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BRINGING BACK FAMILIAR FORMS: RECYCLING QUINA SCRAPERS AT THE LATE LOWER PALAEOLITHIC QESEM CAVE, ISRAEL

Summary. *This study presents a technological analysis of 18 old patinated scrapers and spalls, mostly of Quina technology, that were recycled into new scrapers of the same type at the Late Lower Palaeolithic site of Qesem Cave, Israel (420–200 kyr). Recycling scrapers into the same Quina and demi-Quina types offers a rare, controlled opportunity to investigate a technology's biographical character. Comparing the tools' pre- and post-recycling phases demonstrates that the selection of old items was highly intentional, guided by the original tool's morphology and the affordances of its pre-existing features. This process suggests an enacted perceptual experience, demonstrating a skilled recognition of the potential remaining in discarded objects. A sophisticated understanding of material properties and technological trajectories is thus revealed. This behaviour suggests a form of historically-aware material engagement, offering new insights into the cognitive and technological capabilities of Late Lower Palaeolithic humans and providing a basis for future cognitive studies.*

INTRODUCTION

The Lower Palaeolithic saw the emergence of diverse and complex lithic technologies, providing a unique window into early human behaviour. These developments suggest that early humans possessed a deep understanding of their environment, which was crucial for their daily economy and cultural worldviews (e.g. Foley and Lahr 2015; Domínguez-Rodrigo and Pickering 2017; Assaf 2021; Barkai 2021; Finestone et al. 2025).

In the Late Lower Palaeolithic Levant, a deep engagement with the environment is argued to be reflected in the convergence of distinctive practices, such as the development of Quina technology (e.g. Bourguignon 1996; 1997; Hiscock *et al*. 2009) during the Acheulo-Yabrudian and the collection and recycling of old patinated flint items (e.g. Belfer-Cohen and Bar-Yosef 2015; Peresani *et al*. 2015; Shimelmitz 2015; Brumm *et al*. 2019), producing artefacts often known in the literature as being 'double patinated'. The co-occurrence of both practices within Qesem Cave, Israel, is a key factor in this paper.

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The present study focuses on a specific recycling practice at Qesem Cave: the transformation of old, patinated Quina and demi-Quina scrapers into new tools of the same type. This practice offers a unique case study for exploring human choice, perception and material engagement in the Palaeolithic, as well as the broader practice of using old patinated items and tools as blanks for making scrapers at the site. Through a detailed technological analysis of the small sample, this study demonstrates that the selection of old scrapers was guided by specific criteria related to their pre-existing form. I argue that this recycling method reveals careful consideration and sophisticated technological knowledge, contributing to a deeper understanding of hominin behaviour at Qesem Cave.

QESEM CAVE AND THE DOUBLE-PATINA PHENOMENON

Qesem Cave is a Levantine Late Lower Palaeolithic cave site in Israel, located 12 km east of Tel Aviv (Fig. 1). Excavations between 2001 and 2016 revealed a stratigraphical profile of approximately 11 m of sediments, all of which is dated to 420–200 kyr (MIS 11-7; Gopher *et al.* 2010; Mercier *et al.* 2013; Falguères *et al.* 2016; 2022). The sequence is attributed to the local Acheulo-Yabrudian Cultural Complex (AYCC), which is distinct from the preceding Acheulian and the succeeding Mousterian. The AYCC is characterized by three co-occurring lithic industries: blade-dominated Amudian, scraper-dominated Yabrudian, and handaxe-dominated Acheulo-Yabrudian. At Qesem, Amudian and Yabrudian industries are present, with the Amudian being more prominent (Barkai *et al.* 2009; Gopher *et al.* 2016; Parush *et al.* 2016).

Flint recycling was a fully integrated practice throughout the Qesem sequence, and is thought to have held both functional and socio-cultural meaning (Parush *et al.* 2015; Agam

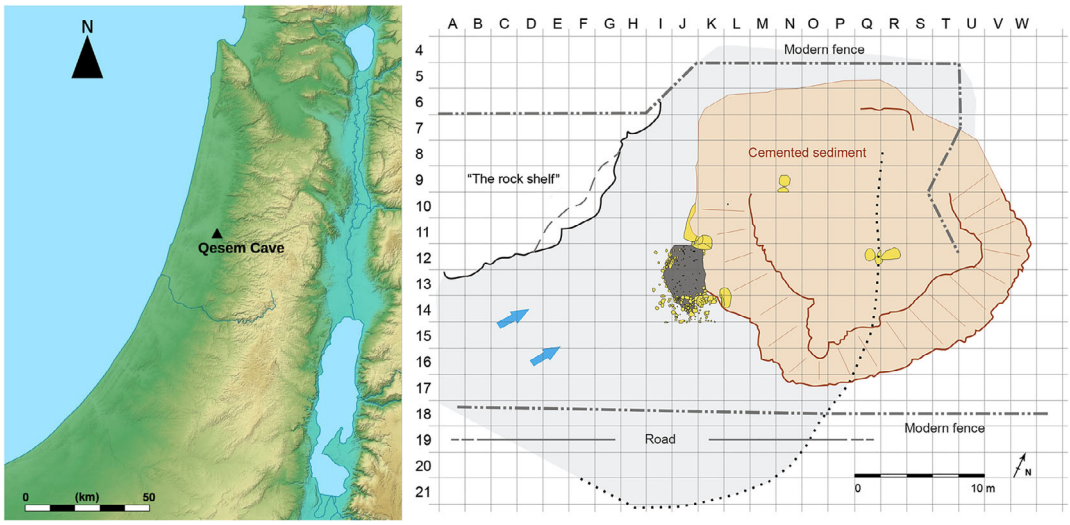

FIGURE 1
The settings of Qesem Cave, Israel. Geographical location of the site (left) and the site's top-plan (right), featuring the upper sequence of the cave, the hearth area (dark grey feature), and the location of the rock shelf where the lower sequence of the cave begins. Materials with permission from R. Barkai and A. Gopher.

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et al. 2019; Assaf *et al*. 2020; Efrati and Barkai 2024). It has been suggested that the cave inhabitants engaged in these recycling practices were reflecting an awareness of previous human activity in the landscape, which may have fostered a tangible connection with the deep-past (Agam *et al*. 2019; Assaf *et al*. 2020; 2023; Efrati 2021; 2024; Assaf 2024).

In the case of the collection and recycling of old patinated items and tools, the long life-histories embedded in these objects, from their creation through recycling and preservation, exemplify this awareness. This paper focusses on one of these recycling trajectories, that of old patinated human-made items (double-patinated items). This recycling practice is a known cultural behaviour during prehistory. It involved a process in which stone artefacts that had been discarded into the archaeological record (in used or unused condition) were exposed to environmental and sedimentological elements for a length of time sufficient to result in the formation of a patina and were then collected and reworked by later prehistoric knappers. In the case of this paper, during the Acheulo-Yabrudian, older, externally weathered artefacts salvaged from the archaeological record were reshaped in a manner that exposed fresh surfaces, resulting in unambiguous evidence for double patination.

In the context of lithic recycling, patina differences are widely recognized as evidence of recycling, particularly in prehistoric sites (Goodwin 1960; Amick 2007; Vaquero 2011). Later retouching and/or knapping scars that cut through older, patinated surfaces create a visible differentiation that signifies a time gap between modification phases. This time gap is crucial for identifying the practice as recycling, even when the tool's general purpose remains the same (Amick 2007; Vaquero 2011). While the time required for a patina to form naturally is debated (with suggestions ranging from minutes, months, and decades to thousands of years[1]; Benedict 1992; Friedman *et al*. 1994–95; Thiry *et al*. 2014), its presence on a flaked surface reliably indicates a period of exposure and disuse prior to its collection and subsequent modification.

Recycling at Qesem was a deliberate choice, not a response to material scarcity. High-quality flint was readily available (Wilson *et al*. 2016; Agam 2020; 2021), and freshly made tools constitute the majority of the assemblages (87% of fresh tools, n=4920, in comparison to 13% recycled patinated tools, n=720, as tested in 12 assemblages; Efrati and Barkai 2024). Two main recycling trajectories for patinated items have been identified: Type-A, where flakes are detached from old items, and Type-B, where the old item itself serves as the blank for a new tool (Fig. 2; Efrati and Barkai 2024).

Previous studies suggested that for Type-B tools, blanks were selected based on their morphology, with new modifications often limited to shaping a new working edge while preserving the original outline (Efrati 2021; Efrati and Barkai 2024). While the lack of standardization in most recycled tools makes it difficult to test this hypothesis of intentional, form-based selection, Quina technology provides a unique opportunity. Since Quina and demi-Quina scrapers have more standardized techno-morphological features, they offer a controlled context by which to investigate choice. This study therefore analyses a distinctive sample where old, patinated scrapers mostly of Quina or demi-Quina type were themselves chosen as blanks for new scrapers, hence providing a focused lens to examine the intentionality and technological awareness involved in this specific recycling practice.

[1] Short patina formation times observed in laboratory settings do not necessarily reflect natural conditions, which are more complex and thus not directly comparable (VanNest 1985).

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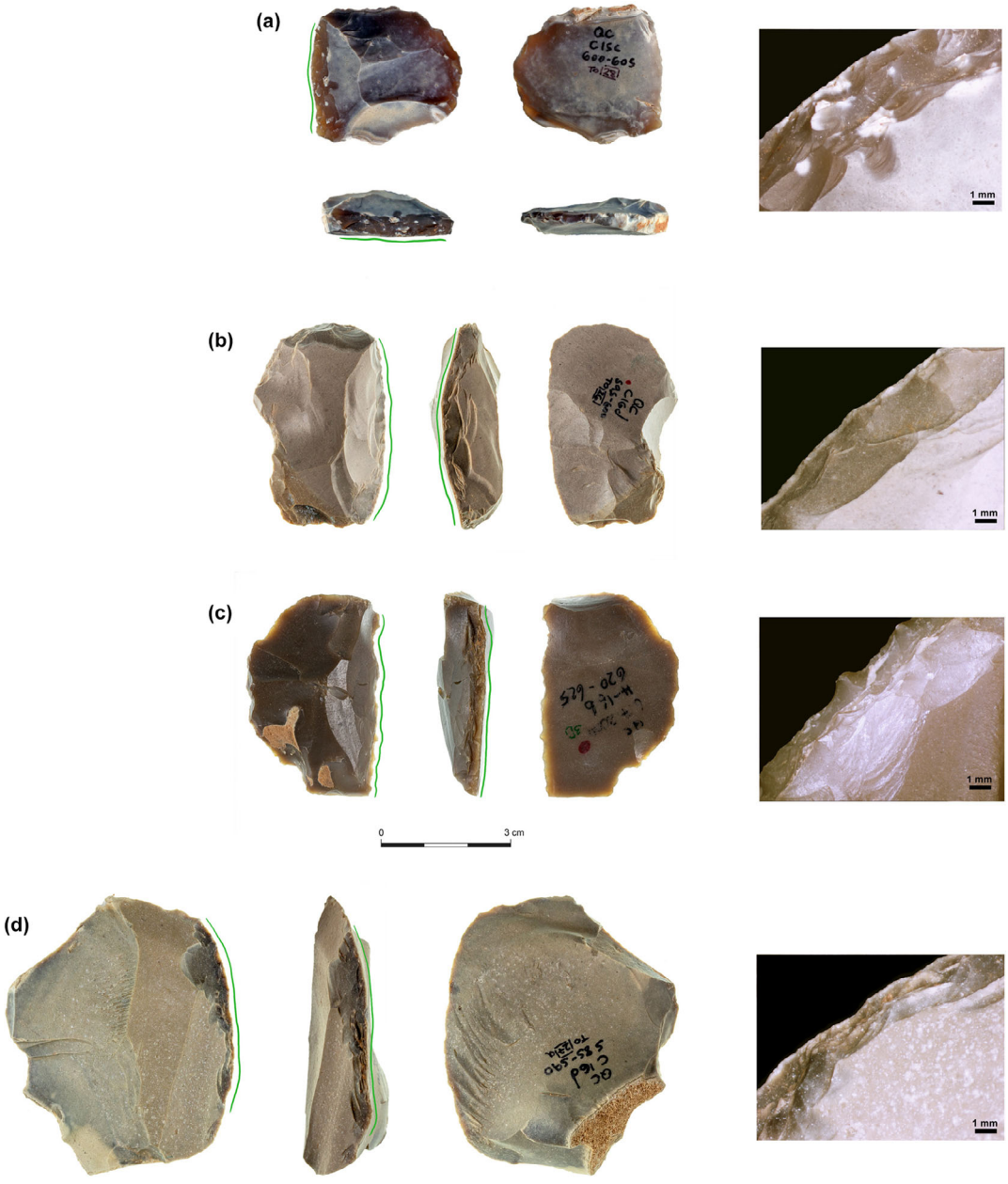

FIGURE 2
Recycled Type-B Quina and demi-Quina scrapers from Qesem Cave made on older patinated blanks (a-d). Marked in green are the locations from which a close-up (right) was taken for a better observation of the patina differences. Reproduced from Efrati and Barkai (2024).

