presence of an accompanying adult household

member. Because the population turns over daily, the construction of the strata and the randomisation procedure require explanation, and both are set out below.

The sampling frame was the daily arrival register kept by the centre's administration, which records every household admitted together with the province of prior residence in Pakistan, household size, and the age and gender of each member. Because the population is a flow rather than a settled community, the frame was rebuilt each morning from the previous twenty-four hours' admissions. Members of arriving households who had lived in Pakistan and were willing and able to be interviewed were eligible; we excluded people who had returned before 2023 and those too unwell to be interviewed. We did not exclude younger household members, since one question asks what the generation raised in exile has and has not been told. Eligible participants on each daily register were assigned to strata formed by crossing sex with age class (under 18, 18–30, 31–50 and over 50 years). Area of prior residence in Pakistan served as an implicit secondary stratifier. Within each stratum, we sorted the list by province before selection, spreading the sample across provinces without creating eighteen thinly populated cells.

Within each stratum, we drew participants using pseudo-random numbers generated by the RAND function in a spreadsheet applied to the numbered stratum list and approached them in the order drawn. If a selected person had already departed, declined, or could not be interviewed in private, we took the next number in the sequence and recorded the substitution. Allocation was proportionate to the observed composition of the arriving population, which is why women outnumber men in the final sample (81 against 61). Adult men often remain behind in Pakistan to settle debts or travel separately, so women and older adults are overrepresented in the return flow itself. Table 1 presents the full sample profile and the variables used in the analysis.

The target of at least 140 completed interviews was set a priori on two grounds. The first was coverage: with strata defined by gender and four age classes, and three areas of prior residence represented within them, a sample of this order was required for each cell to support more than anecdotal inference. The second was the practical limit of what a single researcher can achieve in a transit centre where residence is measured in days. One hundred and forty-two interviews were completed over 26 working days, and all are included in the analysis. For a two-group comparison of approximately equal size, this yields 80% power at $\alpha = 0.05$ to detect a medium effect ($d = 0.5$). Power is lower for the comparison between voluntary and expelled returnees, where the groups are markedly unequal (22 against 120) and only large effects are detectable; the corresponding results are interpreted accordingly.

Table 1 Profile of the 142 participants and coding of the variables used in the analysis of differential knowledge retention (Omari Refugee Temporary Shelter Centre, Nangarhar, May 2025)

Variable	Categories	*n*	%
Sex	Female / male	81 / 61	57.0 / 43.0
Age class	Under 18 / 18–30 / 31–50 / over 50	14 / 58 / 41 / 29	9.9 / 40.8 / 28.9 / 20.4
Age (years)	Median 30 (IQR 23–45), range 4–77	–	–
Area of prior residence in Pakistan	Islamabad / Punjab / Khyber Pakhtunkhwa	67 / 61 / 14	47.2 / 43.0 / 9.9
Character of the return	Expelled (forced) / voluntary	120 / 22	84.5 / 15.5
Length of prior residence in Pakistan (years)	Median 32 (IQR 12–40), range 1–65	–	–
Length of prior residence, banded	≤15 / 16–30 / >30 years	41 / 29 / 72	28.9 / 20.4 / 50.7
Household members migrating together	Median 8 (IQR 5–10), range 0–25	–	–
Province of onward destination in Afghanistan	Kunduz / Nangarhar / Kabul / Baghlan / other or unknown	32 / 30 / 16 / 14 / 50	22.5 / 21.1 / 11.3 / 9.9 / 35.2
Taxa recalled per participant.	Mean 0.56 (SD 0.83), median 0 (IQR 0–1), range 0–3	–	–
Participants naming at least one taxon	Yes/no	53 / 89	37.3 / 62.7
Participants still using at least one taxon	Yes/no	19 / 123	13.4 / 86.6

Data collection

The first author (AKM) conducted semi-structured ethnobotanical interviews in Pashto and Farsi/Dari, the two dominant languages among participants. The first author (AKM) obtained prior verbal informed consent from all participants in accordance with the Code of Ethics of the International Society of Ethnobiology (ISE) [29]. Interviews covered current and remembered uses of wild vegetables and herbal ingredients, including folk names, procurement methods, preparation techniques, and perceived health properties. For each taxon mentioned, participants also reported where and when they gathered it, who taught them about it, whether they used it in Pakistan, whether they have used it since returning, and, if not, why not. We explored the food-as-medicine interface using established ethnopharmacological frameworks [30, 31].

We excluded mushrooms and wild fruits because the survey was conducted at a medical camp with limited interview time. This was a pragmatic decision, and it has consequences. Both categories fall under regional Local Ecological Knowledge. Children gather wild fruits such as *Ziziphus*, *Elaeagnus*, *Morus*, and *Berberis* fruits, and they are among the most often retained where adult foraging has stopped. At the same time, fungal knowledge tends to be concentrated on a small number of specialists. Their omission therefore means that the erosion figures reported here describe the vegetable-and-herbal-tea repertoire specifically rather than LEK as a whole. The likely direction of this bias is considered in the Limitations section.

Plant identification

Participants took part directly in the identification process, and the procedure varied with what was physically available at the time of the interview. Most households still held the plant material, which was usually the case for herbal-tea ingredients. In practice, this meant dried seeds, bark, rhizomes or dried aerial parts bought in the bazaar rather than fresh whole plants. We examined and photographed the material with the participant, who confirmed the folk name, the part used, and the preparation. For the two taxa still gathered from the wild, participants accompanied the first author to the places they use on the margins of the centre and along the adjacent irrigation channels, where fresh material was seen, photographed and discussed in situ. For taxa that were only remembered, identification rested on the vernacular name, the participant's description of habit, habitat, odour, season, and preparation, and photographs shown during the interview.

We identified plants with available voucher specimens at the herbarium of the Faculty of Pharmacy, Kabul University, using regional floristic references [32–34]. The alphanumeric codes given in Table 2 are the accession numbers of the herbarium specimens (KUFP, Faculty of Pharmacy; KUFS, Faculty of Science) against which each determination was made. For species without vouchers, we based identification on photographs, comparisons of folk names with published ethnolinguistic surveys in Pashto- and Dari-speaking areas [35–43], and expert consultation (AGK). The qualifier "#" indicates identification based on folk names and descriptions only. We regard these nine determinations as tentative, and dried commercial material, even when physically present, cannot be determined to species with the confidence a flowering specimen allows. Nomenclature follows World Flora Online [44]; family assignments follow the Angiosperm Phylogeny Website [45], which implements APG IV, so that Peganum harmala is placed in Nitrariaceae rather than in Zygophyllaceae sensu lato.

Data analysis

Frequency of quotation (FQ) was calculated as the percentage of participants citing each species and is reported in Table 2 as a percentage rather than as a class interval. Plant uses were classified as WFPP (wild food plants remembered from the past), WFPCF (currently foraged), or WFPCP (currently practised through cultivation or purchase). We used data from Manduzai et al. [26] (Afghan refugees in Mansehra, Pakistan) and applied the same methodological categories to enable direct cross-context comparison.

We derived two response variables for each participant: the number of distinct taxa named and the number still in use. Both are counts and strongly zero-inflated, so we examined group differences nonparametrically and via regression. We used the Mann–Whitney U test for two-group comparisons, reported with rank-biserial correlation as an effect size; for more than two groups, we used the Kruskal–Wallis test, followed where warranted by Dunn's test with Holm correction. We assessed associations between continuous variables and counts with Spearman's rho, and between categorical predictors and binary outcomes with the chi-squared test.

