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The Magnitude of a Practice: Collection and Recycling of Patinated 'Old' Flint Items During the Levantine Late Lower Paleolithic

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Abstract: This study examines the prevalent practice of recycling patinated flint tools ("double patina") of 18 lithic assemblages from three Late Lower Paleolithic sites in Israel. Determined as recycled from 'old' patinated items using visual observation, these tools, bearing both old, patinated surfaces and new modifications, offer insights into lithic strategies, cultural behaviors, and memory preservation. The study shows that the collection and recycling of 'old' patinated items into new tools was ubiquitously practiced, ranging from 41% at Late Acheulian Jaljulia and 11–17% at Acheulo-Yabrudian Qesem Cave. Two main recycling methods were identified, with variations across sites reflecting diverse cultural norms and functional needs (Type A–B). The type-B recycling trajectory was found to be the most prominent, as it prioritizes the preservation of the tool's original appearance, patinated surfaces, and old scars. Following these features, the study additionally suggests that type-B recycling likely stemmed from necessity, cultural preferences, and a choice to connect with the past and preserve it, thus emphasizing the complex interplay of practicality, culture, and memory in the Late Lower Paleolithic period.

Keywords: Levantine Late Lower Paleolithic; lithic recycling; double patina; lithic technology; traditional ecological knowledge; cultural and behavioral implications

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1. Introduction

The recycling of lithic artifacts throughout the Paleolithic Period has been gaining more attention in recent years and is exemplified by the special volume on lithic recycling in the Paleolithic Period, published in Quaternary International, titled "The Origins of Recycling: A Paleolithic Perspective" [1]. This growing interest is further evidenced by the publication of a large number of subsequent studies [2–12]. The practice of recycling also extends beyond the Paleolithic Period and is found in later archeological contexts worldwide, including Prehistoric, protohistoric, and historical periods [13–22]. The study of recycling in The Paleolithic record is instrumental in enhancing our understanding of prehistoric human behavior and cultural worldviews and practices, ecological understanding, availability of fresh material, technological complexity and flexibility, problem-solving, and decision-making mechanisms, as well as other important facets of human behavior such as attention and conscious thinking [23,24].

The traditional definition of recycling implies the use of an existing 'old' artifact for a purpose that is new and different from the original one [24]. However, another component considered a strong proxy for defining recycling is the ability to detect a time gap between two use events, even if they are similar in appearance or task and use, as they are now different in a temporal context. Thus, maintenance (e.g., resharpening) and recycling should and can be discerned from one another [1,24]. While a maintenance procedure is aimed at extending the use life of an item, in the case of recycling, the stages of modification

are discerned by a phase of discarding between them. Thus, recycling does not extend the original use phase of the item in a temporal sense [1,24–28]. The main subject of the current study, the "double patina" phenomenon, i.e., the collection and recycling of existing 'old' items covered in patina into new items, serves as widely accepted evidence of recycling when detected in prehistoric flint assemblages. In most cases, the second phase, i.e., the later modifications on the 'old' item, can be distinguished from the original old flaked patinated surfaces both by color differentiation and by the technological chaîne opératoire/reduction sequence the items underwent [27,29,30].

Flint patination and patination of other stone artifacts have been a focus of interest since the end of the 19th century [31]. Since then, studies on flint and rock patination have varied in subject and terminology [32,33]. Relevant to the current study and as suggested above, patina differences in human-made lithic finds became part of an attempt to document evidence for lithic recycling and, as a result also, lithic procurement strategies and lithic economy. Thus, the current study and its introductions would not discuss patination as a chemical phenomenon, nor will it elaborate on patination chemical variation or its multiple ways of development. The study will focus on the practice of collecting and recycling 'old' items.

"Double patina" items [29], as they are often called in prehistoric research, refer to recycled 'old' human-made items discarded after manufacture (sometimes after being subsequently used) and covered in patina by various environmental agents. After some unknown time, these patinated items were collected by later prehistoric groups and shaped in a manner that exposed fresh surfaces. This modification process fits the term recycling. While the time it takes for patination to form on silica (i.e., flint) is not definitive, patina is assumed to form over thousands of years. In the case of flint, Thiry et al. [34] suggest patina occurs over periods of 20–50,000 years, while thick weathering can be developed in less than 130,000 years, and friable weathering could be formed in several decades [34].

The collection and recycling of 'old' patinated items is a phenomenon that is prevalent at many Early to Upper Paleolithic sites worldwide and has gained more and more recognition in recent years [3,5,6,14,27,30,35–40]. The collection and recycling of old artifacts were also documented in ethnographic studies of contemporary hunter-gatherer groups [13,41–47]. These studies suggest that recycling was fully integrated into the provisioning strategies of these groups, influencing waste disposal strategies and being a part of their cultural worldviews and practices. Ethnographic examples demonstrate how certain Indigenous groups are aware of past human presence in the same environments, evidenced by 'old' human-made objects available in the landscape. These studies demonstrate how such objects are at times collected and brought home for use with or without further modifications and how their antiquity is also recognized [23,42,46,47]. Moreover, the same collected 'old' objects may have been perceived as belonging to entities in the past (may it be past humans, cosmic beings, or "ancestors") [43,46–49]. Alternatively, other cases suggest old items were believed to be given by the landscape, by "nature" [41,45,47].

Recycled patinated 'old' items have recently undergone extensive study at the Late Acheulian open-air site of Revadim and the Acheulo-Yabrudian site of Qesem Cave, Israel [36,37,50]. This study aims to extend the discussion by observing 18 lithic assemblages from both studied sites while also introducing new evidence regarding the practice at a third, more recently excavated site: the Late Acheulian open-air site of Jaljulia, Israel. This study will demonstrate and discuss the magnitude of collecting and recycling 'old' patinated human-made items, presenting the capacity of the practice at each site using preliminary analysis and suggesting interpretations regarding collection methods. The study will also show why this practice constitutes a conscious and complex behavior that goes beyond practical necessity, explicitly emphasizing the noted technological trajectory of collecting and recycling 'old' patinated items by using them as blanks for making new tools by minimally shaping them, resulting in a recycled tool that still preserves the original outlook of the old collected item, with its varying colors and old patinated scars present and dominant [50].