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QUINA AND DEMI-QUINA SCRAPERS

Before delving deeper into the discussion of recycled patinated scrapers at Qesem, specifically those recycled from older scrapers, it is useful to provide some background on Quina and demi-Quina scrapers during Lower Palaeolithic times, and during the AYCC specifically.

Scrapers, defined by a continuous and durable working edge created by abrupt to semi-abrupt retouch (Bordes 1961a), are among the most common tools in the Palaeolithic Old World and were used to process both animal and vegetal materials (Carpentieri *et al*. 2023; Hardy 2004). In the Late Lower Palaeolithic Levant, this tool type was transformed by the innovation of Quina and demi-Quina scrapers. The shift in technical and technological bases is notable mainly in AYCC contexts (420–200 kyr); however, their appearance in Levantine Late-Acheulian contexts *c*.500 kyr is also evident (Litov *et al*. 2025). In Europe, the Quina technology appeared later, in Middle Palaeolithic contexts, and is associated with some cultural complexes of the Mousterian (Bordes 1961a; Bourguignon 1997).

The defining characteristic of these innovative tools is their scalar-stepped retouch (Quina retouch), which creates a working edge with an angle varying from acute to 90°, but that is nonetheless exceptionally durable and sharp (Bordes 1961b; Bourguignon 1997; Hiscock *et al*. 2009; Lemorini *et al*. 2016). Quina technology has been defined as a ramified production system, wherein multiple core reduction strategies (often termed *clactonian*) achieved the same final product (Bourguignon *et al*. 2004; Zupancich 2019): that is, large and thick blanks that are often asymmetrical in cross-section and retaining cortex (Turq 1985; 2000; Bourguignon 1997; Hiscock and Clarkson 2015; Lemorini *et al*. 2016; Zupancich 2019). The emergence of this AYCC innovation may be linked to shifting subsistence patterns, particularly that to processing medium-sized ungulates (Finkel and Barkai 2021; Dembitzer *et al*. 2022).

Beyond their functional role in daily tasks such as butchery and hide processing, these scrapers are suggested to have held cultural significance and 'potency' for early humans (Agam and Zupancich 2020; Litov and Barkai 2024a). Potency may refer to the capacity of objects to be imbued with vital significance and agency (Litov and Barkai 2024b), extending beyond their practical utility to connect individuals with ontological and cultural worldviews, and mnemonic relationships to their environment and ancestral past (Efrati 2021).

In the specific case of recycled patinated Quina scrapers, it is suggested that the recycling process was used as a preservation method that is 'readymade-like' in technique, in the sense that it relies on the selection of a near-complete or a pre-existing form which was then modified in a minimal manner. This practice is suggested to imbue the tools with mnemonic and ontological value, connecting users to past others, familiar landscapes, and the essence of their prey (Efrati 2024; for similar archaeological cases that suggest encounters with the deep-past see Pope and Roberts 2005; Whyte 2014; Foley and Lahr 2015; Brumm *et al.* 2019; Ota *et al.* 2020). The localized presence of these specialized scrapers during the Levantine AYCC, followed by their subsequent disappearance in the region during the Mousterian techno-complex, underscores their profound resonance for the populations of this specific time and place. Moreover, these tools occupy a significant position in the daily economy of the AYCC while appearing to reflect cognitive and cultural sensibilities. Thus, investigating them through the lens of material engagement holds the potential to contribute to the broader discourse on the evolution of human perception, consciousness and worldviews.

While Levantine AYCC scraper production is less explored than that of the European Mousterian, studies show that both share nearly identical techno-morphological features

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(Bourguignon 1997; Shimelmitz *et al*. 2014; Zupancich 2019; Franklin and Kuhn 2021). A key similarity is the low degree of pre-shaping of the blank, with more effort invested in edge retouching to achieve the final tool form (Meignen *et al*. 2009; Shimelmitz *et al*. 2014; Zupancich 2019). Moreover, predetermination and retouch intensity seem to have been involved in blank production and retouching respectively (Shimelmitz *et al*. 2014; Lemorini *et al*. 2016; Zupancich *et al*. 2016; Zupancich 2019; Agam and Zupancich 2020). This specific combination engages with a long-standing debate in Palaeolithic typology concerning both the interpretation of Bordes' morphological types, often argued to represent mental templates, and reduction models such as Harold Dibble's (1987; 1995), which views Bordes' types as arbitrary stages in a continuous life cycle of resharpening. In contrast, later studies emphasize a more middle-ground model, where reduction and blank morphology are both of importance (Shimelmitz *et al*. 2014; Hiscock and Clarkson 2015).

In the context of Qesem Cave, the data so far supports a middle-ground model informed by a techno-functional approach (Lemorini *et al*. 2016; Zupancich 2019), which suggests that the overall morphology of Quina scrapers is not an outcome of exhaustion alone, but rather represents a deliberate functional strategy. Knappers are assumed to intentionally create or select blanks to support the steep, scalar retouch required for heavy-duty tasks, thereby maintaining the tool's functional efficacy throughout its reduction sequence (Lemorini *et al*. 2016). In such cases, the final morphology of the scraper is heavily constrained by the original material's affordances, thus the retouching and blank morphology components are in constant interaction because of the scraper's shape.

However, tracing this specific production trajectory on-site is challenging. At Qesem Cave, scrapers appear in large numbers (especially in Yabrudian contexts), yet their production sequence cannot be fully reconstructed on-site, as characteristic Quina cores and débitage are absent. Indeed, spalls associated with Quina scrapers are found in significantly smaller numbers than the scrapers themselves, and are often attributed to minor edge maintenance rather than extensive maintenance or typological transformation. Thus, the Quina technological trajectory at Qesem can only be assumed, based on the finished products found at the site coupled with other technological studies conducted on the subject (Bourguignon 1997; Hiscock *et al*. 2009; Shimelmitz *et al*. 2014; Lemorini *et al*. 2016; Zupancich *et al*. 2016; Zupancich 2019; Franklin and Kuhn 2021).

Lemorini *et al*. (2016) and Zupancich (2019) show that Quina and demi-Quina retouching at Qesem was not limited to Quina blank production methods, but was also applied to blanks from various production trajectories. Crucially, in cases where scrapers were made on Quina blanks, it is suggested that ready flake blanks or finished scrapers were imported to the site rather than made on-site, often using high-quality, non-local flint procured from distant sources (Agam and Zupancich 2020).

COLLECTING AND RECYCLING OLD SCRAPERS INTO NEW SCRAPERS

Within the technological landscape of Qesem Cave, where Quina scrapers held functional and cultural value, the specific practice of recycling older versions of these tools into new scrapers provides a powerful lens for examining human decision-making as well as for investigating the biography of the technology. This section analyzes a sample of 18 Type-B recycled scrapers to explore the relationship between the new, post-patination modifications and the pre-existing features of the original blanks. The investigation expands upon previous suggestions that this recycling

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reflects a conscious choice based on the old item's form and features (Efrati 2021; Efrati and Barkai 2024), exploring its implications for our understanding of material selection, cognition and hominin behaviour.

Building upon this understanding of deliberate tool selection, it is worth noting that the concept of blank preference and the exploitation of existing physical features is a recognized feature of the AYCC Quina technology in general (Shimelmitz *et al*. 2014; Franklin and Kuhn 2021). This broader context provides good grounds for suggesting that a similar preference for pre-existing shapes and forms guided the selection of old items for recycling, a possibility that was also raised in studies of scraper production at Qesem (Lemorini *et al*. 2016).

Standardized technological trajectories, like that of Quina scrapers, are therefore ideal for examining such planned selectivity. This is especially true for this study's sample, where one standardized tool (an old Quina scraper) was transformed into another of the same type. This specific situation provides a uniquely controlled opportunity to analyze the criteria that guided the selection and transformation of these items.

MATERIALS AND METHODS

The analysis presented in this paper builds upon a multi-stage process, as carried out and published in past studies. Work forming the underpinning for the present study had established the initial techno-typological classifications for the Qesem assemblages as part of the general site analysis. Following this, a broader study of recycling at the site documented the patina differences across the assemblage, allowing for the identification of the specific sample of recycled scrapers. The present study focuses exclusively on the final stage of this process: a new, detailed technological analysis of the relationship between the old, patinated blanks and their subsequent modifications.

STAGE 1: INITIAL TYPO-TECHNO-FUNCTIONAL ANALYSES. Following the established framework for Qesem assemblages (e.g. Barkai *et al*. 2005; Gopher *et al*. 2005), items were identified as scrapers based on the presence of continuous retouch on at least one edge (Debénath and Dibble 1994, 70); some of these artefacts were initially published in other works (Lev 2010; Parush *et al*. 2015; 2016). To distinguish them from scrapers, items with a retouched edge opposite a sharp lateral edge were classified as 'backed knives', due to the high probability that the retouched edge was used for gripping or hafting (a hypothesis supported by use-wear and residue-analysis; Zupancich *et al*. 2016). The scrapers were then classified into types following Bordes (1955), Bourguignon (2001) and Hiscock *et al*. (2009), and initially published as part of other studies (Lev 2010; Lemorini *et al*. 2016; Zupancich *et al*. 2016; Zupancich 2019).

STAGE 2: DOCUMENTATION OF OLDER, PATINATED SURFACES AND POST-PATINATION RECYCLING. The sample of recycled patinated scrapers had been identified, separated and quantified in previous studies aimed at determining the extent of recycled old patinated tools at Qesem Cave (Efrati *et al*. 2019; Efrati and Barkai 2024). This identification process relied solely on visual inspection, without the use of microscopy. Scrapers were classified and counted as recycled from old patinated items if they exhibited patinated flaked surfaces, as well as later scars that cut through them. These later scars either revealed the fresh colour of the flint or were covered with a later and distinct patina. The methodology generally followed that of previous research (Belfer-Cohen and Bar-Yosef 2015) and Goodwin's definition of *double patina* – namely items 'that

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have been modified again, thus leaving newer scars in unpatinated, or less patinated, condition' (Goodwin 1960, 68).

In the case of the current analysed sample, where most patinated old items preserve their typo-technological identity post-recycling, the operational distinction between recycling and reuse hinges strictly on the physical evidence of a discard state. While reuse or maintenance implies a continuous or near-continuous life-history within a single systemic context, the presence of a double patina indicates that the object had entered the archaeological record and experienced a temporal gap, before being reclaimed. Therefore, even when an item was modified into the exact same tool type (as here, where an old scraper was modified into a new scraper), this intervening period of discard and weathering justifies its methodological classification as recycling, marking thereby a distinct, new cycle of production rather than one of continuous reuse.