Multivariable models followed. We modelled the number of taxa recalled using Poisson regression, with sex, age, length of residence in Pakistan, area of prior residence, character of the return, and household size as predictors. Dispersion was mild, with a variance-to-mean ratio of 1.24 and a residual deviance of 1.14 per degree of freedom, and a negative binomial alternative did not improve fit on AIC (289.0 against 290.5). The Poisson model is therefore reported here, and the negative binomial is retained only as a sensitivity check, from which the same conclusions follow. Because the counts are small and the majority are zero, two logistic models were also fitted, one for naming any taxon at all and one for still using any taxon, with the same predictors. We entered age as a continuous term; we used the four age classes in Table 1 descriptively, since no participant under 18 reported current use and a categorical specification therefore produced complete separation. We conducted analyses in Python 3.12 using SciPy 1.14 and statsmodels 0.14 and set significance at $\alpha = 0.05$.

We quantified similarity between the returnee pharmacopoeia and that recorded among Afghan refugees still resident in Mansehra, Pakistan [26] using the Jaccard index, $J = a / (a + b + c)$. Here, a is the number of genera shared between the two datasets, and b and c are the numbers exclusive to each [46]. We computed the index at the generic level because the Mansehra study reports several taxa only to the genus level. It was also computed on actively used plants rather than on remembered ones, so that the comparison is between living practices and not between reservoirs of memory.

Thematic analysis of qualitative interview data followed an inductive coding approach, and all authors reviewed emergent themes. Following Reyes-García et al. [47], we coded statements about transmission separately by the generation from which a participant reported learning a given use, or by whether they reported not having learnt it. This allowed us to treat the youngest participants as a distinct interpretative unit rather than merely the lowest stratum of a gradient.

Results

Overview of recorded plants

Table 2 lists 23 plant species across 23 genera and 18 botanical families; twenty-two were quoted during the interviews, while *Momordica charantia* was documented during fieldwork but not named by any participant in the interview series. Nineteen (83%) were quoted as remembered from the past (WFPP), reflecting a profound disconnection from active foraging among returnees. One species is still foraged from the wild (WFPCF: *Mentha longifolia*), and three are still practised through cultivation or purchase (WFPCP: *Bryophyllum pinnatum*, *Salvia rhytidea*, *Trachyspermum ammi*). Each taxon falls into a single category, so that the 23 taxa yield 23 use records; four are in some form of active use, leaving 19 (83%) that survive as memory alone.

The repertoire is not merely eroded but extremely thin. Participants named on average 0.56 taxa each (SD 0.83, median 0, interquartile range 0–1, maximum 3), and 89 of the 142–62.7% – named none at all. Only 19 participants (13.4%) reported still using any plant. No taxon approached the "very commonly quoted" threshold of 40%, and only one, *Trachyspermum ammi* (12.0%), exceeded 10%. The next most frequently named were *Foeniculum vulgare* (9.9%), *Curcuma longa* (7.7%) and *Descurainia sophia* (5.6%); fewer than four people named every remaining taxon, and eleven were named by a single individual. A distribution of this shape – a long tail of singletons under a very low ceiling – is what a repertoire looks like at the point where it stops being shared knowledge and becomes a scatter of private recollections.

Table 2 Wild food plants and herbal-tea ingredients recorded among Afghan returnees from Pakistan at the Omari Refugee Temporary Shelter Centre, eastern Afghanistan (field survey, May 2025)

Plant taxon and voucher code	Botanical family	Vernacular name (Pashto/Dari)	Procure-ment	Used parts	Preparation and perceived health properties	FQ (%)	Native range/provenance	Wild, semi-domesti-cated or domesticated (AF / PK)
Berberis lycium Royle. #	Berberidaceae	*Zardchoba*	bmP	Roots	B: decoction, anti-allergic	2.8*	Native (W Himalaya)	Wild (AF, PK)
Bryophyllum pinnatum (Lam.) Oken. #	Crassulaceae	*Patarchat*	cP	Leaves	F: leaves chewed, litholytic for kidney stones	0.7	Introduced (Madagascar); naturalised in South Asia	Cultivated as an ornamental / pot plant (AF, PK)
Cannabis sativa L. KUFS 010443	Cannabaceae	*Charas*	bmP	Resin	F: resin consumed, analgesic	1.4*	Native (Central Asia)	Wild and cultivated (AF, PK)
Cinnamomum verum J. Presl. #	Lauraceae	*Daar cheeni*	bmP	Inner bark	B: decoction, anti-diabetic	1.4*	Introduced (Sri Lanka, S India)	Domesticated; imported spice (AF, PK)
Curcuma longa L. #	Zingiberaceae	*Korkaman*	bmP	Rhizome	F: lateral rhizome decoc-tion, analgesic and for internal wounds; powder applied to the skin for rashes	7.7*	Introduced (South Asia)	Domesticated; obtained as imported market produce (AF, PK)
Dactylorhiza umbrosa (Kar.&Kir.) Nevski. KUFP-2024-2531	Orchidaceae	*Chambolak*	bmP	Roots	B: decoction, antidepressant	0.7*	Native (Irano-Turanian / W Himalaya)	Wild (AF, PK)
Descurainia sophia (L.) Webb ex Prantl. KUFP-2014-0624	Brassicaceae	*Khaksheer*	bmP	Seeds	B: decoction, anti-cough, anti-cold	5.6*	Native (Eurasia)	Wild, ruderal (AF, PK)
Ferula sp. KUFP-2013-0758	Apiaceae	*Badbarak*	bmP	Roots	B: decoction, carminative	1.4*	Native (Irano-Turanian)	Wild (AF, PK)
Foeniculum vulgare Mill. KUFP-2015-0908	Apiaceae	*Badyan*	bmP	Fruits	B: powdered and ingested, nootropic	9.9*	Introduced (Mediterra-nean); long naturalised	Semi-domesticated; cultivated and traded (AF, PK)
Glycyrrhiza glabra L. KUFP-2006-0032	Fabaceae	*Khogawalay*	bmP	Roots	B: decoction, anti-cough, anti-cold	0.7*	Native (Eurasia)	Wild; locally cultivated (AF, PK)
Mentha longifolia (L.) L. s.l. KUFP-2015-0794	Lamiaceae	*Velanay*	fP	Aerial parts	F/B: aerial parts dried and taken orally with water or green tea, carminative	2.1	Native (Eurasia and N Africa)	Wild; occasionally in home gardens (AF, PK)
Momordica charantia L. #	Cucurbitaceae	*Karela*	bmP	Peel	B: decoction, anti-diabetic	0.0 §	Introduced (Palaeotropi-cal, S Asia)	Domesticated (PK); imported (AF)
Nepeta junica Benth. KUFP-2013-0744	Lamiaceae	*Gulbakhoor*	bmP	Aerial parts	B: decoction, anti-pyretic	0.7*	Native (Afghanistan to W Himalaya)	Wild (AF, PK)
Olea europaea L. #	Oleaceae	*Zaitoon*	bmP	Leaves	B: decoction, analgesic	0.7*	Introduced (Mediterranean)	Cultivated, incl. planta-tions in Nangarhar (AF); imported (PK)
Papaver somniferum L. KUFS 016418	Papaveraceae	*Ghozay post*	bmP	Pericarp	B: decoction, analgesic	0.7*	Introduced cultigen (Mediterranean origin)	Domesticated (AF, PK)
Peganum harmala L. KUFP-2014-0199	Nitrariaceae (Zygophylla-ceae sensu lato)	*Esphand*	bmP	Roots	B: powdered roots taken orally in small quantities with water or green tea, anti-diabetic	0.7*	Native (Irano-Turanian)	Wild, ruderal (AF, PK)

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Table 2 (continued)