2. The Archeological Sites

2.1. Revadim

Revadim is a multi-layered open-air site located on the southern coastal plain of Israel (Figure 1) [51]. Four main areas (A–D) and two trenches (stratigraphically connecting areas B and C) were excavated during four seasons of excavation, comprising an area of 250 m^2. Areas C and B were the main excavated areas (Figure 2). Paleomagnetism results showed normal polarity, thus, indicating that the sequence is younger than 780 kyr. Uranium–thorium analysis conducted on carbonates that cover flint items suggests that the estimated minimum dates of the site range between 500 and 300 kyr [51]. Lithic and faunal analyses suggest that all layers at the site date to the Late Acheulian [2,7,51–58].

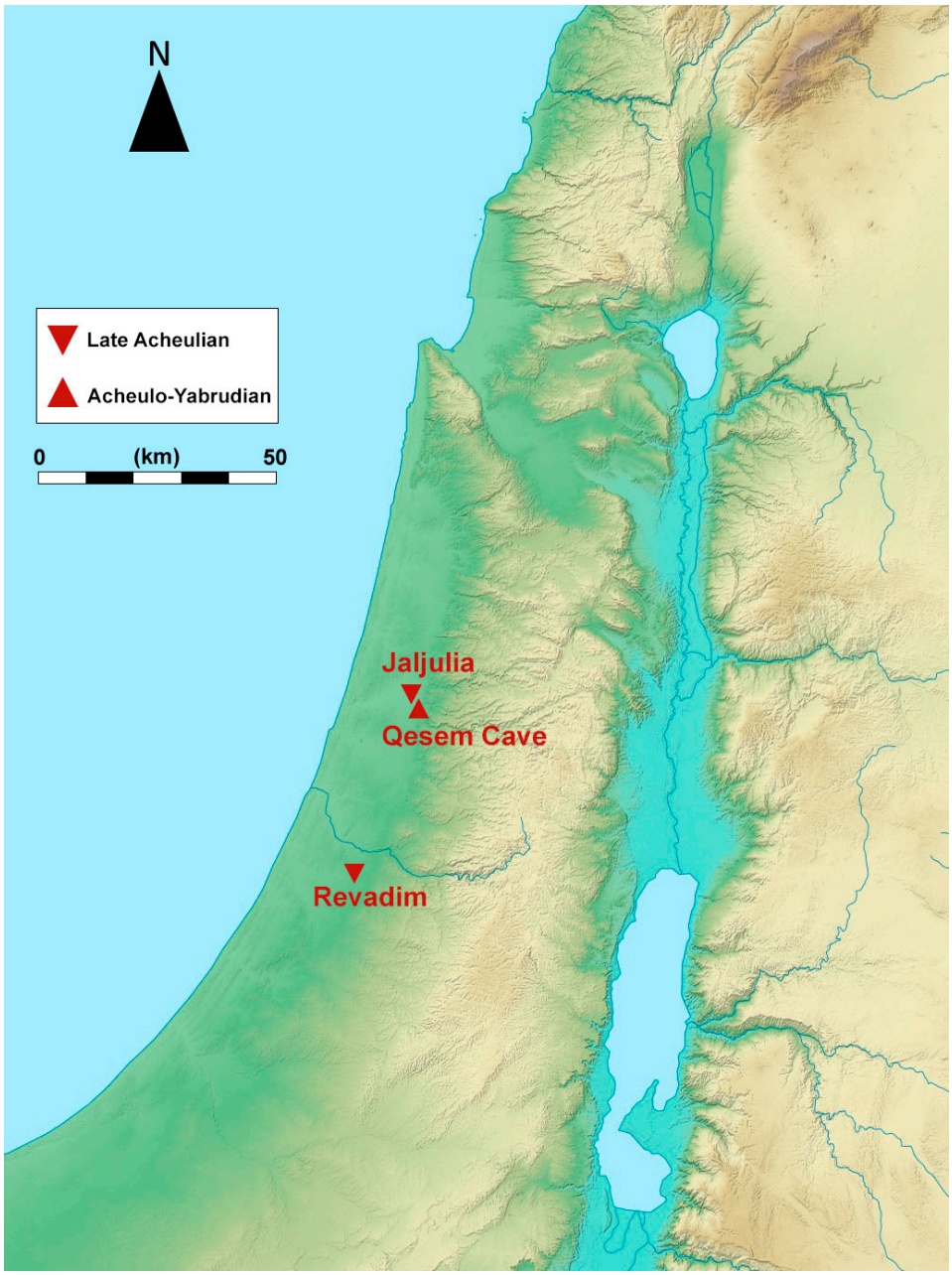

Figure 1. Geographical location of Revadim, Jaljulia and Qesem Cave, Israel.