STAGE 3: TECHNOLOGICAL ANALYSIS OF BLANKS. For this study, the patinated blanks of the current scrapers were re-examined, focusing on their original shape, the nature of the old retouch, and the relationship between the old and new modifications. The purpose was twofold: first, to describe the technological characteristics of the old blank as an individual scraper; second, to assess the evidence for intentional blank selection by evaluating the technological description of the item's phases and links between them (i.e. between the old blank and new retouch). Evaluation was made according to prior examinations of Quina blank preferences at Qesem (e.g. Lev 2010; Lemorini *et al*. 2016; Zupancich 2019), alongside detailed investigations into the Levantine AYCC Quina technological sequence, blank morphology and use-life as seen in Tabun Cave, Israel (e.g. Shimelmitz *et al*. 2014; Franklin and Kuhn 2021).

Where original edges were extensively modified or removed during the recycling process, classifications were based on remnant morphology. This refers to the assessment of the surviving 'material package', specifically the relationship between the blank's overall outline, traces of old retouch, dorsal scar patterns, thickness, and retouch scars. These features often seem to remain intact in Type-B recycling trajectories because this method typically involves minimal intervention. Hence, the preserved geometry of the blank serves as a consistent and material-based proxy for identifying the original tool's outline.

This study has two main limitations: first, the small sample size, which precludes the comprehensive statistical analysis and inter- and intra-site comparisons needed to better understand the Quina technology at Qesem and in the Southern Levant; second, the known variability of blank production trajectories at Qesem, where not all Quina scrapers result from a typical Quina *chaîne opératoire* (Turq 1985; 2000; Bourguignon 1997; Hiscock and Clarkson 2015; Lemorini *et al*. 2016; Zupancich 2019).

Despite these limitations, a detailed technological description of this sample is valuable. Given that a notable portion of the Qesem assemblage is made on collected old items (of which 22% are ones used as blanks for making scrapers using minimal shaping, i.e. by the Type-B method; Efrati and Barkai 2024), this analysis offers an opportunity to gain insights about behaviour for Quina blank selection across multiple life cycles. To this end, the following descriptive and metric attributes were collected: (1) techno-morpho-functional grouping (Groups I-V; Bourguignon 1997; Lemorini *et al*. 2016; Zupancich 2019) based on old and new features; (2) dorsal scar orientation and presence of cortex; (3) plane of the ventral face; (4) presence of clactonian notches; and (5) type and orientation of old and new retouch (Shimelmitz *et al*. 2014; Franklin and Kuhn 2021).

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RESULTS

The sample of 18 artefacts is composed of 16 scrapers recycled from older scrapers and two scrapers made on old scraper spalls. This section will first focus on the 16 scrapers to detail the modification patterns. The two spalls, which offer important broader technological biographical insights into old patinated blank selection for scraper-making, will be discussed separately.

Active edge and retouch description

Of the 16 items recycled from old scrapers, 14 were originally Quina (n=9) or demi-Quina (n=5) types. The remaining two old blanks displayed non-scaled, abrupt to semi-abrupt retouched edges (see Table S1 in Supplementary Information).

Of the 16 recycled scrapers, most old patinated scrapers (now blanks; n=11) displayed a single retouched edge. The five remaining old scrapers retain two active edges from their earlier use. Modifications performed during recycling show three distinct strategies: (1) shaping a new active edge: five scrapers that originally had a single edge were modified by creating a second active edge which transformed their Bordes-type classification into convergent, double or alternate scrapers (Fig. 3); (2) refining an existing edge: three scrapers retained their single-edge form, but the original working edge was partially refined with new retouch (Fig. 4a); and (3) replacing an existing edge: the remaining three single-edged scrapers had their original working edge entirely reworked to create a new one, thus preserving their overall form (Fig. 4b).

It is notable that in every instance where two old edges were present, the subsequent retouching was applied to one of these existing edges, either selectively along their lengths or by completely reworking one or both, leaving few clues on the presence of the previous retouch. Scraper #126 (Fig. 5) presents an intriguing case within this pattern. While the extensive removal of the original retouch during recycling makes the original status of its old edges uncertain, it is suggested that this tool initially possessed two active edges based on the laterally offset, déjeté form that the recycled scraper possesses, which seems to have been maintained from the item's original form. This morphological interpretation is supported by the preservation of the specific asymmetry and lateral thickness of the blank. Following this line of thought, the déjeté shape seems to have been retained from the original form of the scraper rather than created anew to suit the new retouched edge. If the déjeté form were a new modification, one would expect to see further new scars in order to prepare the offset angle and accommodate the new retouch, thereby exposing the natural colour of the flint.

Despite the ambiguity surrounding the original edges, the déjeté shape was retained in the item's renewed use, suggesting the recycling process leveraged this pre-existing morphology rather than forming it anew.

Further illustrating the concept of prolonged tool use is scraper #162 (Fig. 6), which exhibits signs of three distinct life cycles. These are discernible through colour variations resulting from later reduction sequences in specific areas. The two old cycles are marked by two distinct patinated layers, while the third and most recent is identified by removals that reveal the flint's natural colour.

To assess morphological changes, the 16 scrapers were classified into techno-morpho-functional groups for both their original and recycled forms (Chart 1; Lemorini *et al*. 2016; Zupancich 2019). Originally, the sample was diverse: Group I comprised seven scrapers distinguished by clactonian notches, while other groups showed features like extensive

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FIGURE 3
Type-B recycled patinated scrapers made on old scrapers including close-up pictures to show old patinated retouch and new retouch (along with patina differences). a) Scraper #10 – this item started as a single edge demi-Quina scraper. The recycled new scraper features an additional Quina edge, resulting in a convergent form. b) Scraper #92 – this item started as a single edge non-Quina scraper. The recycled new scraper is a Quina scraper that features a fresh single active edge located on the opposite edge, resulting in a double form. c) Scraper #153 – this item started as a single edge Quina scraper. The recycled new scraper features a new Quina edge opposite the original edge, resulting in an alternate shape. Interestingly, the old Quina edge may have been used for gripping the recycled scraper with its new edge. Materials used with permission from R. Barkai and A. Gopher.

resharpening (*n*=2; Group II), had shorter retouch cycles (*n*=3; Group III), or were made on thinner blanks (n=2; Group V). For three scrapers, the original classification could not be determined due to the removal of the old edges. Following recycling, a noteworthy increase in Group I scrapers was revealed. This shift was often the result of conscious technical choices. For instance, on scraper #122, a new clactonian notch was added to facilitate the new retouch, while the second life-cycle of scraper #162 was also classified as Group I after new notches were created on the

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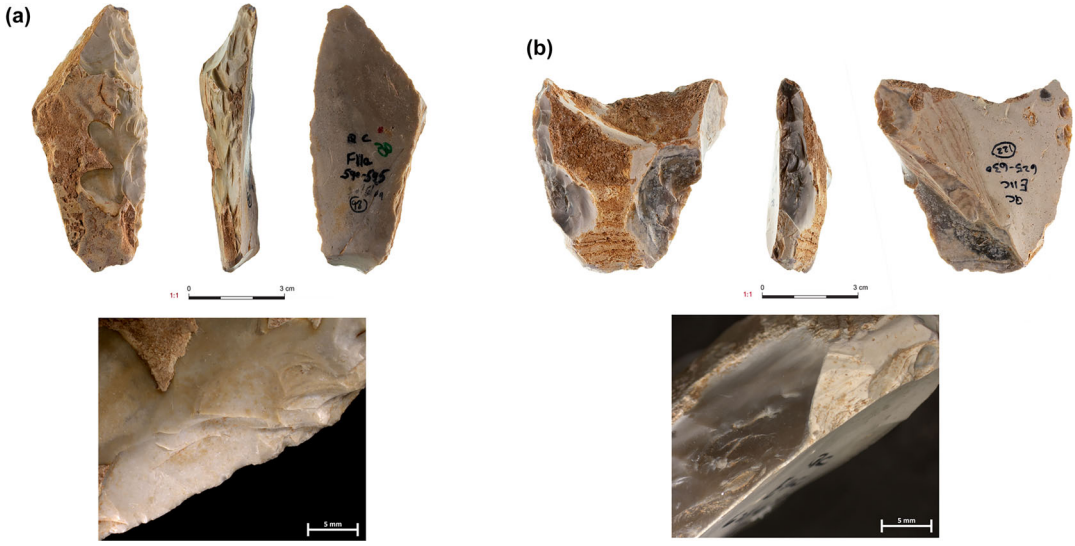

FIGURE 4
Type-B recycled patinated scrapers made on old scrapers including close-up pictures to show old patinated retouch and new retouch (along with patina differences). a) Scraper #98 – this item started as a single edge Quina scraper. The recycled new scraper retains the original scraper's shape and features a fresh Quina retouch where the old edge was located. b) Scraper #122 – this item started as a single edge Quina scraper. The recycled new scraper retains the original scraper's shape and features a new Quina edge that largely overrides the old edge. Materials used with permission from R. Barkai and A. Gopher.

patinated blank (Figs. 4b, 6). Other shifts between other groups were also observed, suggesting the recycling process could alter a tool's functional classification in response to evolving needs. However, the small sample size of this study precludes definitive conclusions about the specific impulses behind these transformations. A larger-scale investigation is necessary to fully understand these dynamic changes.

Blank description

An examination of the blanks themselves (i.e. old scrapers) reveals that they were typically collected in a complete state (*n*=14). The remaining two were fragments collected after breaking and patination (Fig. 7). The old blanks generally retained their bulb of percussion and original cortex, with varied dorsal scar patterns. When absent, the bulb's removal appears to be the result of later modifications (either pre- or post-patination and recycling, as shown in Figs. 3a, 4b) or further blank preparation before retouching (for instance, see Fig. 3c). Crucially, these pre-existing features were not incidental, but appear to have been central to the selection and recycling process.

Most old scrapers (*n*=9) had a straight ventral surface, while four exhibited a convex and three a concave ventral platform. The orientation of dorsal scars varied. Many old scrapers retained a natural surface (e.g. cortex or unmodified patinated surface; *n*=5), while others showed a convergent symmetrical (*n*=4), multidirectional (n=3) or plain dorsal face. These plain dorsal faces