Plant taxon and voucher code	Botanical family	Vernacular name (Pashto/Dari)	Procure-ment	Used parts	Preparation and perceived health properties	FQ (%)	Native range/provenance	Wild, semi-domesticated or domesticated (AF / PK)
Plantago ovata Forssk. KUFP-2018-2034	Plantaginaceae	*Aspaghol*	bmP	Seeds	B: boiled in milk, carminative	2.8*	Native (SW Asia to NW India)	Wild (AF); wild and cultivated (PK)
Salvia rhytidea Benth. KUFP-2015-0430, and possibly *Lallemantia royleana* (Benth.) Benth. and *Ocimum basilicum* L.	Lamiaceae	*Tukhm-e-malanga*	bmP	Seeds	B: cold macerate, carminative	0.7	Native (Irano-Turanian)	Wild (AF, PK)
Syzygium aromaticum (L.) Merr. & L.M.Perry. #	Myrtaceae	*Lawang*	bmP	Flower buds	B: decoction, carminative	0.7*	Introduced (Maluku, Indonesia)	Domesticated; imported spice (AF, PK)
Trachyspermum ammi (L.) Sprague ex Turrill. KUFP-2019-2209	Apiaceae	*Ajwain*	bmP	Fruits	B: decoction, carminative	12.0	Native (SW Asia to NW India)	Domesticated; cultivated (PK), mostly imported (AF)
Withania coagulans (Stocks) Dunal. KUFP-2014-1927	Solanaceae	*Khamazoora*	bmP	Seeds	B: decoction, anti-hepatic	0.7*	Native (Iran, Afghanistan, NW India)	Wild (AF, PK)
Zingiber officinale Roscoe #	Zingiberaceae	*Adrak*	bmP	Rhizome	B: decoction, bronchodilator	0.7*	Introduced cultigen (SE Asia)	Domesticated; imported (AF, PK)
Zygophyllum indicum (Burm.f.) Christenh. & Byng. #	Zygophyllaceae	*Mazhgakai*	bmP	Whole plant	B: decoction, bronchodilator	0.7*	Native (Irano-Turanian, Palaeotropical)	Wild, ruderal; invasive outside its native range (AF, PK)

Abbreviations and symbols. Procurement – fP: plant foraged by the participants themselves from the wild; cP: plant grown by the participants themselves as a pot or dooryard plant; bmP: plant obtained as dried material bought in local markets or bazaars. Preparation – B: the preparation is drunk, as an infusion or decoction, that is, as a herbal tea; F: the preparation is eaten, as a food or a food-medicine; F/B indicates a taxon used in both ways. FQ – the percentage of the 142 participants who cited the taxon. *: taxon quoted as remembered from past use and not actively used at the time of the survey (WFPP). #: taxon for which no reference specimen was available, the determination resting on vernacular name, participant description and photographs, and therefore tentative. §: taxon documented during fieldwork but not named by any participant in the interview series. AF: Afghanistan; PK: Pakistan. Voucher codes are the accession numbers of the specimens held at the herbaria of the Faculty of Pharmacy (KUFP) and the Faculty of Science (KUFS), Kabul University, against which each determination was made. *Nepeta junica* Benth. is given in the spelling used in the regional literature; the accepted name is *Nepeta juncea* Benth. The material vouchered here is *Mentha longifolia*. The species is a highly variable complex, readily confused with *M. spicata* L. and with their hybrids, and the folk name *Velanay* is applied locally to more than one mint, so that individual interview reports may refer to other species of *Mentha*. Two of the taxa listed here are distinguished in local usage by name, part used and indication and should not be conflated. *Zardchoba* denotes the root of *Berberis lycium*, taken as a decoction against allergies. *Korkaman* denotes the lateral rhizome of *Curcuma longa*, used as an analgesic and, as a powder, on the skin

The four taxa still in use account for all remaining practice, and it is very unevenly distributed across them: *Trachyspermum ammi* accounts for 17 of the reports of current use, while *Mentha longifolia*, *Salvia rhytidea* and *Bryophyllum pinnatum* were each named by a single participant. Current practice, in other words, rests on a single cheap bazaar spice (Fig. 3).

The repertoire is overwhelmingly one of herbal teas: twenty of the 23 taxa are drunk as infusions or decoctions (coded B in Table 2) and only four are eaten as food or food-medicine (coded F), with *Mentha longifolia* falling into both categories.

Lamiaceae (3 species: *Mentha longifolia*, *Nepeta junica*, *Salvia rhytidea*), Apiaceae (3 species: *Foeniculum vulgare*, *Ferula* sp., *Trachyspermum ammi*), and Zingiberaceae (2 species: *Curcuma longa*, *Zingiber officinale*) were the best-represented families, consistent with South Asian ethnobotanical patterns [26, 27]. The predominance of aromatic species rich in essential oils reflects their dual culinary-medicinal significance and their availability in dried form through market channels, a factor central to understanding differential persistence across knowledge types. The remaining fifteen families are represented by a single taxon each, a flat distribution that itself reflects erosion: what survives in memory is a scatter of individually salient plants rather than the coherent, family-clustered repertoires typical of communities still foraging (See Fig. 2).

Patterns of knowledge erosion and gendered LEK

The 83% of taxa relegated to passive memory (WFPP) is the study's most striking quantitative finding. Wild vegetables show near-total erosion: no leafy weed or vegetable species is actively foraged or cultivated. Not one of the wild greens that participants named as childhood foods – and several named them fluently, with season, habitat and cooking method attached – has been gathered since the return. This collapse is linked to extended residence in peri-urban Pakistani settings where foraging was impractical, and, as the analysis below shows, to the coercive character of the return itself. As one female participant stated: "*In the cities*, *we cannot go outside to forage wild plants*." Another added: "*We have not heard from our elders about wild green plants*." These testimonies reveal not just behavioural discontinuity but ruptures in intergenerational transmission chains, which Reyes-García et al. [47] identify as the primary vector of LEK loss.

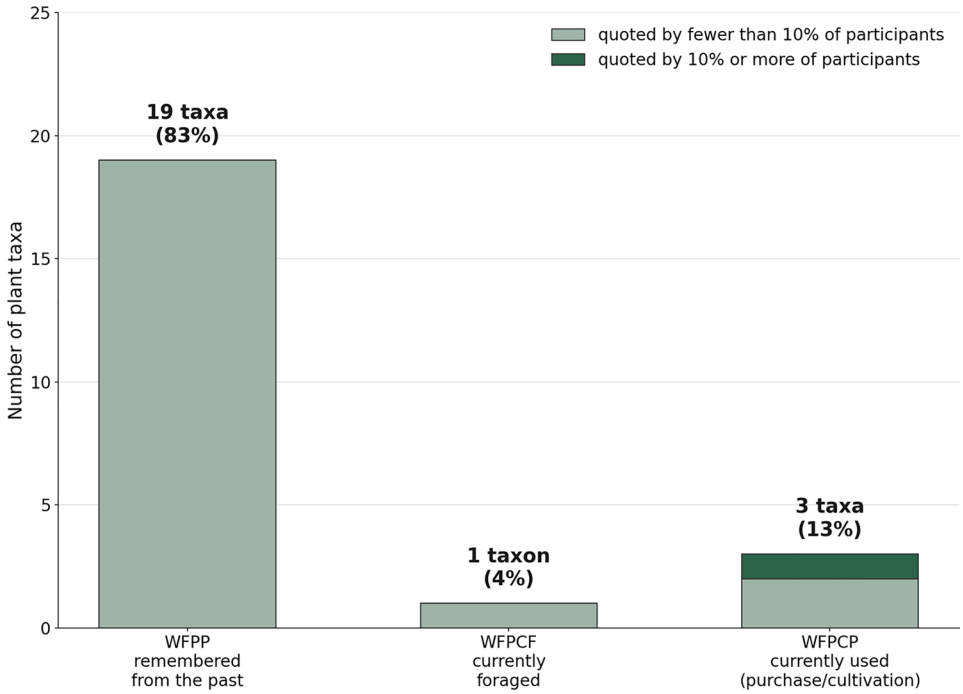

Fig. 2 Number of plant taxa in each use category among the Afghan returnees surveyed, shaded by frequency-of-quotation class. WFPP: taxa remembered from the past; WFPCF: taxa currently foraged; WFPCP: taxa currently used through purchase or cultivation. Percentages are of the 23 recorded taxa. Each taxon is assigned to a single use category, so that the three bars sum to 23: *Bryophyllum pinnatum* is counted as currently used through cultivation, and *Mentha longifolia* as currently foraged from the wild

What survives, however, does not follow this division. Of the four taxa still in any form of use, three are drunk – *Mentha longifolia*, *Salvia rhytidea* and *Trachyspermum ammi* – and two are eaten: *Bryophyllum pinnatum* and *Mentha longifolia* again. Three beverage taxa out of twenty remain in use (15%) against two food taxa out of four (50%), but with only four food taxa in the whole dataset the comparison carries no weight, and we do not rest an argument on it.