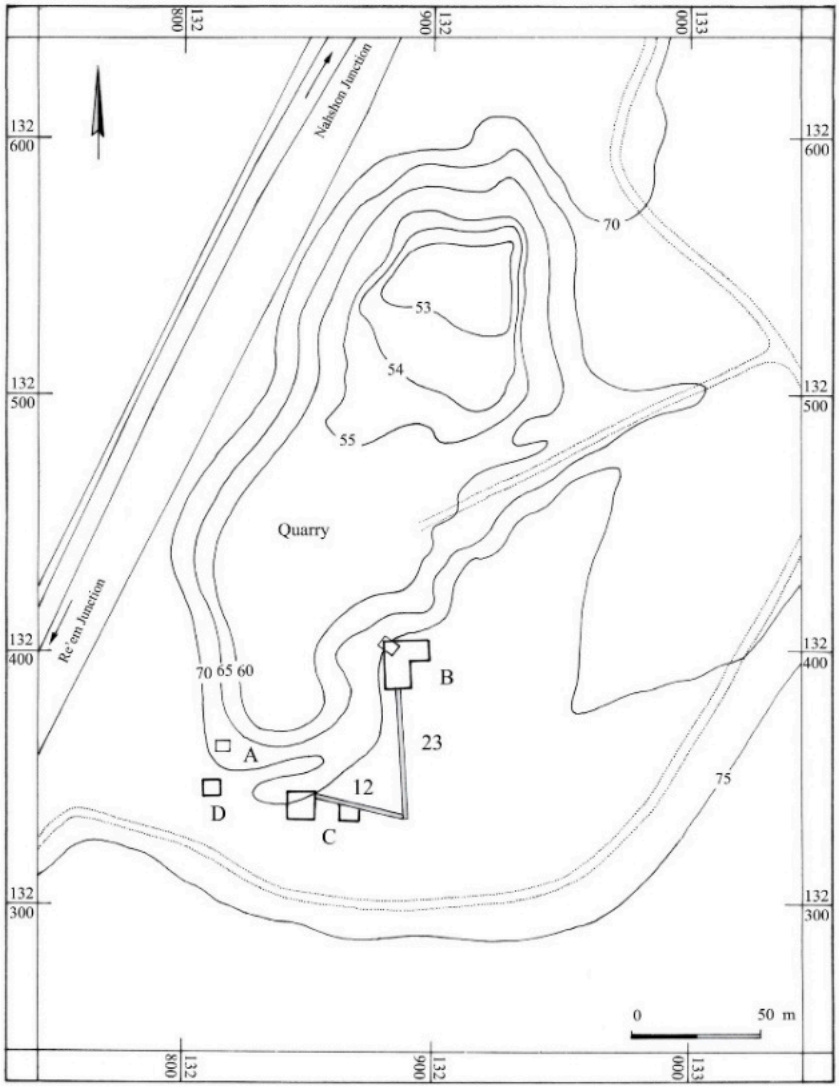

Figure 2. The site of Revadim, featuring the excavated areas designated as A through D. As published in [25].

The lithic assemblages are rich. Various core technologies were detected and include three main sequences: the production of moderately large and medium flakes; the production of pre-determined items from prepared cores, including proto-Levallois cores and discoidal cores; and the production of small flakes by recycling "parent" flakes (cores-on-flakes) [2,7,9,10,55,59,60]. Lithic recycling, in general, is a recurrent practice at the site, and aside from the production of small flakes from cores-on-flakes [2,9,10,59], recycling is evident in all archeological contexts in two other technological and technical forms: recycling of handaxes into cores [7], and the collection and recycling of old patinated flaked items ("double patina"; Figure 3) [2,7,37]. The tool category comprises mostly retouched flake tools ("retouched flakes") and includes items produced by various methods that were further retouched in different ways [7]. Alongside retouched flakes, the tool category consists of other tool types including handaxes, chopping tools and scrapers [55–57,60–63]. Animal bones were also recycled into bone tools, suggested to be the earliest bone tools in the Levant [54].

Extensive use-wear and residue analyses were conducted on the Revadim lithic material, with a particular focus on the lithic material of Area C Layer 3, which provided exceptional results on the functionality of some categories of items and tools due to an excellent state of preservation [12,64]. Among others, functional analyses were conducted on the lithic recycling trajectories available at the site [9,10,64,65], including a study on

recycled 'old' patinated tools [37], where the life cycles and functional traits of 28 recycled tools made on 'old' patinated tools were traced. Use-wear results were detected on the new and old edges of eight tools. Six of these items were found to have been in use for different purposes during their first and second life cycles. The results provided additional evidence, this time from a functional perspective, that the recycled 'old' patinated items underwent two life cycles, further supporting the technological assessment that these items are old, shaped tools that were abandoned and then collected and recycled to function as tools again. The studied recycled patinated tools were functionally used for several purposes during their first life cycles as the 'old' patinated active edges bear evidence of cutting, scraping, mixed activities, and chopping. Interestingly, most items were used for scraping during their second life cycle. Moreover, most items were used to work with soft to medium materials, and residue analysis further revealed that their main function was to process animal carcasses [37].

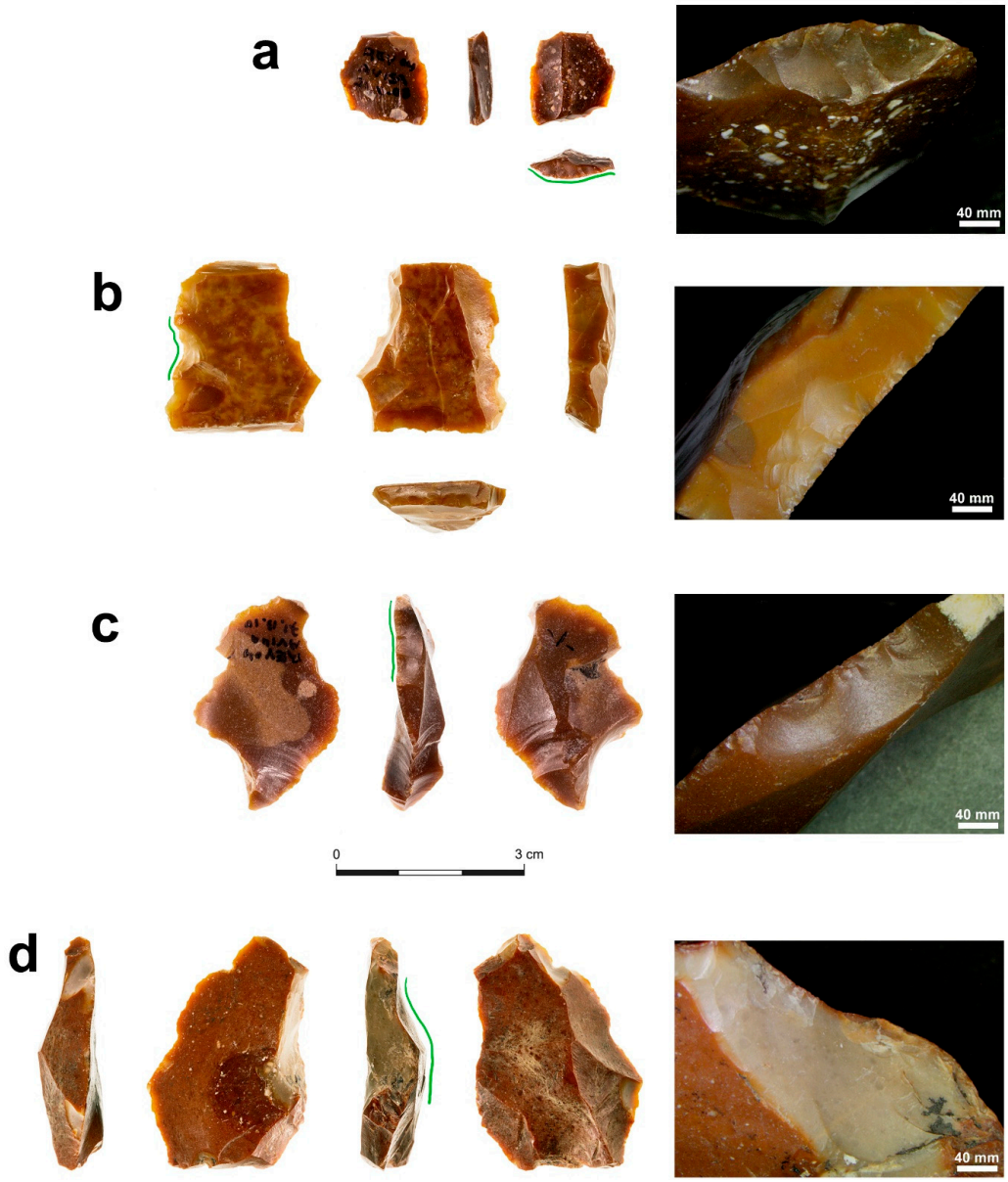

Figure 3. (**left**) Recycled patinated tools from Revadim (items **a**–**d**). Marked in green are the locations from which a close-up caption (**right**) was taken to allow a better observation of patination differences.