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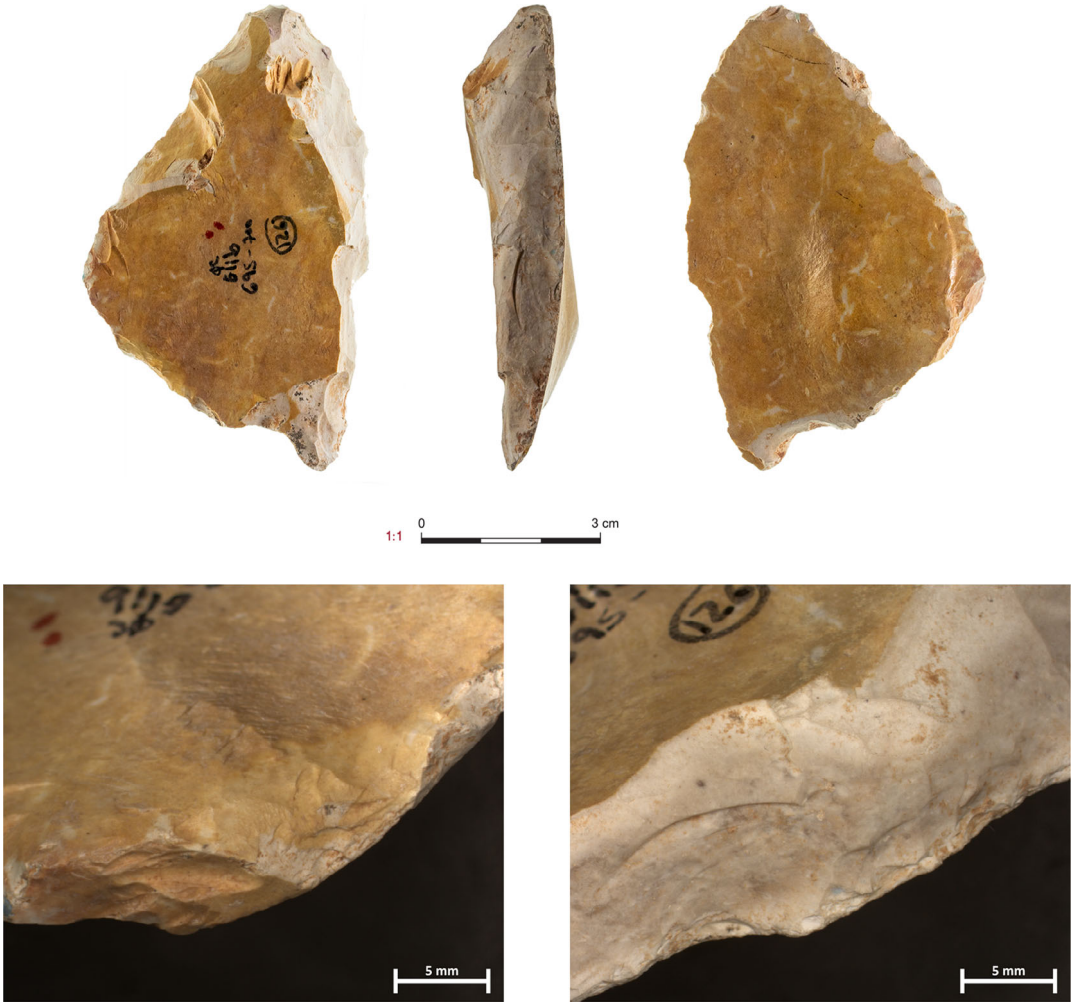

FIGURE 5

Scraper #126. Type-B recycled patinated scraper made on old scraper, including close-up pictures to show old patinated retouch and new retouch (along with patina differences; bottom). This item started as a demi-Quina scraper; however, the original retouch is largely absent due to the modifications made during recycling. As a result, the scraper's original form and the number of active edges are difficult to identify with certainty. Nevertheless, its outline suggests that it may have originally had a déjeté form, which typically features two edges. In its new use phase, the item exhibits a déjeté form with new Quina retouch applied to one edge. Materials used with permission from R. Barkai and A. Gopher.

were often parallel to the new retouched edge (n=3). Notably, scrapers #126 and #162 (Figs. 5–6) clearly show that their convergent symmetrical dorsal scar orientation originated during their initial production and use. In the case of scraper #162, its original form was already somewhat prepared for the addition of a second active edge. Thus, the shape and scar orientation of scraper #162 that existed after its two earlier phases seem to have facilitated the formation of the latest active edge, as the new modification largely preserves a portion of the old active edge.

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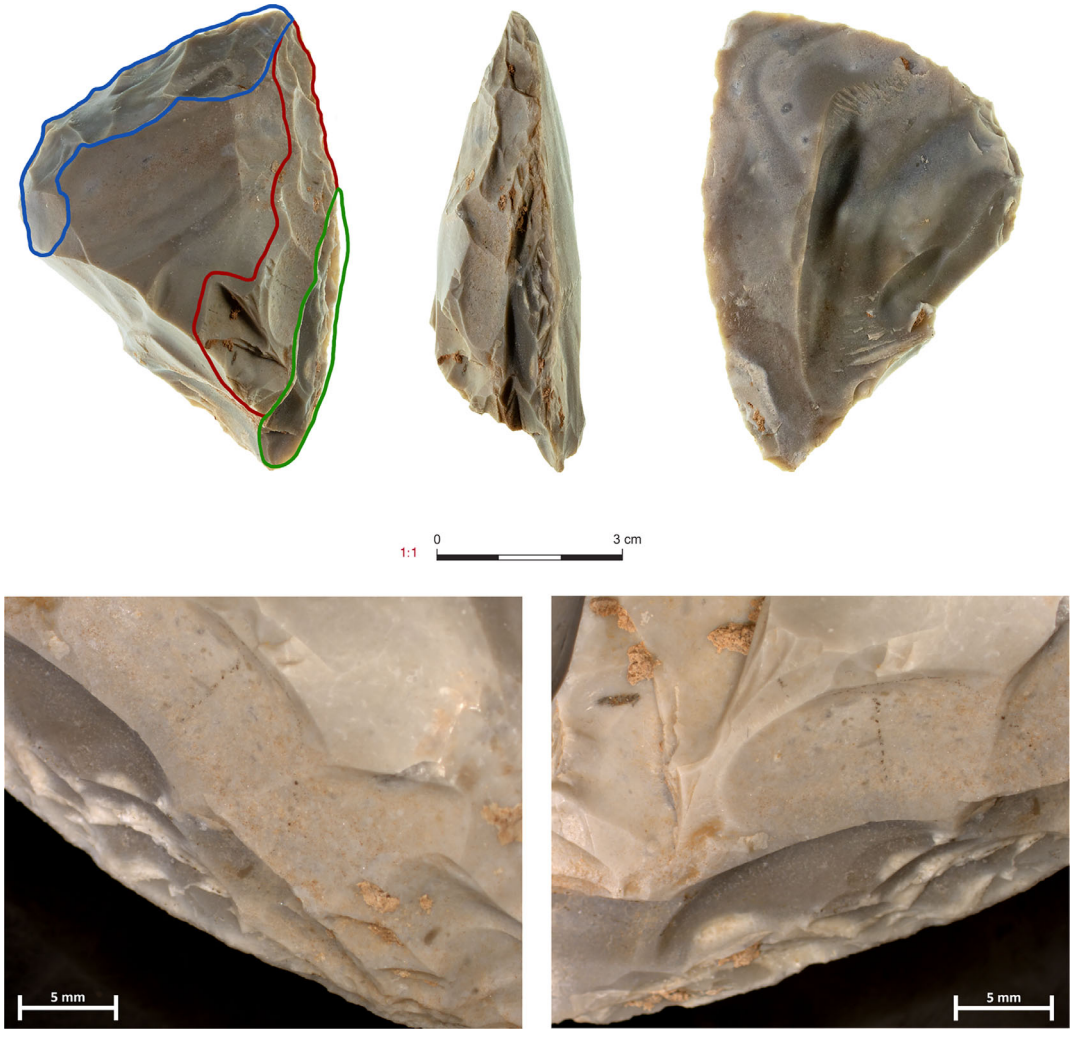

FIGURE 6

Scraper #162. Type-B recycled patinated scraper made on old scraper, including close-up pictures to show old patinated retouch and new retouch (along with patina differences; bottom). This scraper has three distinct life cycles. Initially, it started as a transverse scraper featuring one Quina edge (red). In its second phase, a new Quina edge was added, transforming the scraper into a déjeté (blue). The third and latest phase involved the addition of another Quina retouch, which overlaps the original edge while maintaining its déjeté shape (green). Materials used with permission from R. Barkai and A. Gopher.

Clactonian notches (old and new) were present on nine of the scrapers, with some notches preserved from the original tool and others added during recycling. In some cases, pre-existing notches appear to have been utilized for the new retouch. Other cases even demonstrate how the old, retouched edge served as a functional notch for the new edge. Scraper #153 is one notable example (Fig. 3c), exhibiting both dorsal and ventral clactonian notches after recycling. This scraper was classified as an alternate scraper post-recycling because the new Quina edge was created

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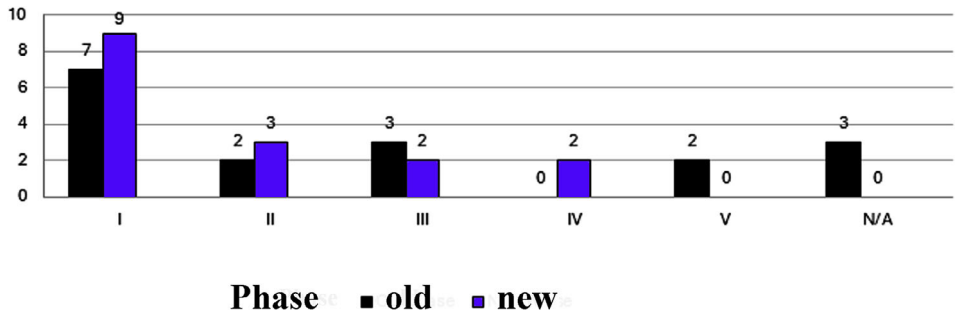

CHART 1
Showcasing the variation in techno-morpho-functional grouping (I-V) of the sample of scrapers made from old scrapers, based on their initial use phase (black) and new use phase (blue)

parallel to the original one, but on the opposing face. Following this modification, new dorsal clactonian notches were formed, likely aiding the new retouch. Additionally, it is proposed that the pre-existing Quina retouch on the opposite face served as ventral clactonian notches, enhancing one's grip when using the new edge.

Five recycled scrapers with dorsal notches exhibit old notches from their earlier use phase (see Figs. 4b, 6, 8). In each case, the new retouch partially or completely covers the older edge, yet the pre-existing notches appear compatible with both the old and new modifications. This suggests that not only the notches, but also the configuration of the original retouched edge itself, were suitable for guiding the subsequent recycling. This novel correlation between old notches and subsequent retouch has two significant implications for lithic analysis. First, it serves as a tangible indicator during analysis by which to identify prior Quina technology modifications and to assess their relationship to later Quina modification. Second, it represents an ancient marker of human, specifically Quina-related, alterations, involving a surface evaluation in preparing the new edge and representing the persistence of the technology and the individual scraper through recycling and continued use. This emphasizes the material and technical biography of the object, paving the way for investigating theoretical interpretations.

To better understand the variability or uniformity in the scraper's dimensions, a general dimensional comparison was made between the 16 recycled scrapers and a larger sample of 207 scrapers from the site analyzed by Zupancich (2019; Chart 2). While a critical factor in interpreting these comparisons is the difference in sample size, the recycled scraper sample demonstrates a higher internal consistency, with narrow interquartile ranges and few outliers for length, width, and thickness. While the median dimensions of both samples overlap, the striking homogeneity of the recycled sample suggests a highly consistent selection process for blanks chosen for their desired size and shape.