What they share is how they are obtained. People pick *Mentha longifolia* along the irrigation channels beside the shelter. *Bryophyllum pinnatum* is grown in a pot on a windowsill and propagates from a detached leaf. The seeds of *Salvia rhytidea* and the fruits of *Trachyspermum ammi* are among the cheapest items in the Torkham bazaar. None of the four requires land, and none requires more than a trivial sum of money. The contrast with what has been lost is exact. Every one of the nineteen taxa that survive as memory alone is coded bmP in Table 2, meaning that during the exile it was bought as dried seed, bark or rhizome in a Pakistani bazaar. The only taxon in the entire dataset ever gathered from the wild is the one still gathered. That market channel, and not the landscape, sustained the knowledge attached to the other nineteen. When repatriation removed household purchasing power, the channel closed, and the knowledge went dormant. What survives, in short, is not what mattered most but what remained reachable.

As one female participant noted: "*We do not use wild plants for food or medicine*, *since our elder women forbid it; instead*, *we rely on conventional medicines from local markets*". This testimony reveals how elder authority, operating within a context of cultural adaptation to urban displacement, can actively reinforce the abandonment of traditional practices.

Neither the gendered nor the generational contrast anticipated in earlier literature is visible in these data, while an unanticipated contrast is. The following section reports the tests and summarises them in Table 3.

Cultural, social and gendered determinants of retention

Because we drew the sample using stratified random sampling and recorded each participant's plant list individually, we can test the correlates of retention rather than describe them. We modelled two outcomes: the number of taxa a person named, and whether the person still used any plant. Results are summarised in Table 3. First, we report a set of absences, since neither of the two variables that the literature on local ecological knowledge would lead us to expect explains anything. Women named slightly fewer taxa than men (means of 0.49 vs. 0.64 and a median of zero in both groups), and the difference was neither large nor significant ($U = 2242.5$, $p = 0.276$, rank-biserial $r = 0.09$). The same holds for current use, reported by 12.3% of women and 14.8% of men ($\chi^2 = 0.03$,

Table 3 Predictors of the number of wild food plant and herbal tea taxa recalled and of current use among 142 Afghan returnees. Bivariate tests and Poisson and logistic generalised linear models adjusted for all listed predictors

Predictor	Comparison	Taxa recalled: bivariate test	Taxa recalled: adjusted IRR (95% CI), p	Any current use: adjusted OR (95% CI), p
Character of the return	Voluntary vs. expelled	$U = 912.0$, $p = 0.008$, $r = 0.31$	1.79 (1.07–3.00), $p = 0.026$	1.65 (0.46–5.94), $p = 0.445$
Area of prior residence	Khyber Pakhtunkhwa vs. Islamabad	$H = 6.12$, df = 2, $p = 0.047$	2.57 (1.32–4.99), $p = 0.005$	5.76 (1.15–28.86), $p = 0.033$
Area of prior residence	Punjab vs. Islamabad	see above	1.44 (0.87–2.38), $p = 0.155$	3.60 (1.06–12.24), $p = 0.040$
Sex	Male vs. female	$U = 2242.5$, $p = 0.276$, $r = 0.09$	1.27 (0.81–1.98), $p = 0.300$	1.28 (0.47–3.53), $p = 0.629$
Age	Per year; four classes	$H = 6.63$, df = 3, $p = 0.085$	1.007 (0.994–1.021), $p = 0.284$	1.014 (0.984–1.044), $p = 0.366$
Length of residence in Pakistan	Per year; three bands	$H = 1.15$, df = 2, $p = 0.563$	1.000 (0.985–1.015), $p = 0.997$	0.998 (0.965–1.032), $p = 0.906$
Household members	Per person	rho = −0.07, $p = 0.381$	0.954 (0.899–1.013), $p = 0.123$	not included

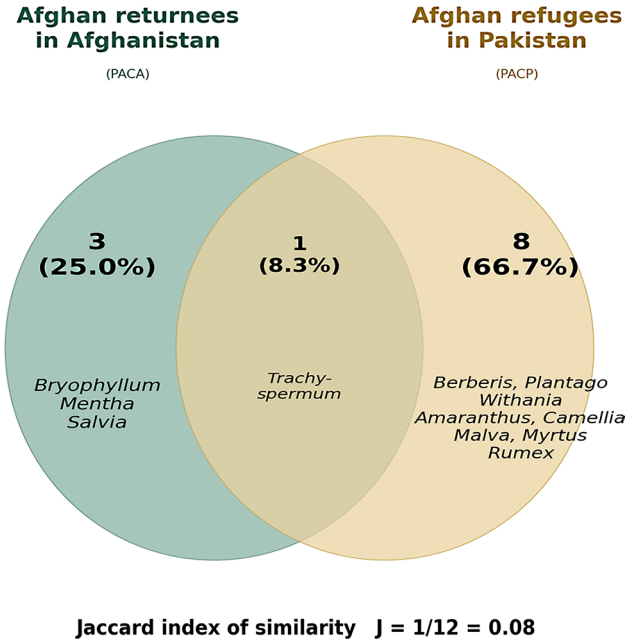

Fig. 4 Venn diagram comparing the genera actively used by Afghan returnees in Afghanistan (PACA, this study) with those actively used by Afghan refugees still resident in Mansehra, Pakistan (PACP) [26]. The overlap contains the genera used in both settings; *Trachyspermum* is the only one. Jaccard index of similarity J = a/(a + b+c) = 1/12 = 0.08

$p=0.866$), and sex was not a significant predictor in any of the three multivariable models. The 12% and 18% figures cited in earlier accounts of this material correspond closely to the observed proportions, but the difference between them lies well within sampling variation.

Age behaves no better, and it does not behave as the literature predicts either. Recall peaks in the middle of the range rather than at the top of it. The 31–50 class named the most taxa, with a mean of 0.80 and 53.7% naming at least one, followed by the over-50s (0.52, 34.5%), the 18–30 class (0.45, 29.3%) and the under-18s (0.36, 28.6%). Across the four classes, the Kruskal–Wallis test falls short of significance ($H=6.63$, $df=3$, $p=0.085$), and age entered as a continuous term is unrelated to the number of taxa recalled (Spearman's rho = 0.13, $p=0.139$; adjusted IRR = 1.007 per year, 95% CI 0.994–1.021, $p=0.284$). The oldest participants, who on the conventional account should be the custodians of the repertoire, are not the group that named most. Nor does the length of the exile help. We expected years spent in Pakistan to be the clearest single predictor of loss, but they predict nothing at all. Participants had spent a median of 32 years there, with a range of 1 to 65, and the association with recall is negligible (Spearman's rho = −0.02, $p=0.789$; Kruskal–Wallis across three bands $H=1.15$, $df=2$, $p=0.563$; adjusted IRR = 1.000 per year, $p=0.997$). Whatever destroyed this repertoire did not do so gradually, in proportion to time away.