2.2. Jaljulia

Jaljulia is a more recently discovered Late Acheulian site located on the central part of the coastal plain of Israel, on the ancient route of Wadi Qana (Figure 1) [66]. Approximately 80 m^2 of Late Acheulian deposits (Areas A–E, G) were excavated by the Israel Antiquities Authority in collaboration with the Institute of Archeology at Tel Aviv University (Figure 4). Techno-typological analysis conducted so far on the lithic assemblages presents classic attributes associating the material with the Late Acheulian industries. Furthermore, paleomagnetic analysis and TT-OSL and pIR-IR290 analyses on quartz and feldspar grains, as well as ESR analysis on quartz grains, provided an absolute chronological frame for the primary human activity on-site of ca. 500–300/200,000 kyr [66].

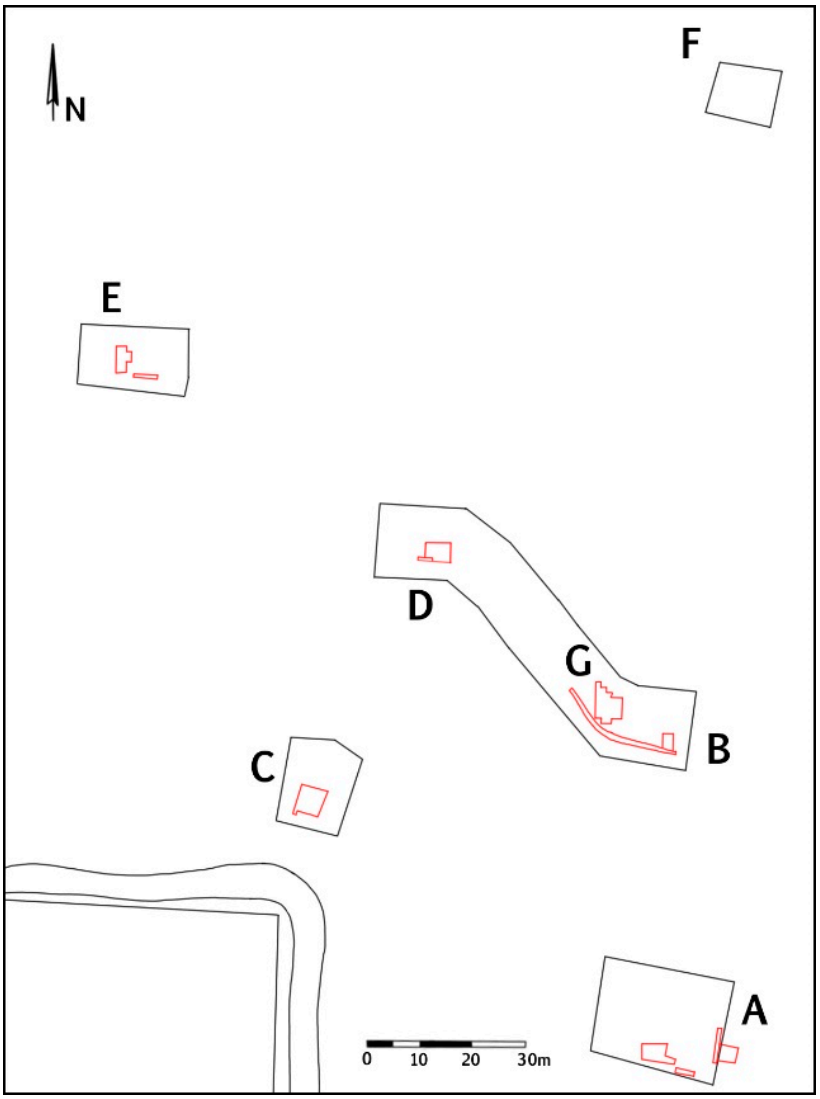

Figure 4. The site of Revadim, featuring the excavated areas designated as A through G.

The lithic assemblages are rich and dominated mainly by flake production, flake tools, and handaxes [66,67]. Core technology varies and includes three primary reduction sequences, similar to those observed at Revadim: the production of moderately large and medium flakes, the production of pre-determined items from prepared cores (including proto-Levallois and discoidal), and the production of small flakes by recycling "parent" flakes [7,66,68–70]. As is the case at Revadim, handaxes were recycled to cores [2] and old patinated flaked items were collected and recycled at Jaljulia (Figure 5) [7,69,70].