Old scraper spalls

The two recycled items made on old scraper spalls provide further insight. Though not traditional scrapers themselves, these spalls were selected and modified with new Quina retouched edges (Figs. 9–10). A metric comparison shows that both spalls fall squarely within the dimensional range of the main sample of 16 recycled scrapers, closely matching the median length, width, and

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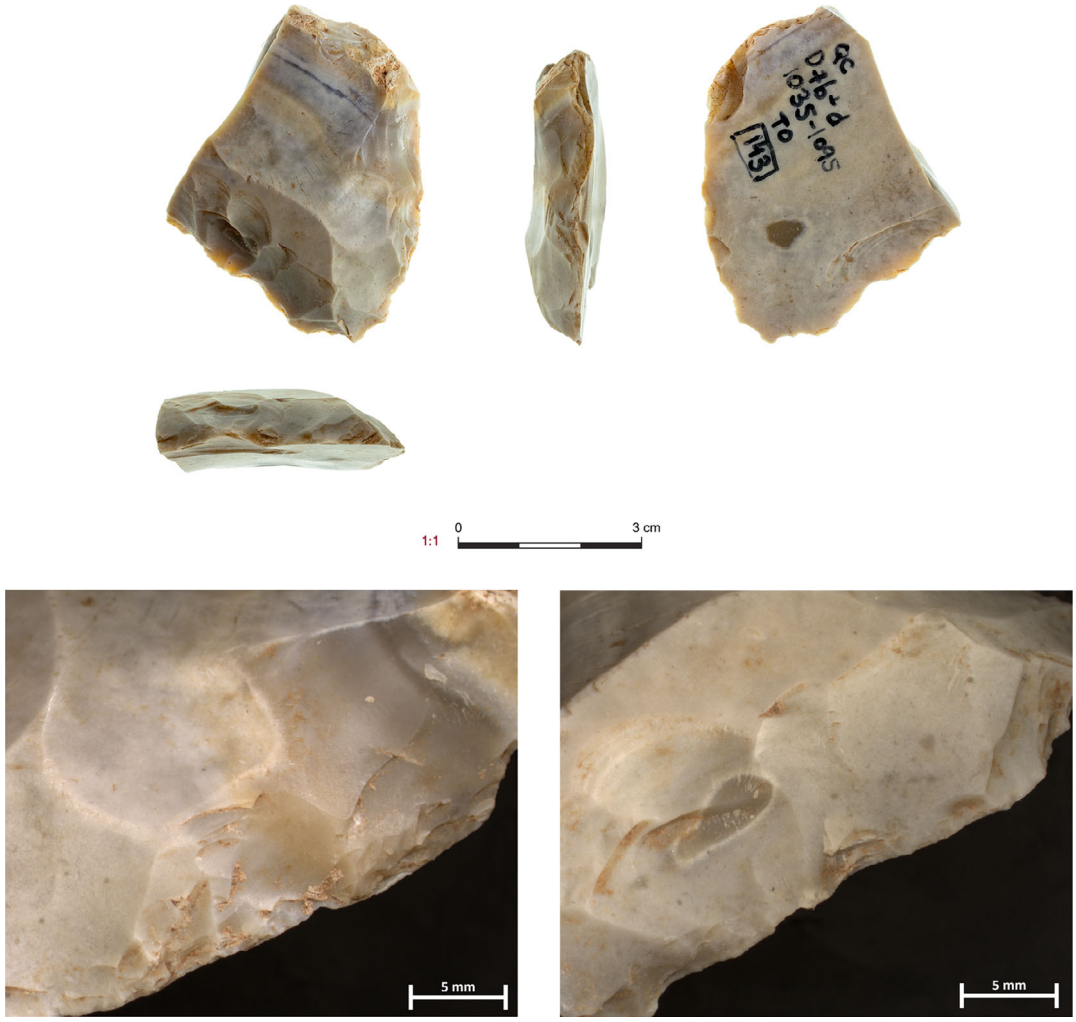

FIGURE 7
Scraper #143. Type-B recycled patinated scraper made on old scraper, including close-up pictures to show old patinated retouch and new retouch (along with patina differences; bottom). This item started as a fragment of a Quina scraper, featuring two active edges and a convergent form. The recycled new scraper retains the original convergent shape and features one fresh demi-Quina retouch located on one of the old edges. The breakage surface is patinated, suggesting that the item was collected as a fragment. Materials used with permission from R. Barkai and A. Gopher.

thickness (Chart 3). This indicates that even when the original item was not a formal tool, blanks were selected based on their adherence to a consistent dimensional template.

When assessed as new scrapers, both display a new demi-Quina retouch and have been assigned to Group V. Scraper #136 features two new demi-Quina edges that converge at an angle, transforming the old spall into a déjeté scraper (Fig. 10). It is suggested that some old scars visible on the dorsal face, now covered in patina (with remnants observable near the new retouch), may

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FIGURE 8
Scraper #26. Type-B recycled patinated scraper made on old scraper, including a close-up picture to show old patinated retouch and new retouch (along with patina differences; bottom). This item started as a Quina scraper featuring two edges and a convergent form. The recycled new scraper retains the original convergent form and features two fresh Quina edges where the old edges were located. Materials used with permission from R. Barkai and A. Gopher.

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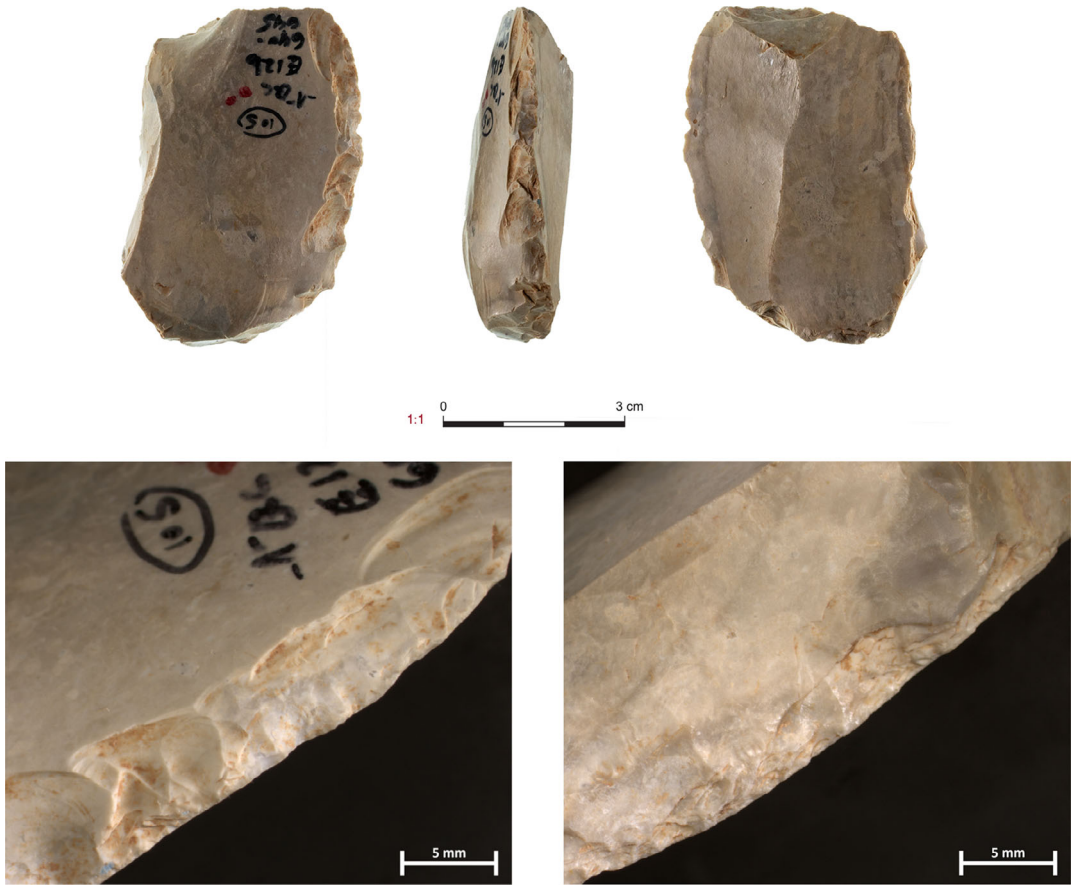

FIGURE 9
Scraper #105. Type-B recycled patinated scraper made on old scraper spall, including close-up pictures to show old patinated retouch and new retouch (along with patina differences; bottom). The recycled new scraper retains the spall's original shape and features a fresh single demi-Quina edge. Materials used with permission from R. Barkai and A. Gopher.

have served a similar purpose to dorsal clactonian notches in facilitating the new retouch (Fig. 11). Similarly, the old and patinated dorsal scar pattern resembles a convergent symmetrical orientation relative to the new retouch. It is, therefore, suggested that these features may also have aided in applying the new edges.

DISCUSSION

The analysis of 18 Type-B recycled scrapers made on older scrapers at Qesem Cave allows for a close observation of Late Lower Palaeolithic decision-making. The results support previous suggestions that recycling was an attentional, intentional and informed process, not merely opportunistic exploitation. Furthermore, the findings align with the concept of early prehistoric

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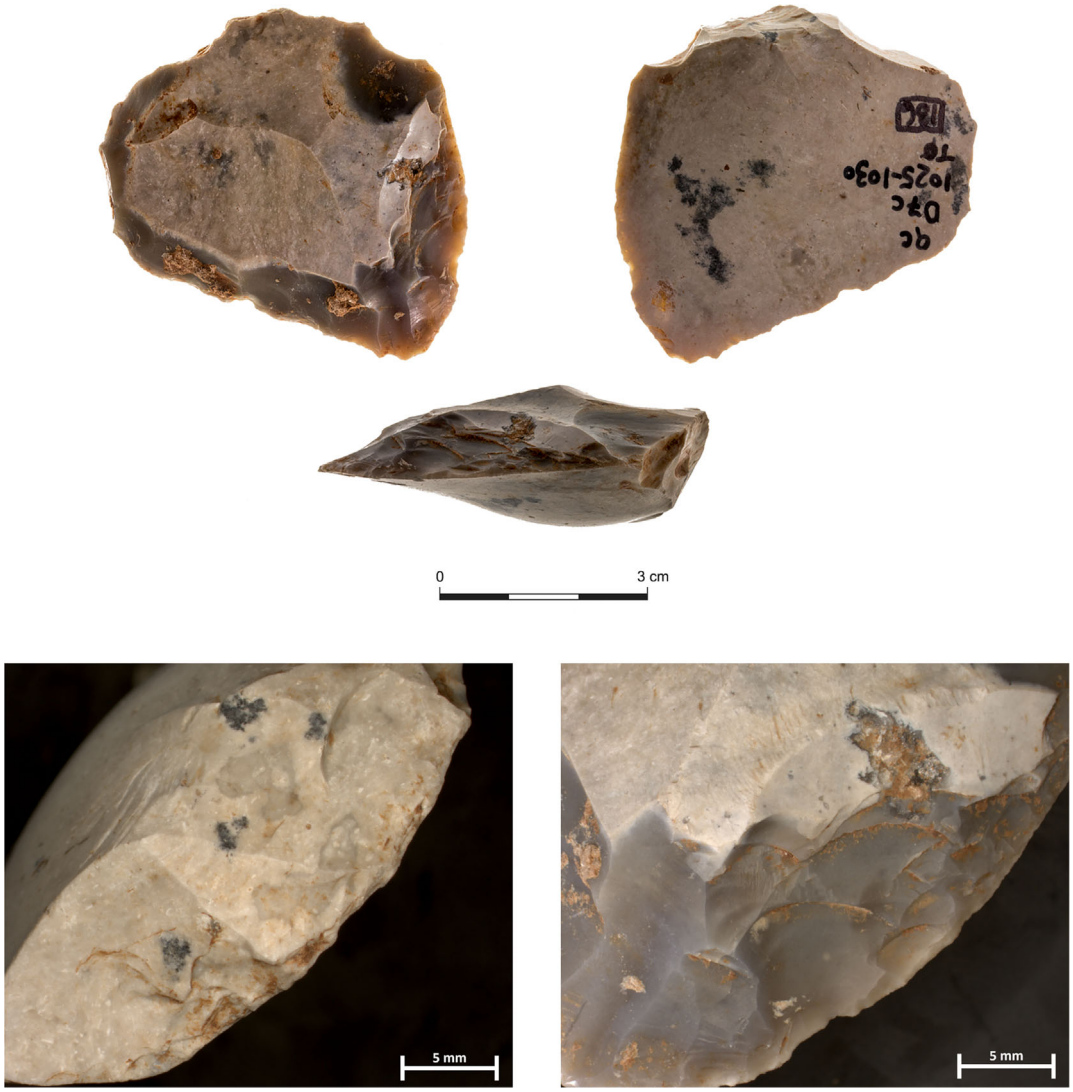

FIGURE 10

Scraper #136. Type-B recycled patinated scraper made on old scraper spall, including close-up pictures to show old patinated retouch and new retouch (along with patina differences; bottom). The item exhibits remnants of the old Quina edge at the item's base. The recycled new scraper features a déjeté form, a result of retaining the original spall's shape, with the addition of two new demi-Quina edges. Materials used with Permission from R. Barkai and A. Gopher.

people actively engaging with their own archaeological traces, demonstrating a form of awareness of the past (Pope and Roberts 2005; Whyte 2014). As highlighted, the modification of these scrapers into the exact same tool type is classified as recycling due to the intervening discard state. By defining this specific practice as recycling rather than reuse, I emphasize the transformation of the object's ontological status. The double patina serves as a diagnostic temporal bridge between two

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FIGURE 11
Old patinated scar pattern (left) and a close-up on the old retouch signs (right) on scraper #136. Materials used with permission from R. Barkai and A. Gopher.

distinct lives. This represents a deliberate, historically-aware act of same-type recycling, where the knapper engages with an object from the past rather than simply maintaining a current tool.