One socio-demographic variable does carry a signal, and it reflects the place rather than the person. Those returning from Khyber Pakhtunkhwa named more taxa than those from Punjab, and those from Punjab more than those from Islamabad, with means of 1.07, 0.59 and 0.42 (Kruskal–Wallis $H=6.12$, $df=2$, $p=0.047$). The gradient is steeper for current use, at 28.6%, 18.0% and 6.0% ($H=7.05$, $p=0.029$), and both effects survive adjustment. Relative to Islamabad, residence in Khyber Pakhtunkhwa carries an incidence rate ratio of 2.57 for taxa recalled (95% CI 1.32–4.99, $p=0.005$) and an odds ratio of 5.76 for any current use (95% CI 1.15–28.86, $p=0.033$), with Punjab intermediate (OR = 3.60, 95% CI 1.06–12.24, $p=0.040$). The ordering follows the degree of urbanisation of the exile. Islamabad is the most metropolitan of the three settings, and it is where the fewest plants survived. What people retained depended less on who they were than on where they had been living.

The character of the return

The strongest and most consistent result in the dataset concerns not who the returnees are but how they came back. One hundred and twenty participants were expelled under the repatriation drive, and twenty-two returned

voluntarily. The two groups differ sharply. Voluntary returnees named almost twice as many taxa as those expelled (mean 0.91 against 0.49, median 1 against 0; U = 912.0, $p = 0.008$, rank-biserial $r = 0.31$). Among them, 63.6% named at least one plant, against 32.5% of the expelled group ($\chi^2 = 6.43$, df = 1, $p = 0.011$).

The effect holds after adjustment for gender, age, length of exile, area of prior residence and household size. In the Poisson model, voluntary return is associated with an incidence rate ratio of 1.79 for the number of taxa recalled (95% CI 1.07–3.00, $p = 0.026$). In the logistic model for naming any taxon at all, it carries an odds ratio of 3.81 (95% CI 1.42–10.21, $p = 0.008$). Time does not explain it: voluntary returnees had spent a comparable period in Pakistan, with a median of 28 years versus 34. Nor does the effect extend to current use, where the difference is small and not significant (18.2% against 12.5%, $p = 0.445$). That is what one would expect if coercion damaged the transmission and rehearsal of knowledge rather than the material conditions for practising it, since both groups face the same conditions on arrival at the centre.

This is, to our knowledge, the first within-population demonstration that the manner of return, and not the demographic profile of the returnee, is what separates those who have kept something from those who have kept nothing. This finding also bears most directly on the argument of this paper, and we return to it in the Discussion.

Perceptions of the youngest generation (18–30 years)

The younger participants deserve separate treatment, since they are the group in which the transition from dormant to lost knowledge will or will not occur. Fifty-eight participants were aged 18–30 and fourteen were under 18; most were born in Pakistan or left Afghanistan as small children, and their relationship to the plants in Table 2 is mediated entirely by what older relatives told them. Between them, they named a mean of 0.43 taxa, and fewer than a third named any; none of the under-18s reported using a plant. Three patterns emerged from the thematic coding.

First, recognition without practice. Young participants could frequently attach a Pashto name and a general therapeutic attribution to a plant – that *Khaksheer* is good for a cough, that *Zardchoba* is for allergy – while being unable to say where it grows, when it is gathered or how it is prepared. This is dormant knowledge in its thinnest form: the label survives, the procedure does not, and a label without a procedure cannot be reactivated.

Second, an explicit break in transmission. Several younger women stated flatly that the subject had never been raised with them, as in the quotation given above: "*We have not heard from our elders about wild green plants.*" Older women framed abandonment as a loss imposed by circumstance. Younger ones described it as an absence they had never experienced as such.

Third, and more encouragingly, they described an interest disconnected from stigma. Younger participants did not associate gathered plants with poverty as consistently as the middle generation did; several framed them instead in terms of health, being "natural", or belonging to Afghanistan rather than Pakistan. That framing is a resource for any revitalisation effort, and it suggests that the barrier for this cohort is opportunity and instruction rather than attitude.

Comparative analysis: Pakistan vs. Afghanistan

Figure 4 presents a Venn diagram comparing plant genera cited by Afghan returnees in Afghanistan (PACA) with those documented among Afghan refugees in Pakistan (PACP), as reported by Manduzai et al. [26]. The two repertoires of actively used genera share a single element out of twelve, giving a Jaccard index of similarity of J = 1/12 = 0.08. On the conventional reading of that index, the two assemblages are all but disjunct: the nine genera in active use at Mansehra and the four in active use at Omari have almost nothing in common.

Afghan refugees in Pakistan actively used nine genera (Berberis, Plantago, Trachyspermum, Withania, Amaranthus, Camellia, Malva, Myrtus, Rumex), while returnees in Afghanistan used only four (*Bryophyllum*, *Mentha*, *Salvia*, *Trachyspermum*). Only *Trachyspermum ammi* persists across both contexts, attributable to its dried-seed storability, pan-cultural culinary importance, and market availability, the three conditions identified by Shah et

al. [27] as necessary for LEK maintenance under structural constraint. The genera lost upon return reflect compound barriers: ecological mismatch (*Berberis*) requires highland environments absent near lowland camps; economic collapse prevents purchase (Camellia); loss of plant material during forced, rapid repatriation; severance of the elder-knowledge networks that sustained use; and food aid dependency that reduces foraging motivation. The presence of *Bryophyllum* and *Salvia* exclusively in the returnee list suggests adoption during the Pakistani exile, followed by transport to Afghanistan, representing a form of cultural neo-genesis within the displaced pharmacopoeia.

Read against the native-range and cultivation status given in Table 2, the pattern of loss is not random with respect to provenance. Of the nine genera actively used in Pakistan, those lost on return are dominated by taxa whose supply depended on a highland habitat absent around Jalalabad (*Berberis*) or on a functioning cash market (*Camellia*, *Myrtus*). The wild ruderal greens *Amaranthus*, *Malva*, and Rumex were lost too, and these are native, abundant, and within walking distance of the shelter. That last point matters. The plant's absence cannot explain their disappearance, since the plant is there. The absence of practice, and the mobility it requires, explains it.

Two of the three genera present only in the returnee list, *Bryophyllum* and *Salvia*, run in the opposite direction. *Bryophyllum pinnatum* is not native to the region at all. It is a Malagasy succulent, grown in South Asia as a pot ornamental and used there as a litholytic. Its presence in an Afghan returnee pharmacopoeia is best explained as an acquisition made during the Pakistani exile and carried home, together with the plant itself, which travels easily as a cutting. This is the cultural neo-genesis Pieroni and Vandebroek [4] described, and it shows that even a trajectory as destructive as this is not purely subtractive. Mentha longifolia is a different case again: it is native and abundant on both sides of the border and was not among the genera in active use at Mansehra, so its reappearance in the returnee list records a local opportunity, an irrigation channel a few metres from the shelter, rather than an acquisition made in exile.

Discussion

The findings of this study advance refugee ethnobiology as a distinct theoretical trajectory within migration studies, one that foregrounds not adaptation and hybridisation, the dominant themes in voluntary migration contexts, but rupture, fragmentation, and the structural determinants of biocultural loss. Three theoretical contributions merit extended discussion.