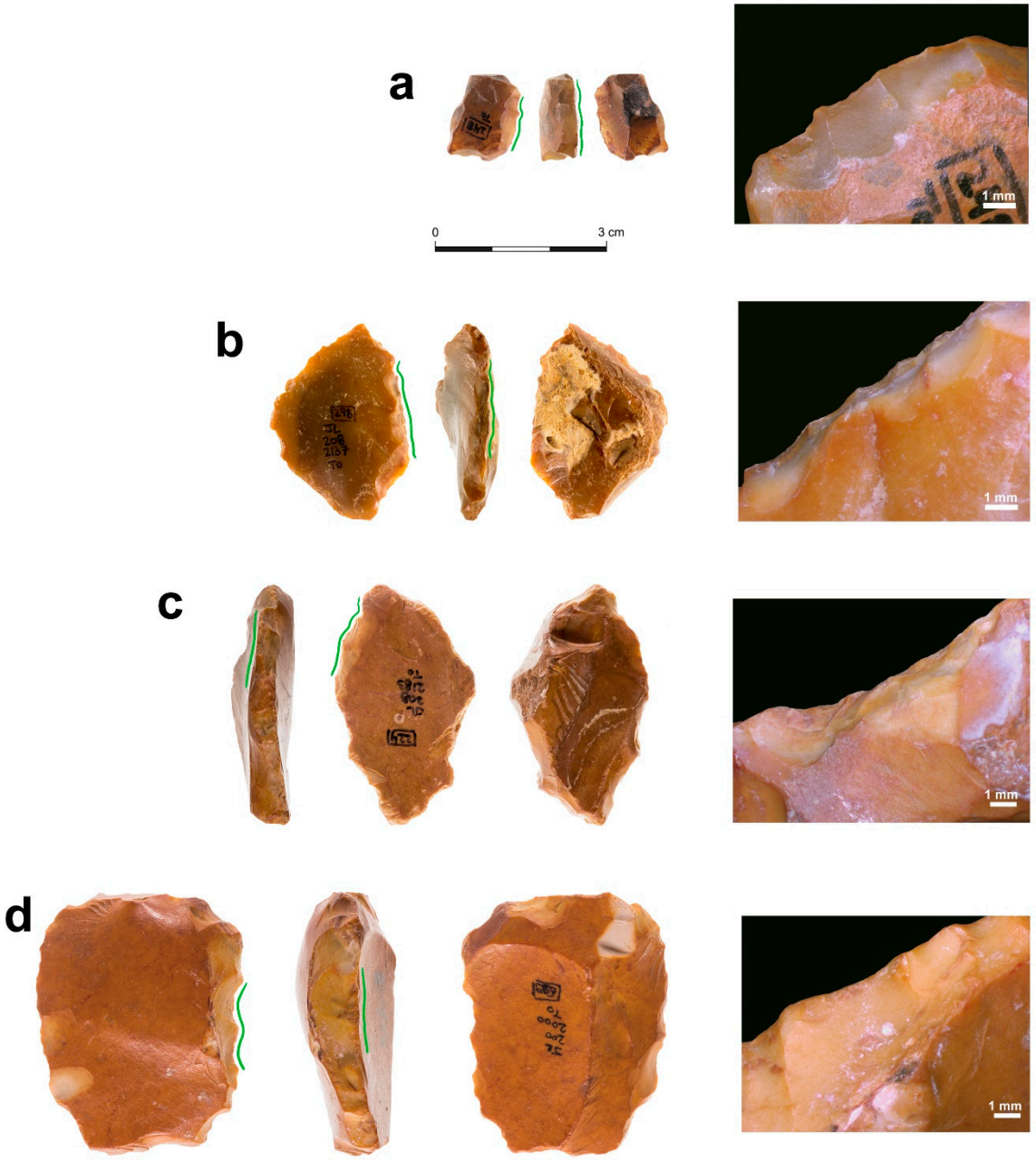

Figure 5. (**left**) Recycled patinated tools from Jaljulia (items **a**–**d**). Marked in green are the locations from which a close-up caption (**right**) was taken to allow a better observation of patination differences.

2.3. Qesem Cave

Qesem Cave is situated about 12 km east of Tel Aviv, Israel, on the western foothills of the Samaria Hills (Figures 1 and 6) [71–74]. So far, excavations have exposed a stratigraphic sequence of over 11 m anthropogenic deposits, including a large central hearth [75]. Bedrock has yet to be reached. U/Th analysis of speleothems from the cave, thermoluminescence (TL), and electron spin resonance (ESR) analyses date the site to ca. 420–200,000 kyr [76–80]. Both absolute dating and the site's lithic assemblages assign Qesem to the Acheulo-Yabrudian Cultural Complex (hereafter, AYCC) of the Late Lower Paleolithic Levant. The lithic assemblages are dominated by the Amudian blade industry [74,81–87]. The Yabrudian industry, dominated by Quina and demi-Quina scrapers, is also evident in three stratigraphically and spatially distinct areas of the site, presented in six contexts [24,82,83,85,88–93]. Handaxes are rare, and only a few were retrieved within the Amudian and Yabrudian

contexts. These are argued to have been collected from older sites outside the cave and then brought in to be used again [94,95].

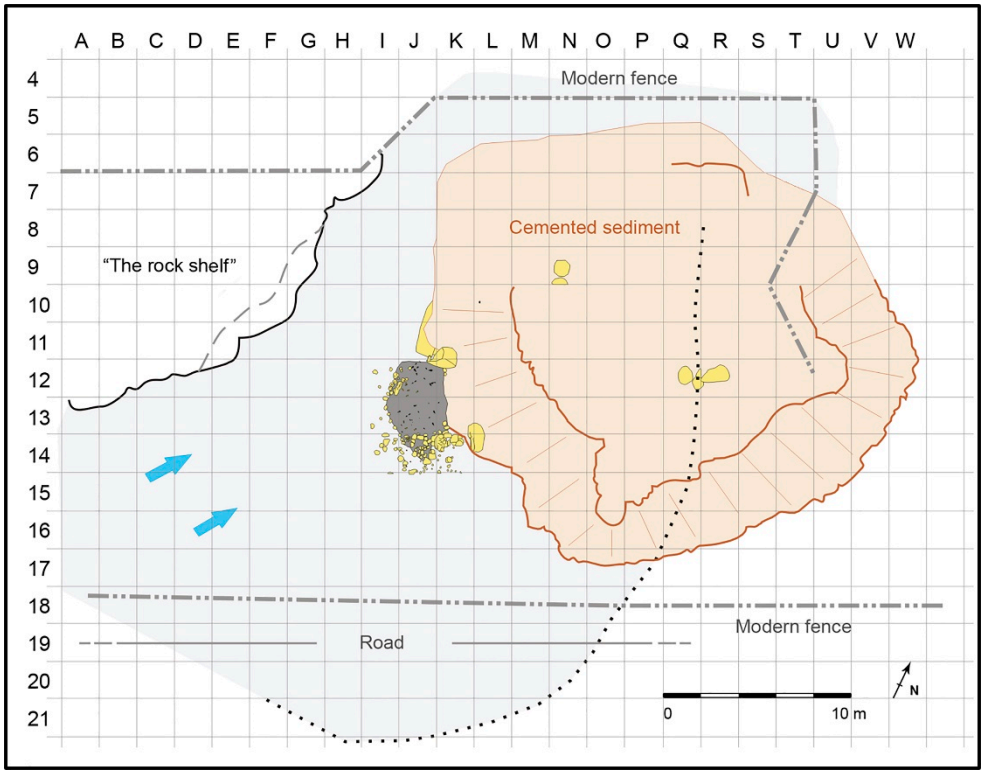

Figure 6. The site of Qesem Cave features the upper sequence of the cave, the hearth area (dark grey feature), and the location of the rock shelf where the lower sequence of the cave begins. As published in [83].