In suggesting that the practice is intentional, I do not mean to imply that collection was necessarily pre-conceived or pre-planned. I accept the possibility that initial discovery and collection occurred fortuitously for any number of reasons. Rather, this paper argues for intentionality in the sense of repeated, considered selection when an old item is found, regardless of whether the collection of any specific item was pre-planned. The following discussion will focus on the evidence for this intentional selection based on pre-existing forms and features.

Regarding the provenance of these items, collection practices varied in the region during the Late Lower Palaeolithic Period (Efrati and Barkai 2024), and throughout the Palaeolithic Period (Belfer-Cohen and Bar-Yosef 2015). In the case of the old patinated Quina scrapers of the current sample, collection from older contexts within the cave is a possible scenario, particularly since there seem to be no additional AYCC sites in the vicinity of Qesem. Nevertheless, I suggest that these specific old and patinated Quina scrapers were collected from outside and brought into the cave. This interpretation relies primarily on the following observations: the types of patina are diverse rather than uniform, as indicated in the varying colours and textures, and are also different from the characteristic patina created in the site (Lemorini *et al.* 2015).

Intentional selection: the importance of form and pre-existing features

The data strongly suggest then that patinated items were intentionally selected for their suitability as blanks, based primarily on their form and pre-existing features. The most persuasive evidence is size-related. The 16 recycled scrapers form a homogeneous group, exhibiting significantly higher than expected internal consistency in length, width, and thickness. While the smaller sample size of the recycled group warrants caution against broad generalizations, this uniformity suggests a consistent profile was sought during the selection of old blanks.

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This trend is further supported by the two recycled scraper spalls, which, despite not being formal tools, fit the same dimensional profile as the scrapers. Although these were products of either scraper use or maintenance worked into new tools, they metrically align closely to the median values of the 16 recycled scrapers made on old scrapers (Chart 3). This suggests that even in cases where the old item was not a scraper, its spatial dimensions were viewed as compatible with the making of a new scraper that pertained to a definable template.

This ability to recognize potential in varied pre-shaped forms as they are encountered likely enhances the enactive character of perceptual experience. Skilled assessment and selection of natural stones based on natural physical properties alone is often observed in non-human primates as well (e.g. Visalberghi *et al*. 2009). However, the skilled selection observed here targets anthropogenic affordances in addition to natural features: specifically, the techno-morphological traits left by previous makers. I suggest that this skilled differentiation reflects a state of technological perceptual awareness. That is, a sensitivity to material possibilities acquired through repeated dynamic engagements with the lithic world through manufacturing and use (or 'know-how') (Efrati 2024; Ingold 2013; Malafouri 2013). This point warrants further investigation with a larger sample of recycled scrapers made on non-scraper blanks, an analysis which is currently underway.

The limited degree of modification observed in many of the recycled scrapers further highlights the significance of the morphology of the original item. As shown for Type-B tools at Qesem in general, and in this sample as well, the recycling process often left the greater part of the original item's outline and patinated surfaces intact. This minimal intervention may suggest that deliberate preservation of the object's original form was desired: e.g. in the case of scraper #126 (Fig. 5). Even while one edge of scraper #126 was extensively reworked, the overall déjeté shape of the scraper was preserved, indicating that the recycling process had made use of this pre-existing morphology. In such cases, it seems that new modifications mainly involved creating a working edge or retouching an existing working edge, lightly adding to it, and may thus suggest that the original overall blank shape was already suitable for use. This careful interaction with existing forms is also suggested to indicate that the Qesem Cave inhabitants were not simply passive agents, but were actively engaging with and modifying their material world, including prior creations.

Beyond their general dimensions, specific features of the old tools were clearly recognized and utilized during the recycling process or incorporated in the recycled new tool as is. The treatment of clactonian notches is a one example. Old notches were often preserved for the new tool, and in one case a pre-existing retouched edge appears to have been repurposed to serve as ventral notches to match the old blank to the new alternate edge (Fig. 3c). This creative interrelation between old retouch or notches and subsequent retouch therefore serves as one analytical indication for identifying previous technical modifications made to an item. More than that, it also suggests an awareness of the pre-existing qualities of the item's surface and signifies the continuity of Quina-related technical understanding through the scrapers' life cycles and recycling episodes. The preservation of the temporal continuity of Quina production is particularly highlighted when the sample of 16 recycled patinated scrapers is compared with the larger sample of fresh scrapers (Chart 2).

The relation between old and new retouch also demonstrates this intentional engagement with existing features. In six scrapers retaining a single active edge, the new retouch either modified specific parts of the existing active edge (n=3; Fig. 4a) or completely replaced it (n=3; Fig. 4b). The former type, where the new retouch lightly reshaped an old active edge (see also the third life cycle of scraper #162; Fig. 6), indicates a clear engagement with, and use of, the old working edge. Similarly, in cases where a new active edge was added to create a double-edged scraper (n=5; Fig. 3), the location of the new active edge was often determined in relation to the existing one,

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indicating a consideration of the overall geometry of the blank and the functional relation between the old and new edges (Figs. 3a, 6–7). The case of scraper #162, showing three separate life cycles reflected in successive patina formation and retouch relationships (Fig. 6), provides an example of this prolonged and adaptive engagement, where traces from one life cycle clearly determined the modifications enacted in the subsequent life cycle. Such artefacts with multiple use phases of the same technological identity, though rare within the context studied here as well as in other archaeological sites, are powerful indicators of long-term material histories, technological histories and repeated human interaction with specific items (an interesting outside equivalent may be the triple-patinated handaxe from Boxgrove, as mentioned in Brumm *et al*. 2019).

These modification patterns, particularly the noted shift from single-edged to convergent forms after recycling (as demonstrated in the five recycled scrapers mentioned above) align morphologically with Dibble's reduction model (Dibble 1985; 1995) and can demonstrate how typological boundaries can become fluid under sustained modification. However, the metric data (Chart 2) shows a high degree of homogeneity in the thickness and width of the selected blanks, which suggests that this trajectory was not accidental. This fits with the idea that blanks were either intentionally produced or collected to support specific retouching intensities (Lemorini *et al*. 2016; Shimelmitz *et al*. 2014; Hiscock and Clarkson 2015). In the case of double patinated scrapers recycled from scrapers, the retrieval of old scrapers and scraper spalls (with their specific morphological ratio) after a significant temporal gap confirms the selection of a material package that is compatible with the Quina technology preferred at that later stage. Thus, while Dibble's reduction model can be morphologically observed in some cases, as new edges cut old patinated surfaces, the process was in many ways enacted through the knapper's conscious selection of an old blank and their attention to details in the recycling process that enabled that specific trajectory.

The Qesem knappers were not just selecting a blank, but a whole 'material package' of pre-existing features. Their ability to utilize the specific topography of an old tool, such as leveraging existing dorsal scar patterns to facilitate new retouch (as suggested for scraper #136; Fig. 11), points to more than just careful choice, but rather to a sophisticated and profound understanding of the lithic medium. This embodies an enacted perceptual experience, whereby the double patina serves as an attracting feature that visually proclaims the tool's reduction history and its remaining volumetric affordances. Thus, rather than imposing a fixed mental template (sensu Bordes), or solely reacting to a reduction stage (sensu Dibble), the knapper recognizes the intersection of past human action and future possibility. This exemplifies a form of enacted intentionality, where the Quina form is brought back not because of a rigid pre-conceived design, but because the knapper's skilled perception identifies that the old scraper already contains the potential to be re-actualized based on skill and memory. Ultimately, this demonstrates the existence of a well-developed technical and conceptual repertoire – an expertise in skillfully adapting existing forms to create a desired tool.

Patterns of modification and implications for lithic technology at Qesem Cave

The observed modification patterns – whether adding new active edges to alter the typological form (Fig. 3), partially reshaping, or replacing the old edge entirely (Fig. 4) – demonstrate a flexible, knowledge-based approach to recycling. Methodologically, these specific transformations may demonstrate that scraper morphologies could be highly fluid, echoing Dibble's (1995) reduction pathways. However, at Qesem Cave, continuous on-site reduction of

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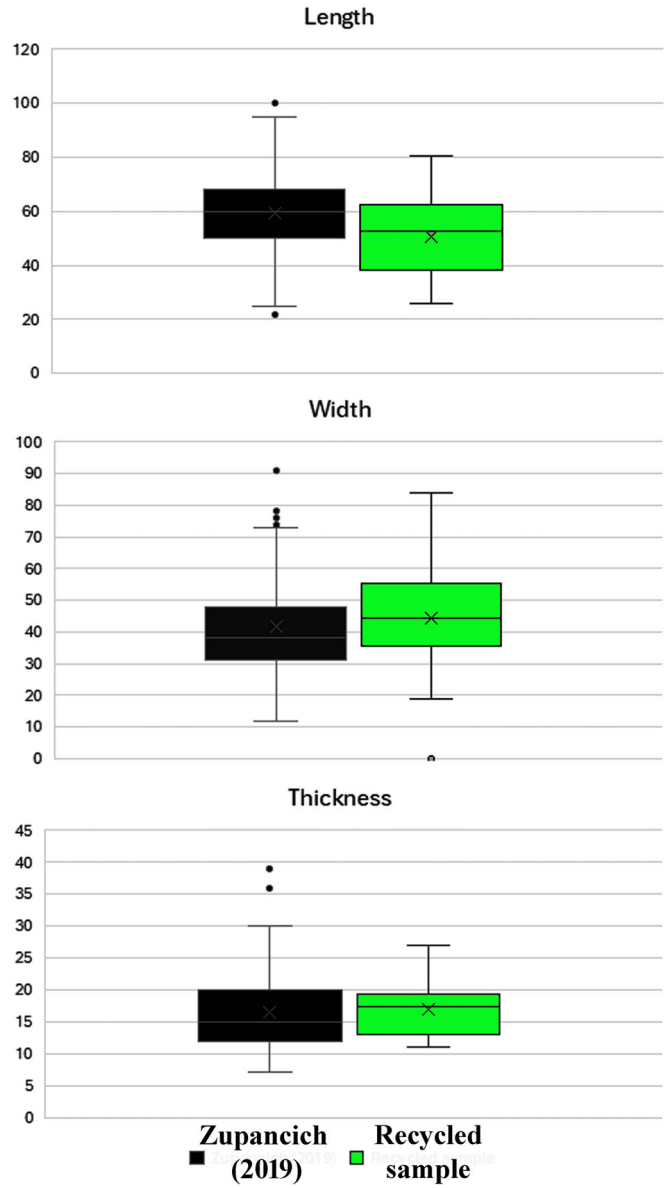

CHART 2
Dimensional comparison (Length, Width, Thickness) between Quina and demi-Quina scrapers published in Zupancich (2019) and the current sample group, using box plots

fresh scrapers appears to have been limited. The low frequency of scraper spalls relative to the abundance of scrapers suggests a technological organization where scrapers were largely imported as finished tools rather than heavily reduced on-site (Lemorini *et al*. 2016; Zupancich 2019). Consequently, the substantial morphological fluidity seen in the 16 double-patinated scrapers (made