First, the magnitude of erosion observed here, 83% of taxa reduced to passive memory, exceeds rates documented in all comparable migrant ethnobotany studies. Ceuterick et al. [14] found approximately 40% retention among Andean migrants in the UK; Fontefrancesco et al. [19] documented 40–70% retention among Albanian and Moroccan migrants in Italy; Pirker et al. [10] reported partial retention with substantial hybridisation among Tyrolean migrants in the Southern Hemisphere. The Afghan returnee case diverges qualitatively from these voluntary migration trajectories. We propose that forced migration, particularly when compounded by prolonged urban exile and conflict-context return, produces a qualitatively distinct mode of knowledge erosion that existing theoretical frameworks derived from voluntary migration fail to capture. Double displacement, the sequential rupture of displacement and repatriation, is not simply additive in its effects but multiplicative, stripping away the social, environmental, and temporal conditions for knowledge transmission at each phase.

The dataset also allows that argument to be made from within, which the comparative literature cannot do. Every participant at the Omari centre had left Pakistan, arrived at the same shelter, and faced the same conditions on arrival; the only difference was whether they had been expelled or had chosen to come. That single difference predicts retention. Voluntary returnees recalled almost twice as many taxa. They were nearly four times as likely, after adjustment, to name any plant at all, while sex, age and length of exile predicted nothing. Comparisons between our sample and Andean migrants in London or Albanians in Italy will always invite the objection that the populations, environments, and instruments differ. This comparison is not. It isolates coercion as the operative variable while holding the destination, the moment, and the interviewer constant. It is the most direct evidence

we can offer that forced displacement is qualitatively, rather than merely quantitatively, different from voluntary migration.

The mechanism by which coercion produces this effect is not self-evident. Expulsion removes the interval in which a household prepares to move. A family that decides to return sorts its possessions, carries seed and dried material, says goodbye, and rehearses in conversation what it is going back to. A family given days to leave carries documents and children. The knowledge at issue here is procedural and conversational, and it survives by being used and retold rather than by being stored. What coercion destroys is therefore not the memory itself but the occasion on which memory is exercised. The effect appears exactly where this account predicts it should. It appears in what people can still name, which differs sharply between the two groups, and not in what they currently use, which does not, because current use is constrained by conditions at the centre that are identical for everyone.

The comparison with voluntary migrants is instructive but incomplete, and we extend it here to populations whose experience more closely matches that of our participants. Volpato and colleagues [20] found that Sahrawi refugees in the Algerian camps retained and even elaborated a repertoire of plant, animal and mineral products across decades of exile. They remained, however, in a desert environment ecologically continuous with the one they had left, in camps that became stable settlements with their own markets and healers. Betancourt et al. [21] documented severe attrition among forcibly displaced Emberá and Uitoto populations moved from Amazonian forest to Colombian urban peripheries, a discontinuity comparable in kind to ours. Sulaiman et al. [48] showed that Syrians under siege conditions reactivated wild food gathering under acute scarcity, precisely because they remained in place. Set beside these, the Afghan returnee case isolates the variable that matters. What destroys LEK is not displacement as such, nor scarcity, nor even duration. It is the combination of ecological discontinuity with the loss of the social space in which gathering is organised and taught. Sahrawi exile preserved both; Syrian siege preserved both; the Afghan double displacement destroyed the second in Pakistan and failed to restore the first on return.

Second, we introduce the concept of "inert knowledge" to describe the specific condition of LEK observed among returnees: culturally present (remembered, nameable, attributable with properties) but behaviourally deactivated (no longer practised, foraged, or transmitted). This concept distinguishes the Afghan returnee situation from both active knowledge (practised and transmitted) and lost knowledge (neither remembered nor named). Inert knowledge occupies a liminal status; it is a form of biocultural heritage that exists as personal and collective memory but has been severed from the environmental and social conditions that gave it functional life. The theoretical significance of this distinction is considerable: it implies that knowledge revitalisation, the reactivation of inert knowledge under changed conditions, may be possible in ways that recovery of genuinely lost knowledge is not. This opens an important policy window, but one that requires urgent action before holders of inert knowledge age out of living memory.

The concept bears pressing further than a definition, because it does analytical work in three places in our data. First, it explains the shape of the repertoire. Dormancy is not distributed at random but falls hardest on knowledge whose object requires access to land. That is why every wild green is dormant, and why the surviving four taxa are all either bought, grown in a pot, or picked at the edge of a path. Second, it accounts for the levelling of the sexes. Dormancy is a property of practice rather than of memory, so a repertoire that has ceased to be practised loses the differences that practice created. Third, it makes a testable prediction: dormant knowledge should reactivate when the missing condition is restored, and only then. The four taxa still in use at Omari are precisely those obtainable without leaving the shelter's immediate surroundings or spending more than a trivial sum, which is weak but real confirmation. Dormancy also has a term. It is held in individual memory; it is not being transmitted, and the youngest cohort holds names without procedures. On the generational arithmetic of our sample, the practical content of this pharmacopoeia has perhaps twenty to thirty years of life in it. After that, reactivation ceases to be a policy option and becomes an archival exercise.

Third, the gendered dynamics that dominate the literature on LEK are absent here, and their absence is informative rather than merely negative. Women in this sample named marginally fewer taxa than men and used plants

at almost the same low rate, with no difference approaching significance in any test or model. Two readings are available, and they are not mutually exclusive. The first is a floor effect: with a mean of 0.56 taxa per person, a maximum of three, and 63% of participants naming nothing at all, the outcome has almost no variance left for a gender differential to express itself. Custodianship presupposes something to be custodian of, and where a repertoire has collapsed to near zero the differential collapses with it – which is itself a claim about the severity of the erosion rather than a null result to be explained away. The second reading concerns what the double displacement did to the division of labour. Gathering is the activity through which women's advantage in this domain is built and transmitted; two or three decades of peri-urban exile without access to land removed the activity for everyone, and with it the mechanism that produced the difference. On this account, equalisation is not an artefact but a consequence: displacement has not redistributed knowledge between the sexes, it has levelled both to a common floor.

One interpretation must accordingly be set aside. Women do not emerge as the principal custodians of this repertoire, and restricted mobility is not a constraint peculiar to them. The second element of that account survives in modified form. Mobility and access to land constrain everyone in this population, and the statements we recorded from women about not being able to go out and gather describe a constraint that in exile came to apply across the household rather than one that singled women out. The statements of younger women who said they had never been taught remain the clearest qualitative evidence for a broken transmission chain. The quantitative data show that the chain broke for their brothers as well.

The distribution of what survives also bears on how knowledge type drives differential erosion, and it does so in a way we did not anticipate. Ellena et al. [18] observed that medicinal-symbolic knowledge tends to outlast subsistence-practical knowledge in migrant contexts, and our data agree emphatically at the level of memory. What these households have retained is a herbal-tea pharmacopoeia, twenty taxa out of 23, with the food plants reduced to four. At the level of practice, however, the same category has all but collapsed, three taxa out of twenty remaining in use. Memory and practice have come apart, and the reason is that the salience of these plants was never what sustained them. Market access was, and remains, precisely what repatriation removed. Our data therefore refine rather than confirm the medicinal-symbolic thesis: cultural weight predicts what a displaced community can still name, but the survival of the means of obtaining a plant predicts whether it will still be used. Where a regional herbal market persists, as in the settings Ellena and colleagues describe, the two look the same; where that market is withdrawn, the medicinal-symbolic category proves the most fragile of all, because nothing in the household's own environment was ever required to reproduce it. The corollary for biocultural policy is uncomfortable but clear: interventions that restore supply without restoring access to land and mobility buy persistence only for as long as the supply lasts.