Aside from collection and re-use of old handaxes, lithic recycling is a recurrent practice at the cave and is present in all of the archeological contexts in multiple technological and technical forms: handaxes recycled to cores, scrapers recycled to cores [24] collection and re-use of old shaped stone balls (spheroids/polyhedrons) [96–99], the production of small blades and flakes with sharp edges from "parent" flakes and blades (cores-on-flakes), which were extensively studied by both technological and functional means [8,11,12,24,71,85,100–102], and the collection and recycling of old patinated flaked items ("double patina"; Figure 7) [36,50,89].

Qesem was a mosaic of environmental and ecological regions [103,104], abundant in numerous fresh lithic sources of various types. A systematic study on flint procurement and exploitation strategies at Qesem Cave indicated the use of a large variety of flint types (>90), some of which were selected for specific types of tools or technological trajectories [105–107]. Moreover, earlier studies provided evidence for lithic procurement by both surface collection and quarrying from specific, designated, primary sub-surface sources [89,108,109]; thus, the collection of handaxes, stone balls, and patinated 'old' lithic items were part of the acquisition of lithic materials from the surface [36]. Animal bones were also recycled and served as a material for toolmaking, as more than 20 fragments of soft flint retouchers were found [110–112].

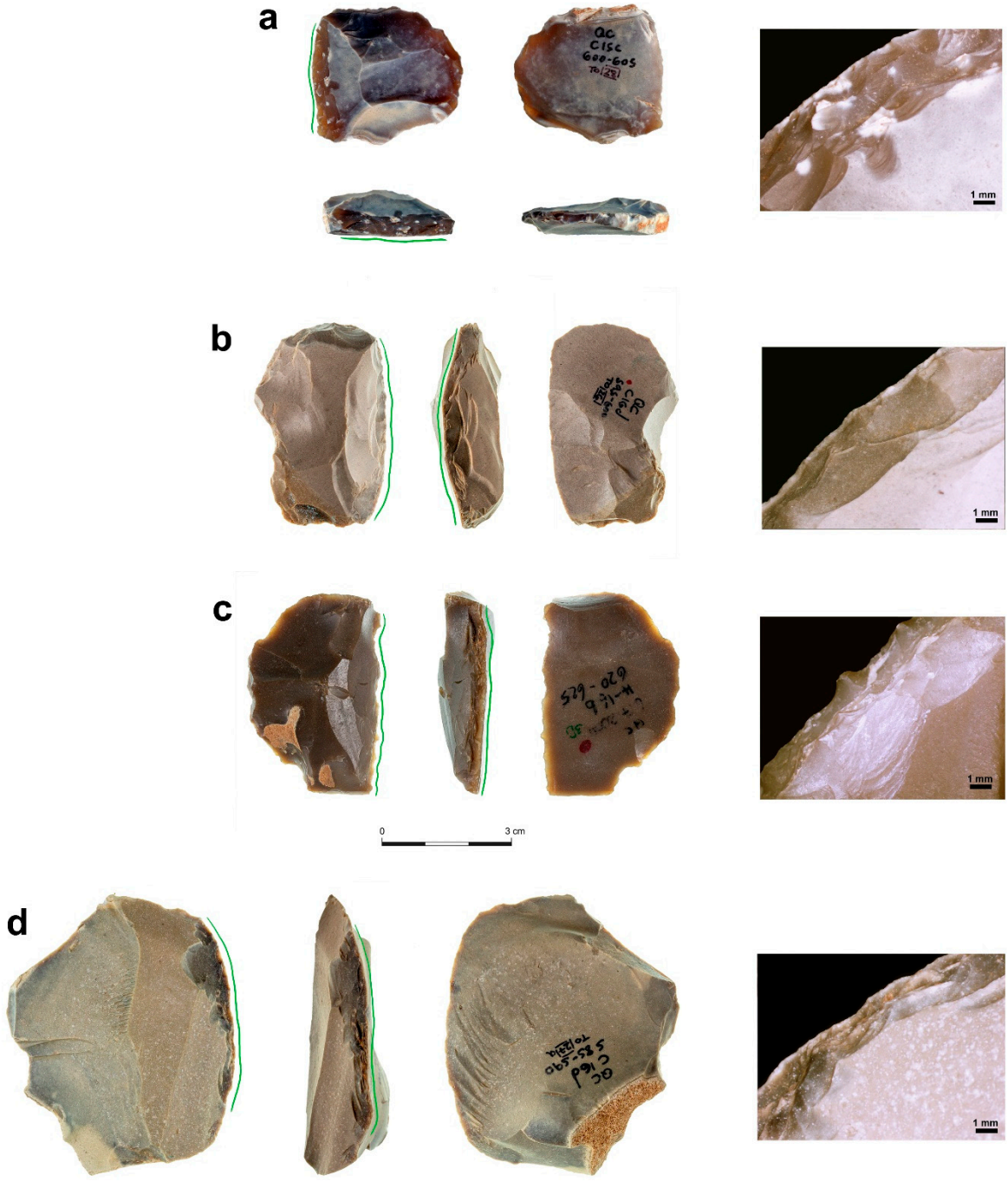

Figure 7. (**left**) Recycled patinated Quina and Demi-Quina Scrapers from Qesem Cave (Items **a**–**d**). Marked in green are the locations from which a close-up caption (**right**) was taken to allow a better observation of patination differences.