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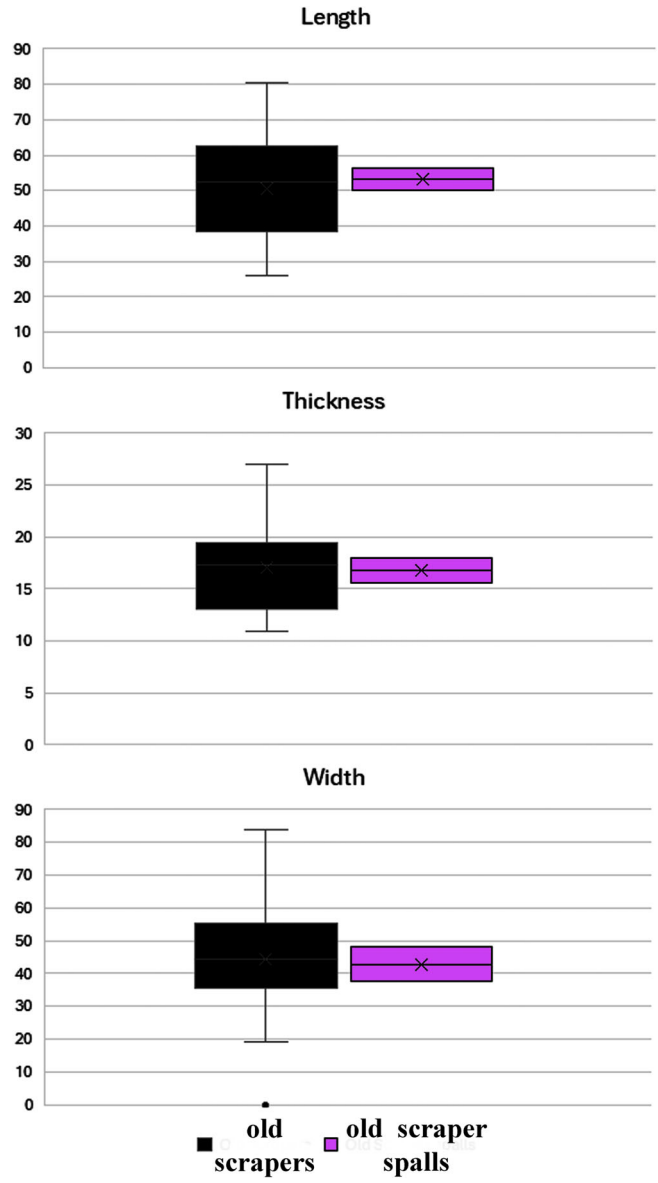

CHART 3
Dimensional comparison (Length, Width, Thickness) between the recycled scrapers made on old scrapers and the two recycled scrapers made on old scraper spalls, using box plots.

on scrapers) represents a distinct behavioural trajectory. The temporal gap revealed by the patina throughout the sample (n=18) emphasizes that this variability was not the outcome of immediate, continuous maintenance. Rather, it represents a deliberate, temporally-disrupted transformation

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where knappers actively took advantage of a discarded blank's existing affordances to fundamentally revive and adapt its form.

As mentioned, this practice of recycling scrapers is part of a broader pattern at Qesem, and the two recycled scraper spalls provide a vital link to this wider context. The fact that these non-formal spalls were selected for the same morphological reasons as the formal scrapers suggests the process was guided by more than a tight and rigidly-imposed mental template. It points instead toward an embodied cognitive process: an enacted, skilful knowledge of what constituted a viable scraper form, allowing knappers to perceive potential in varied shapes encountered in the environment.

Such knowledge is unlikely to have been in the form of a purely abstract concept but probably existed in the form of a skilled perception and attunement to the material. This kind of knowledgeable awareness would have allowed the Qesem knappers to recognize the morphological affordances for scraper-making in the old items, i.e. the compositional possibilities for transformation, irrespective of their original functional purpose. This reflects a coherent approach to recognizing useful forms and to identifying a potential for transformation, whereby the knappers' attuned interaction with the old items consistently led to the recycled new tools.

The decision to regularly seek out these affordances in a landscape rich with fresh flint confirms that this was not a practice driven by necessity. Rather, it was an embedded and skilled technological system grounded in a deep, enacted understanding of material potential and transformation. It suggests the existence of a rooted way of engaging with the material world and landscape.

CONCLUDING REMARKS: DELIBERATE CHOICES AND FUTURE PERSPECTIVES

This analysis of recycled scrapers-to-scrapers from Qesem Cave demonstrates a clear case of a form-related and historically-aware selection process by Late Lower Palaeolithic hominins. The evidence strongly supports the two main observations made before and suggested to have played a vital role in both the collection and subsequent recycling processes. First, the overall form and dimensions of old items were a primary factor in their selection as blanks. Second, pre-existing human-made features (i.e. scars and retouch) were intentionally utilized and incorporated into the new tool.

This practice was not an ad-hoc response to material scarcity, but part of an interconnected technological repertoire at Qesem, reflecting a sophisticated and versatile approach to engaging with the material available. The consistent choices observed suggest a deep understanding of material properties and the technical requirements for producing Quina scrapers. The suggestion that collection and recycling were a genuine and culturally significant practice, rather than only a functional necessity, is reinforced by the fact that it consistently appears alongside the manufacturing of new tools from abundant, fresh flint (Efrati and Barkai 2024).

These findings open avenues for future research into the wider cognitive dimensions of lithic recycling and their cultural contexts. The recognition of the potential of an *old* tool to become a *new* tool, the attention paid to its current characteristics and the performance of new modifications, however minimal, all suggest great familiarity with the material and deliberate action. This sort of enactment does not simply serve an expedient function; rather it is suggested to be a knowledgeable engagement with a material that already has its own biography formed by other humans. Such engagement with the remains of past people is considered a potential pathway to reflective

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awareness (Brumm *et al*. 2019), which further enhances the idea that this recycled practice is also imbued with cultural and social worldviews.

A crucial path for future research lies in exploring how Palaeolithic people may have perceived the affordances of pre-shaped, patinated items as compared to fresh raw material. This would require investigating the role of the wider landscape, the importance of specific places, and the preservation of environmental memory in collected items (Pope and Roberts 2005; Whyte 2014; Brumm *et al*. 2019; Litov and Barkai 2024a). Ultimately, understanding this potential shift in perception, from creating with a 'blank slate' to transforming an object with its own history, is essential for grasping the evolution of technical cognition, awareness, and the complex relationship between Palaeolithic makers and their material world.

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REFERENCES

AGAM, A. 2020: Late Lower Palaeolithic lithic procurement and exploitation strategies: a view from Acheulo-Yabrudian Qesem Cave (Israel). *Journal of Archaeological Science: Reports* 33, 102447.

AGAM, A. 2021: *Flint Procurement and Exploitation Strategies in the Late Lower Palaeolithic Levant: A View from Acheulo-Yabrudian Qesem Cave (Israel)* (Oxford).

AGAM, A., WILSON, L., GOPHER, A. and BARKAI, R. 2019: Flint type analysis of bifaces from Acheulo-Yabrudian Qesem Cave (Israel) suggests an Old Acheulian origin. *Journal of Palaeolithic Archaeology* 3, 719–54.

AGAM, A. and ZUPANCICH, A. 2020: Interpreting the Quina and demi-Quina scrapers from Acheulo-Yabrudian Qesem Cave, Israel: results of raw materials and functional analyses. *Journal of Human Evolution* 144, 102798.

AMICK, D.S. 2007: Investigating the behavioral causes and archaeological effects of lithic artifact recycling. In MCPHERRON, S.P. (ed.), *Tools versus Cores: Alternative Approaches to Stone Tool Analysis* (Newcastle), 223–52.

ASSAF, E. 2021: Throughout the generations: learning processes and knowledge transmission mechanisms as reflected in lithic assemblages of the Terminal Lower Palaeolithic Levant. *Journal of Archaeological Science: Reports* 35, 102772.

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ASSAF, E. 2024: Set in stone: human–horse relations as embodied in shaped stone balls. *Archaeologies* 20(1), 64–105.

ASSAF, E., BAENA PREYSLER, J. and BRUNER, E. 2023: Lower Palaeolithic shaped stone balls — what is next? Some cultural-cognitive questions. *Quaternary* 6(51), 1–12.

ASSAF, E., CARICOLA, I., GOPHER, A., ROSELL, J., BLASCO, R., BAR, O., ZILBERMAN, E., LEMORINI, C., BAENA, J., BARKAI, R. and CRISTIANI, E. 2020: Shaped stone balls were used for bone marrow extraction at Lower Palaeolithic Qesem Cave, Israel. *PLoS ONE* 15(4), 1–28.

BARKAI, R. 2021: The elephant in the handaxe: Lower Palaeolithic ontologies and representations. *Cambridge Archaeological Journal* 31(2), 349–61.

BARKAI, R., GOPHER, A. and SHIMELMITZ, R. 2005: Middle Pleistocene blade production in the Levant: an Amudian assemblage from Qesem Cave, Israel. *Eurasian Prehistory* 3(2), 39–74.

BARKAI, R., LEMORINI, C., SHIMELMITZ, R., LEV, Z., STINER, M.C. and GOPHER, A. 2009: A blade for all seasons? Making and using Amudian blades at Qesem Cave, Israel. *Human Evolution* 24(1), 57–75.

BELFER-COHEN, A. and BAR-YOSEF, O. 2015: Palaeolithic recycling: the example of Aurignacian artifacts from Kebara and Hayonim Caves. *Quaternary International* 361, 256–9.

BENEDICT, J.B. 1992: Sacred hot springs, instant patinas. *Plains Anthropologist* 37(138), 1–6.

BORDES, F. 1955: Le Paléolithique inférieur et Moyen de Jabroud (Syrie) et la question du Préaurignacien. *L'Anthropologie* 59, 486–507.

BORDES, F. 1961a: Mousterian cultures in France: artifacts from recent excavation dispel some popular misconceptions about Neanderthal man. *Science* 134, 803–10.

BORDES, F. 1961b: *Typologie Du Paleolithique Ancien et Moyen* (Bordeaux).

BOURGUIGNON, L. 1996: La conception de Débitage Quina. *Quaternaria Nova* 6, 149–66.

BOURGUIGNON, L. 1997: Le Moustérien de type Quina: nouvelle définition d'une entité technique (Ph.D. thesis, Paris).

BOURGUIGNON, L. 2001: Apports de l'expérimentation et de l'analyse techno-morpho-fonctionnelle à la reconnaissance des processus d'aménagement de la retouche Quina. In BOURGUIGNON, L., ORTEGA, I. and FRERE-SOUTOT, M.-C. (eds.), *Préhistoire Approche Expérimentale, Préhistoires N5* (Montagnac), 35–66.

BOURGUIGNON, L., FAIVRE, J.P. and TURQ, A. 2004: Ramification des chaîns opératoires: une spécificité du Moustérien? *Paléo* 16, 37–48.

BRUMM, A., POPE, M., LEROYER, M. and EMERY, K. 2019: Hominin evolution and stone tool scavenging and reuse in the Lower Palaeolithic. In OVERMANN, K.A. and COOLIDGE, F.L. (eds.), *Squeezing Minds from Stones: Cognitive Archaeology and the Evolution of the Human Mind* (Oxford), 149–78.

CARPENTIERI, M., BERRUTI, G.L.F., TITTON, S., ARZARELLO, M. and PERETTO, C. 2023: Brief interviews with hideous stone: a glimpse into the butchery site of Isernia La Pineta - A combined technological and use-wear approach on the lithic tools to evaluate the function of a Lower Palaeolithic context. *Archaeological and Anthropological Sciences* 15(7), 93.

DEBÉNATH, A. and DIBBLE, H.L. 1994: *Handbook of Palaeolithic Typology: Lower and Middle Palaeolithic of Europe, Vol. 1: Lower and Middle Palaeolithic of Europe* (Philadelphia, PA).