Placed within the cross-cultural adaptation literature reviewed in the Introduction, the returnee trajectory looks less like adaptation than like its failure. Migrants in London, Cologne or Turin adapt because the receiving context offers substitutes: a shop, a diaspora supply chain, a functioning pharmacy [14, 16, 19, 22]. That kind of adaptation is a purchase, and it presupposes both a market and the money to use it. Our participants passed through a first displacement in which the Pakistani bazaar did exactly this work – which is why nearly every dormant taxon in Table 2 is coded bmP – and then a second in which that substitute was removed without the original being restored. Vandebroek and Balick's [23] caution that apparent erosion often conceals reorganisation is well taken, and we test it here: the reorganisation happened in Pakistan, and it collapsed. What remains is neither the ancestral repertoire nor its market-mediated replacement, but the residue of both.

From the perspective of forced migration studies, this paper argues for a "biocultural turn" in refugee research. Humanitarian frameworks have historically prioritised shelter, nutrition, security, and legal status, which Kibreab [2] calls the "material" dimensions of displacement. Our findings suggest that LEK constitutes a "material-symbolic" resource: it is practically useful for food security and healthcare but also a carrier of identity, dignity, and social cohesion. Its erosion is therefore not merely a cultural loss but a material vulnerability. Returners who have lost knowledge of wild edibles depend more on food aid and market access; those who have lost herbal knowledge rely more on formal healthcare in a country where healthcare systems have largely collapsed.

These findings also connect to the political ecology of return migration. Unlike voluntary returnees who may choose the timing and terms of return, Afghan returnees have been expelled under duress, arriving without adequate preparation, resources, or social networks to facilitate reintegration. The ecological conditions for LEK recovery- secure land access, stable community networks, proximity to known ecosystems, and intergenerational interaction- are structurally absent in transit shelters. Without deliberate policy intervention, the inert knowledge documented here may complete its transition to lost knowledge within a single generation.

Comparison with findings from community-based ecological restoration in related contexts such as the UNDP jujube tree-planting initiative in Nangarhar, Afghanistan [49] suggests that cash-for-work programmes combining economic incentives with culturally relevant plant cultivation can simultaneously address livelihood needs and create conditions for biocultural revitalisation. Similar models, adapted to include wild plant species from the WFPP category, could function as vehicles for LEK reactivation.

Two qualifications should govern any such programme; the first concerns provenance. As the columns in Table 2 show, the recorded repertoire mixes taxa native to the Irano-Turanian and western Himalayan region with taxa introduced long ago or traded from far away. The native groups include *Berberis lycium*, *Descurainia sophia*, *Mentha longifolia*, *Withania coagulans*, *Glycyrrhiza glabra* and *Peganum harmala*. The introduced group includes *Curcuma longa*, *Syzygium aromaticum*, *Cinnamomum verum* and *Zingiber officinale*. Erosion tracks this division only indirectly. Non-native taxa were lost because they are commodities and the cash ran out. Native wild taxa were lost because people stopped gathering them. Provenance therefore predicts the *mechanism* of loss rather than its probability, and that distinction matters practically, since the two mechanisms call for different remedies: income support in the first case, access to land and mobility in the second.

The second qualification concerns invasion risk, which seed distribution programmes in post-conflict settings have a poor record of considering. Several taxa in this repertoire are aggressive colonisers of disturbed ground. *Peganum harmala* and *Zygophyllum indicum* are serious invasive weeds of rangeland outside their native range, and *Bryophyllum pinnatum*, the one clear acquisition of the exile, is listed as invasive across much of the tropics and subtropics and propagates from detached leaves [50]. Distributing planting material in returnee settlements without provenance, screening risks introducing exactly the naturalisation events that Richardson et al. [50] describe, in landscapes already degraded by drought and displacement. We therefore recommend four safeguards for biocultural seed programmes. Material should be limited to taxa native or long naturalised in the receiving province. Source it locally rather than import it. Screen it against the national invasive-species inventory. It should be paired with informal seed-system approaches that have proved more durable than external distribution in comparable settings [51]. A pharmacopoeia garden that becomes a weed source will discredit the whole approach.

Limitations of the study

Several limitations of this study require acknowledgement. The cross-sectional design at a transit shelter captures an acute displacement moment rather than long-term resettlement dynamics; current use patterns may shift substantially after resettlement. Retrospective recall of Pakistan-based practices may be subject to memory idealisation. The small sample size ($n = 142$) limits statistical power for subgroup analyses. Future longitudinal research should track the same cohort across the resettlement process, examine LEK dynamics among returnees who settle in rural versus urban areas, and compare findings with those from returnees in Iran and other displacement contexts.

Six further limitations should be stated explicitly. First, excluding mushrooms and wild fruits because of the limited interview time in a medical camp means the erosion figures apply to wild vegetables and herbal teas rather than LEK as a whole. The bias probably runs toward overstating erosion, since children gather wild fruits opportunistically and they are among the categories most often retained where adult foraging has ceased. A study including them would probably report a somewhat larger active repertoire. We see no reason, however, to expect it to alter the contrasts reported here.

Second, the analysis is underpowered for the comparison that matters most. The voluntary group numbers only 22 against 120 expelled, so although the effect is large and survives adjustment, its confidence intervals are wide, and the estimate should be read as an indication of magnitude rather than a precise one. The null results for sex, age and length of exile are subject to the reverse caution. With a mean of 0.56 taxa per person and 63% of participants at zero, the outcome has very little variance, and a real but modest difference could not have been detected. We have therefore treated these as uninformative rather than as evidence of absence, except for gender, where the floor effect is itself the interpretation.

Third, the recorded variables constrain what we can model. The dataset includes sex, age, area of prior residence, character of the return, length of exile, household size, and onward destination, but not education, occupation, or place of birth, so the model cannot separate the effect of urban exile from the schooling and employment that accompany it. Balochistan was also not represented among the areas of prior residence recorded for these participants, although returnees from that province do pass through the centre; the analysis therefore speaks to the Islamabad, Punjab and Khyber Pakhtunkhwa corridors and should not be generalised to the Chaman route.

Fourth, the sample includes fourteen participants under 18, the youngest aged four, each interviewed in the presence of an accompanying adult. We retained them because the transmission question the study asks concerns precisely the generation raised in exile and excluding them would have removed the evidence bearing on it. Their inclusion nevertheless means that this is not a sample of adult household heads, and the very low counts in the youngest class should be read with that in mind.

Fifth, the sample is drawn from a single transit centre on the Torkham corridor and is therefore weighted towards households returning through Torkham from the Islamabad–Rawalpindi conurbation and from Punjab, and towards households destined for eastern Afghanistan. Returnees from Iran, who cross in the west and whose exile was shaped by a different urban and legal regime, are absent altogether.

Sixth, retrospective reports of use in Pakistan cannot be verified and are exposed to recall bias and to the idealisation that displacement encourages; the comparison with Manduzai et al. [26] partly offsets this by setting remembered practice against practice observed contemporaneously in Pakistan, but the two datasets were collected by different means at different times. The Jaccard value should be read as an order of magnitude rather than a precise coefficient.

Towards an ethnobiology of the refugees

An ethnobiology of the refugees does not begin from nothing. It begins from the migrant ethnobiology built over the past two decades by Pieroni and Vandebroek and their colleagues, and in the work of van Andel, Ceuterick, Ellena, Fontefrancesco, Sandhu and Heinrich, and Alrhmoun, among others [4, 14, 16–18, 22, 52, 53]. That literature established the questions, the vocabulary and the comparative method on which everything in this paper depends. It showed that plant knowledge travels with people, is renegotiated rather than carried, and that adaptation, substitution, and hybridisation are its characteristic outcomes [5]. We take all of this as our point of departure. Refugee ethnobiology adds to the conditions under which none of these holds. The founding situation of migrant ethnobiology is a person who chose to move and who arrives somewhere they intend to stay. Almost everything distinctive about that literature follows from those two conditions. Adaptation presupposes a destination where a repertoire can be rebuilt, and a diaspora economy that supplies substitutes. Refugees and returnees satisfy neither condition. They did not choose the moment of departure; they often do not know where they would settle, and in our sample the destination was, in most cases, not even a place they had ever lived.