3. Recycling 'Old' Patinated Human-Made Flint Items

The presence of recycled 'old' patinated tools was brought to our attention during fieldwork and material analysis. Initially, we were not looking for recycling, and it was not on our research agenda. However, it seems that recycling has found us. These items appear together with items made from fresh, unpatinated flint in all the lithic assemblages of all three studied sites, some of which have been previously mentioned or studied [2,7,24,36,37,50,64,70,74,89,113]. The patina presented on the 'old' tools in all three sites varies in type, color, and texture and differs in color and texture from the natural color

of the flint (Figures 3, 5 and 7). So far, the preliminary analysis of recycled 'old' patinated tools from each site revealed two main types of items:

- *Type-A* recycled patinated tools consist of recycled tools detached from 'old' patinated flaked blanks/cores, thus, exhibiting the oldest modified patinated surfaces only on their dorsal face or striking platforms (Figure 8). Their ventral face was detached from the 'old' parent item, revealing the fresh color of the flint, or ventral surfaces that exhibit a less patinated condition (see, for example, Figure 8b) and, thus, counted as a new modification.
- *Type-B* recycled patinated tools consist of completely patinated flaked items that served as blanks to create the new tool. These recycled items preserve and exhibit most of the patinated surfaces of the 'old' items. In most cases, Type B recycled tools preserve almost all of the collected 'old' items, keeping them nearly intact, as the new modifications are few but specific aimed at creating/reshaping a working edge. They, thus, preserve most of the morphological and visual proprieties of the collected 'old' patinated item (Figure 9).

We suggest that old patinated items were collected and recycled for both functional and non-functional reasons. As for functional reasons, we suggest that chosen items were collected and recycled as they were suitable in shape, form, and size for blank production, or alternatively, suitable in shape and form, as is, for the creation of the new desired tool. Previous studies on Qesem Cave and Revadim suggested that 'old' patinated flaked items were selected for their knapping potential, whether they were recognized as being of suitable shape, size, and volume to serve as material mediums for further knapping (type-A) or as being of suitable shape, size, volume, and outline to serve as blanks for the making of new tools (type-B) [36,37]. In the case of recycled patinated type-A tools, a preliminary study indicates that particular morphologies suitable for blank reduction played a role in the selection of the old patinated items. For example, the original patinated scars and ridges would have facilitated the further production of blanks, while previous patinated ridges may have also helped guide new detachments. These patterns were mainly observed in lithic categories such as core trimming elements, cores, and what we defined as "recycling products" (i.e., small flakes and blades detached from cores-on-flakes) [36].

Selection of 'old' flaked items based on knapping potential and desired end-item is even more notable in the case of recycled patinated type-B tools, where all of the tools were recycled in a manner that preserves most of their patinated surfaces and scar patterns. The new modifications were mostly limited to shaping a new working edge. Such specific but minimal reshaping strongly suggests that their collectors wished to preserve the 'old' collected items as-is, as much as possible, while still providing them with new functional potential. Unfortunately, the lack of standardization in ad hoc tools (whether produced by recycling or from fresh flint) makes it impossible to determine, via analysis or technological comparison, what functional properties the collectors of the 'old' patinated items might have sought. Nonetheless, it is reasonable to suggest that the 'old' patinated blank types of varying size and shape were chosen for recycling because their morphology was suitable for creating the desired tool [36,37]. Furthermore, the correlation between form and function noted on the sample of type-B tools from layer C-3, Revadim supports our view that old patinated items were intentionally collected and modified to create new edges, which, in the case of the studied sample, were suitable for scraping activities [37]. In the case of more standardized technological trajectories practiced at each site, we assume that 'old' blanks for making type-B tools (such as recycled Quina and demi-Quina scrapers made on patinated blanks from Qesem Cave [50]) were chosen for their specific shape and morphology. However, further analysis is required to confirm or refute this hypothesis.

Nevertheless, functional reasons do not include a shortage of lithic materials. It has often been suggested that flint recycling is a result of scarcity in lithic materials, a way to maximize lithic resource profitability, including the collection and recycling of 'old' patinated items [13,14,30,39,114,115]. However, lithic recycling has also been documented in areas abundant with lithic materials. Lithic abundance is also evident in the vicinity

of all discussed sites. Not only was the supply of fresh flint at all three sites constant and abundant, but the inhabitants also invested intentional effort in the ongoing acquisition of fresh material and, in the case of Qesem Cave, even from distant sources (15–25 km from the site) [105,107]. At Jaljulia, large quantities of flint nodules were transported by the stream, and at the site, inhabitants were physically sitting on gravel deposits extremely rich in fresh flint nodules [69]. In addition, tools made of fresh flint and typologically identified as similar to recycled patinated equivalent items were found in all the studied assemblages, hand-in-hand with recycled patinated items in the same contexts and even dominated the assemblages at each site [36,37,50].