DEMBITZER, J., BARKAI, R., BEN-DOR, M. and MEIRI, S. 2022: Levantine overkill: 1.5 million years of hunting down the body size distribution. *Quaternary Science Reviews* 276, 107316.

DIBBLE, H.L. 1987: The interpretation of Middle Palaeolithic scraper morphology. *American Antiquity* 52(1), 109–17.

DIBBLE, H.L. 1995: Middle Palaeolithic scraper reduction: background, clarification, and review of the evidence to date. *Journal of Archaeological Method and Theory* 2(4), 299–368.

DOMÍNGUEZ-RODRIGO, M. and PICKERING, T.R. 2017: The meat of the matter: an evolutionary perspective on human carnivory. *Azania: Archaeological Research in Africa* 52(1), 4–32.

EFRATI, B. 2021: Memory scrapers: readymade concepts and techniques as reflected in collecting and recycling patinated Lower Palaeolithic items at Qesem Cave, Israel. *Cambridge Archaeological Journal* 31, 337–47.

EFRATI, B. 2024: Material sense: perceptual experience in stone and mineral selection for tool-making. *Archaeologies* 20, 24–63.

EFRATI, B. and BARKAI, R. 2024: The magnitude of a practice: collection and recycling of patinated 'old' flint items during the Levantine Late Lower Palaeolithic. *Quaternary* 7, 1–27.

EFRATI, B., PARUSH, Y., ACKERFELD, D., GOPHER, A. and BARKAI, R. 2019: Seeing colors: collecting and modifying patinated flaked items at Middle Pleistocene Qesem Cave, Israel. *Mitekufat Haeven: Journal of the Israel Prehistoric Society* 49, 32–62.

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FALGUÈRES, C., BARKAI, R., TOMBRET, O. and GOPHER, A. 2022: New ESR/U-series dates of the Lowest Acheulo-Yabrudian levels of Qesem Cave. *Quaternary Geochronology* 69, 101266.

FALGUÈRES, C., RICHARD, M., TOMBRET, O. and GOPHER, A. 2016: New ESR/U-series dates in Yabrudian and Amudian layers at Qesem Cave, Israel. *Quaternary International* 398, 6–12.

FINESTONE, E.M., PLUMMER, T.W., DITCHFIELD, P.W., REEVES, J.S., BRAUN, D.R., BARTILOL, S.K., KIPRONO ROTICH, N., BISHOP, L.C., OLIVER, J.S., KINYANJUI, R.N., PETRAGLIA, M.D., BREEZE, P.S., LEMORINI, C., CARICOLA, I., OWICH OBONDO, P. and POTTS, R. 2025: Selective use of distant stone resources by the earliest Oldowan toolmakers. *Science Advances* 11, eadu5838.

FINKEL, M. and BARKAI, R. 2021: Technological persistency following faunal stability during the Pleistocene: a model for reconstructing Palaeolithic adaptation strategies based on mosaic evolution. *L'anthropologie* 125(1), 1–19.

FOLEY, R.A. and LAHR, M.M. 2015: Lithic landscapes: early human impact from stone tool production on the Central Saharan environment. *PLoS ONE*, 10(3), 1–15.

FRANKLIN, L.M. and KUHN, S.L. 2021: Scraper blank morphology and artifact use-life in the Acheulo-Yabrudian of Tabun Cave, Israel. *Journal of Palaeolithic Archaeology* 4(3), 1–29.

FRIEDMAN, E., GOREN-INBAR, N., ROSENFELD, A., MARDER, O. and BURIAN, F. (1994–95): Hafting during Mousterian times – further indication. *Journal of The Israel Prehistoric Society* 26, 8–31.

GOODWIN, A.J.H. 1960: Chemical alteration (patination) of stone. *South African Archaeological Bulletin* 15(59), 67–76.

GOPHER, A., AYALON, A., BAR-MATTHEWS, M., BARKAI, R., FRUMKIN, A., KARKANAS, P. and SHAHACK-GROSS, R. 2010: The chronology of the Late Lower Palaeolithic in the Levant based on U-Th ages of speleothems from Qesem Cave, Israel. *Quaternary Geochronology* 5(6), 644–56.

GOPHER, A., BARKAI, R., SHIMELMITZ, R., KHALAILY, M., LEMORINI, C., HERSHKOVITZ, I. and STINER, M. 2005: Qesem Cave: an Amudian site in Central Israel. *Mitekufat Haeven: Journal of the Israel Prehistoric Society* 35, 69–92.

GOPHER, A., PARUSH, Y., ASSAF, E. and BARKAI, R. 2016: Spatial aspects as seen from a density analysis of lithics at Middle Pleistocene Qesem Cave: preliminary results and observations. *Quaternary International* 398, 103–17.

HARDY, B.L. 2004: Neanderthal behaviour and stone tool function at the Middle Palaeolithic site of La Quina, France. *Antiquity* 78(301), 547–65.

HISCOCK, P. and CLARKSON, C. 2015: Retouch intensity on Quina scrapers at Combe Grenal: a test of the reduction model. In BEHIE, A.M. and OXENHAM, M.F. (eds.), *Taxonomic Tapestries: The Threads of Evolutionary, Behavioural and Conservation Research* (Acton), 103–28.

HISCOCK, P., TURQ, A., FAIVRE, J.P. and BOURGUIGNON, L. 2009: Quina procurement and tool production. In BIRAN, A. and BLADES, B.S. (eds.), *Lithic Materials and Palaeolithic Societies* (Chichester), 232–46.

INGOLD, T. 2013: *Making: Anthropology, Archaeology, Art and Architecture* (London).

LEMORINI, C., BOURGUIGNON, L., ZUPANCICH, A., GOPHER, A. and BARKAI, R. 2016: A scraper's life history: morpho-techno-functional and use-wear analysis of Quina and demi-Quina scrapers from Qesem Cave, Israel. *Quaternary International* 398, 86–93.

LEMORINI, C., VENDITTI, F., ASSAF, E., PARUSH, Y., BARKAI, R. and GOPHER, A. 2015: The function of recycled lithic items at Late Lower Palaeolithic Qesem Cave, Israel: an overview of the use-wear data. *Quaternary International* 361, 103–12.

LEV, Z. 2010: Techno-typological analysis of a Yabrudian assemblage from Qesem Cave, Israel (M.A. thesis, Tel Aviv University).

LITOV, V. and BARKAI, R. 2024a: The stone, the deer, and the mountain: Lower Palaeolithic scrapers and early human perceptions of the cosmos. *Archaeologies* 20(1), 106–46.

LITOV, V. and BARKAI, R. 2024b: Lower Palaeolithic stone-animal ontologies: stone scrapers as mediators between early humans and their preferred prey. *World Archaeology* 56(2), 213–36.

LITOV, V., MARINELLI, F., LEMORINI, C. and BARKAI, R. 2025: Continuity and innovation in the Late Acheulian: technological and functional analysis of scrapers from Jaljulia, Southern Levant (500–300 ka). *Journal of Human Evolution* 205, 103716.

MALAFOURIS, L. 2013: *How Things Shape the Mind: A Theory of Material Engagement* (Cambridge, MA).

MEIGNEN, L., DELAGNES, A. and BOURGUIGNON, L. 2009: Patterns of lithic material procurement and transformation during the Middle Palaeolithic in Western Europe. In ADAMS, B. and BLADES, B.S. (eds.), *Lithic Materials and Palaeolithic Societies* (Oxford), 15–24.

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MERCIER, N., VALLADAS, H., FALGUÈRES, C., SHAO, Q., GOPHER, A., BARKAI, R., BAHAIN, J.J., VIALETTES, L., JORON, J.L. and REYSS, J.L. 2013: New datings of Amudian layers at Qesem Cave (Israel): results of TL applied to burnt flints and ESR/U-series to teeth. *Journal of Archaeological Science* 40(7), 3011–20.

OTA, S.B., SRIVASTAVA, N. and PANDEY, S. 2020: An early case of lithic recycling in India: evidence from the Acheulian site at Damdongri, Madhya Pradesh. *Current Science* 118(1), 123–32.

PARUSH, Y., ASSAF, E., SLON, V., GOPHER, A. and BARKAI, R. 2015: Looking for sharp edges: modes of flint recycling at Middle Pleistocene Qesem Cave, Israel. *Quaternary International* 361, 61–87.

PARUSH, Y., GOPHER, A. and BARKAI, R. 2016: Amudian versus Yabrudian under the Rock Shelf: a study of two lithic assemblages from Qesem Cave, Israel. *Quaternary International* 398, 13–36.

PERESANI, M., BOLDRIN, M. and PASETTI, P. 2015: Assessing the exploitation of double patinated artifacts from the Late Mousterian: implications for lithic economy and human mobility in Northern Italy. *Quaternary International* 361, 238–50.

POPE, M. and ROBERTS, M. 2005: Observations on the relationship between Palaeolithic individuals and artefact scatters at the Middle Pleistocene site of Boxgrove, UK. In GAMBLE, C. and PORR, M. (eds.), *The Hominid Individual in Context: Archaeological Investigations of Lower and Middle Palaeolithic Landscapes, Locales and Artefacts* (London), 81–97.

SHIMELMITZ, R. 2015: The recycling of flint throughout the Lower and Middle Palaeolithic sequence of Tabun Cave, Israel. *Quaternary International* 361, 34–45.

SHIMELMITZ, R., KUHN, S.L., RONEN, A. and WEINSTEIN-EVRON, M. 2014: Predetermined flake production at the Lower/Middle Palaeolithic boundary: Yabrudian scraper-blank technology. *PLoS ONE* 9(9), e106293.

THIRY, M., FERNANDES, P., MILNES, A. and RAYNAL, J.P. 2014: Driving forces for the weathering and alteration of silica in the regolith: implications for studies of prehistoric flint tools. *Earth-Science Reviews* 136, 141–54.

TURQ, A. 1985: Le Moustérien de type Quina du Roc de Marsal (Dordogne). *Bulletin de la Société Préhistorique française* 82(2), 46–51.

TURQ, A. 2000: Le Moustérien de type Quina. *Paléo Supplément*, 310–43.

VANNEST, J. 1985: Patination of Knife River flint artifacts. *Plains Anthropologist* 30(110), 325–39.

VAQUERO, M. 2011: New perspectives on recycling of lithic resources using refitting and spatial data. *Quartär* 58, 113–30.

VISALBERGHI, E., ADDESSI, E., TRUPPA, V., SPAGNOLETTI, N., OTTONI, E., IZAR, P. and FRAGASZY, D. 2009: Selection of effective stone tools by wild Bearded Capuchin monkeys. *Current Biology*, 19(3), 213–17.

WHYTE, T.R. 2014: Gifts of the ancestors: secondary lithic recycling in Appalachian summit prehistory. *American Antiquity* 79(4), 679–96.

WILSON, L., AGAM, A., BARKAI, R. and GOPHER, A. 2016: Raw material choices in Amudian versus Yabrudian lthic assemblages at Qesem Cave: a preliminary evaluation. *Quaternary International* 398, 61–9.

ZUPANCICH, A. 2019: Understanding the use of Quina scrapers at Middle Pleistocene Qesem Cave (Israel), and the implication for the study of the Quina phenomenon in the Levant and beyond (Ph.D. thesis, Tel Aviv University).

ZUPANCICH, A., LEMORINI, C., GOPHER, A. and BARKAI, R. 2016: On Quina and demi-Quina scraper handling: preliminary results from the Late Lower Palaeolithic site of Qesem Cave, Israel. *Quaternary International* 398, 94–102.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1: List of the type-B scrapers available at the sample.

Figure S1: Site plan of Qesem Cave, showing the location of the studied areas (numbered as in text). Materials used with permission from R. Barkai and A. Gopher.

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