This step asks us to consider a different set of causes. Where migrant ethnobiology asks how knowledge is renegotiated in a new place, refugee ethnobiology has to ask what happens when people are detached from nature altogether. It has to treat the expropriation of the right to interact with a landscape, rather than the mere inconvenience of doing so, as a determinant of knowledge. And it has to reckon with the fact that the memory in which plant knowledge is stored has been shaped by war, loss, and the aftermath of violence. These are not modifiers of the migrant case. They are causes of a different kind, and the double displacement documented here brings them

into view. One consequence is that this field has fewer plants and requires more care. Our list runs to 23 taxa, a fraction of what a village study in the same region would yield, and the material's interest lies less in the plants than in what their absence records. Refugee ethnobiology will therefore sit closer to the social sciences than to the natural ones. It needs the botany to be right, but its explanatory work is done by displacement history, by property and access, by household structure and gender, and by trauma.

That object has three features which we would propose as the organising questions of the subfield. The first is coercion as a variable in its own right. Our data show that the manner of departure predicts retention within a single population, holding destination and environment constant, and we would expect this comparison to be reproducible wherever voluntary and involuntary returnees arrive at the same place. The second is the intermittency of the trajectory. Displacement is rarely a single move, and knowledge is lost, partly rebuilt and lost again at each stage, so the unit of analysis is a sequence rather than a pair of endpoints. The third is dormancy. Between full transmission and complete loss lies a long interval in which a repertoire persists as memory without practice, and it is in that interval that almost every displaced population will be found when a researcher reaches it.

The subfield also needs its own methods, and this study was partly an experiment in devising them. Transit centres, border crossings and reception facilities are where displaced populations are concentrated and reachable, and they are almost entirely unstudied because they suit no conventional design. Residence is measured in days, rapport must be built in minutes, and no follow-up is possible. What we found workable was a narrow instrument, a community researcher working in the participants' own language, and a sampling frame rebuilt daily from the arrivals register. What we could not do was equally instructive: no longitudinal design, no free-listing of a whole pharmacopoeia, and no reliable voucher collection where the plants themselves have been left behind. Methodological work on rapid, ethically defensible protocols for these settings would be as valuable to the field as any individual case study.

Ethics in these settings differs from ethics in a village. Consent is asked of people who have just been expelled from their homes, who often assume that the interviewer has some influence over their circumstances, and for whom refusal may feel costly even when it is not. Compensation is fraught for the same reason. Households arrive fragmented, so the family is not a stable unit of consent, and minors are present in numbers that no village-based protocol anticipates. We took the view that these difficulties argue for care rather than for avoidance, since the alternative is that the populations losing knowledge fastest remain the least documented. The field would nonetheless benefit from an explicit ethical framework, developed with humanitarian agencies rather than around them.

Finally, an agenda. Four lines of work seem to us immediately available. Comparative studies of voluntary and forced returnees arriving at the same site would test the coercion effect reported here on larger samples and in other corridors, including the Iranian border, which we could not reach. Longitudinal follow-up of returnee households after resettlement would establish whether dormant knowledge reactivates when land becomes available, the framework's central prediction and a key untested assumption. Documentation targeted at the oldest returnees is urgent on a timescale of decades rather than of research cycles. Intervention studies that evaluate seed distribution or home-garden schemes for biocultural as well as nutritional outcomes would tell us whether any of this can be reversed. The Afghan return of 2023 to 2025 has displaced more than a million people across a single border in two years. Whatever the ethnobiology of these refugees is, it will not lack material.

Conclusion

This preliminary study provides the first systematic documentation of wild plant LEK among Afghan returnees, revealing a pattern of biocultural erosion that exceeds any previously documented in migrant ethnobotany. Of the 23 recorded taxa, 83% persist only as dormant or inert knowledge culturally present but behaviourally inactive. Wild vegetables have disappeared from the repertoire altogether, and the herbal teas that dominate what remains of it in memory – twenty taxa out of 23 – have proved the least durable of all in practice, because the bazaar rather

than the landscape was what kept them alive. The four taxa still in use survive for the opposite reason: they cost next to nothing and need no land. The "double displacement" trajectory specific to returnees produces compounding disruptions to the social, environmental, and generational transmission of LEK that voluntary migration frameworks cannot adequately capture.

Theoretically, this study advances refugee ethnobiology as a distinct research field. It introduces inert knowledge as a framework for understanding biocultural fragmentation under forced displacement. It also shows that, within a single displaced population, the coercive character of a return leaves a measurable trace on what its members can still name. Practically, the findings support targeted biocultural interventions in returnee settings.

The individual-level analysis allows the central claim to be stated more sharply, and in a form that does not depend on comparison with other populations. Within a single returnee community, at a single site, on a single instrument, the manner of return predicts what people have kept. Those who came back voluntarily recalled almost twice as many taxa as those expelled and were nearly four times as likely to name any plant at all, while sex, age and length of exile predicted nothing. Coercion, not demography, is the operative variable. Four consequences follow. Documentation and revitalisation should target displacement history rather than demographic category, reaching expelled households first, since their repertoire has thinned the most. Interventions should address household access to land and mobility rather than women specifically, since the erosion documented here has levelled the sexes to a common floor. Programmes for the youngest cohort should supply procedure rather than nomenclature, because this group already has names without procedures. And any distribution of planting material should be restricted to locally sourced, native or long-naturalised taxa screened for invasion risk. Each follows from a result rather than a principle, and each remains open to testing under a design with a larger voluntary comparison group.

In an era of escalating forced displacement globally, the fate of LEK under conflict-induced migration is not merely an academic question: it is a question of food security, health resilience, cultural dignity, and the conservation of the biocultural heritage that displaced communities carry with them across every border they are forced to cross.

Fig. 3 Fruits of *Trachyspermum ammi* (L.) Sprague ex Turrill, the ajwain of the Afghan and Pakistani bazaars, as sold loose in Pakistan. It is the only taxon in this study still used by more than one participant in ten, and the only element common to the returnee and the Pakistan-based repertoires (Fig. 4). Photograph by Miansari66, 16 February 2009, released by the author into the public domain, via Wikimedia Commons (File: Ajwain.JPG); https://commons.wikimedia.org/wiki/File:Ajwain.JPG

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Author contributions Ajmal Khan Manduzai & Andrea Pieroni designed the study and methodology, analyzed the most salient outcomes, and drafted the preliminary version; Ajmal Khan Manduzai & Andrea Pieroni reviewed the initial manuscript. Abdul Ghani Karimi assisted in plant identification. The final version was later revised and approved by all authors.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate The study adhered to the International Society of Ethnobiology Code of Ethics (https://www.ethnobiology.net). We obtained verbal informed consent from all participants before the interview. We informed participants of their right to withdraw at any time.

Human ethics and consent to participate The study was conducted under the Code of Ethics of the International Society of Ethnobiology and with the permission of the management of the Omari Refugee Temporary Shelter Centre. Prior verbal informed consent was obtained from every participant. For the fourteen participants under 18 years of age, consent was given by an accompanying adult household member, who was present throughout, and the young person's own assent was obtained before the interview began. No personal identifiers were recorded, and participation had no bearing on any assistance received at the centre.

Consent for publication All participants consented to the publication of their opinions in accordance with the ISE ethical guidelines. Figure 3 reproduces a photograph by Miansari66, made available on Wikimedia Commons (File: Ajwain.JPG) and released by its author into the public domain worldwide, so that no permission is required for its reproduction, adaptation or commercial use; the author is nonetheless credited in the figure caption.

Competing interests The authors declare no competing interests.

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