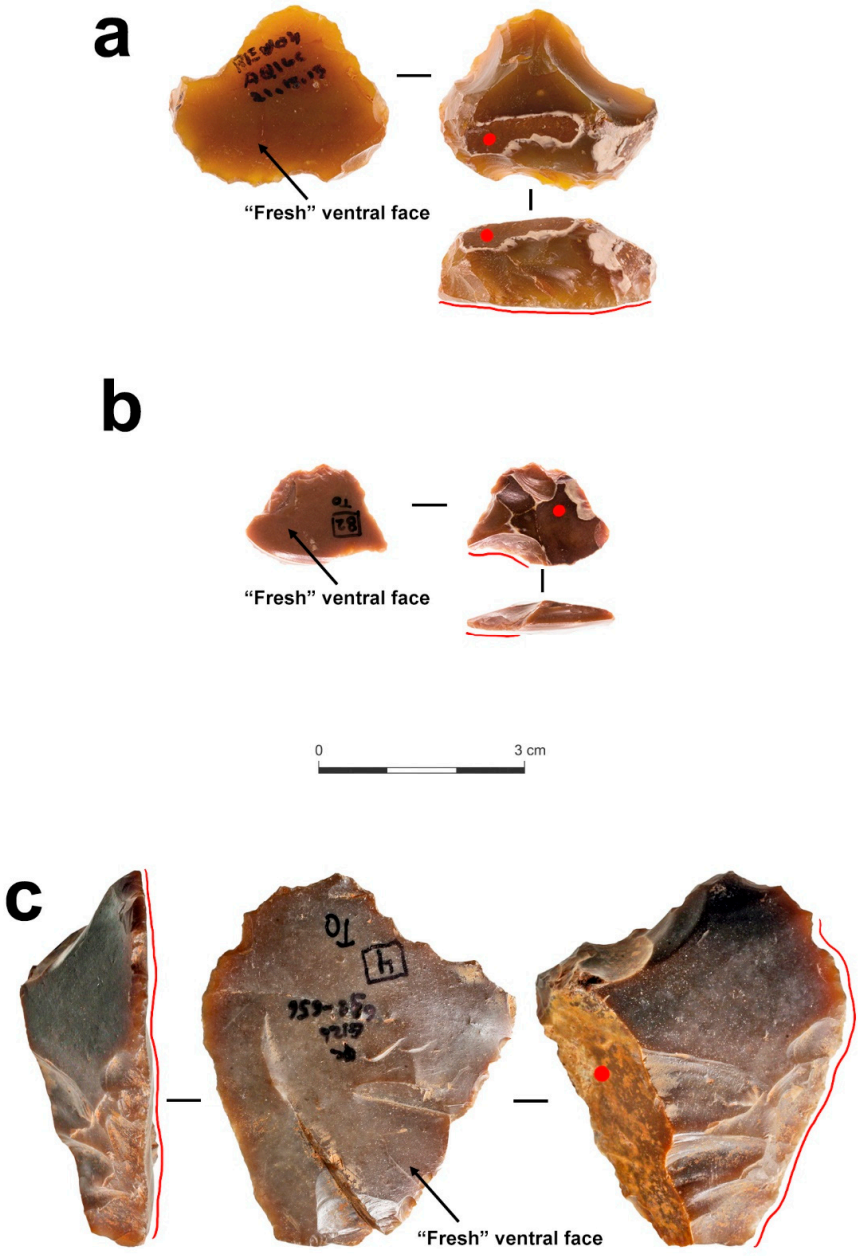

Figure 8. Type-A recycled patinated old items from Revadim (**a**), Jaljulia (**b**), and Qesem Cave (**c**). The patinated 'old' surfaces on the items' dorsal faces are noted (**red dot**), while the ventral surfaces clearly exhibit fresh flint or a different (**black arrow**), later type of patina matching the tools' retouch (**red line**).

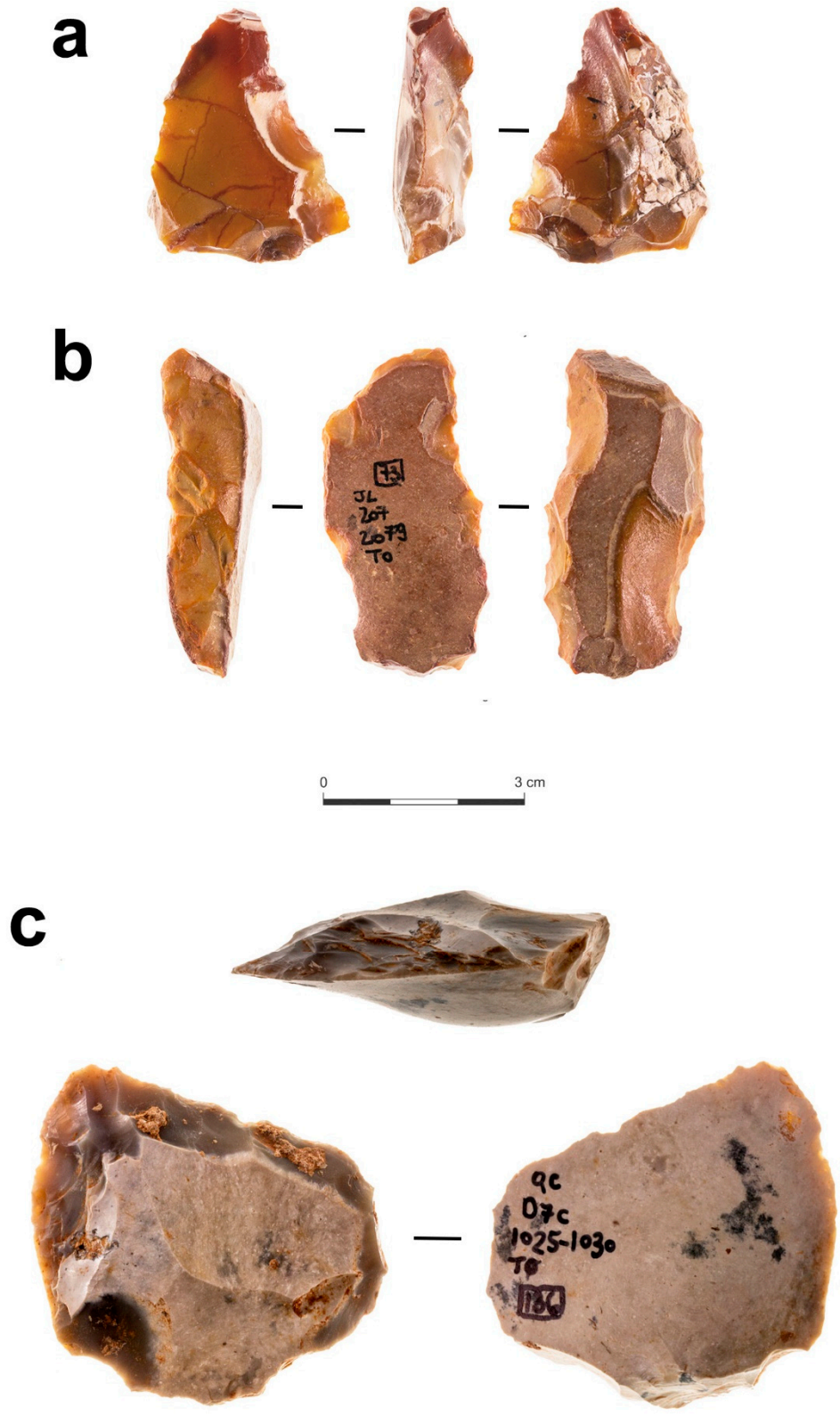

Figure 9. Type-B recycled patinated old items from Revadim (**a**), Jaljulia (**b**), and Qesem Cave (**c**).

We, therefore, contend that lithic recycling practices should also be viewed in cultural and social terms [24,27,105–108,116–118]. The same can be said regarding the collection of 'old' patinated items as workable materials at Revadim, Jaljulia, and Qesem Cave. We believe this practice should be viewed in the framework of traditional (in our case, ancient) ecological knowledge and use of resources and as a set of behaviors that combined necessi-

ties and cultural choices. Traditional ecological knowledge is referred to in the literature as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission about the relationship of living beings (including humans) with one another and with their environment. It is a subset of Indigenous knowledge, which is local knowledge held by Indigenous people or local knowledge unique to a given culture or society" [119]. Thus, we suggest that these choices were based on cultural settings, worldviews, perceptions, and economic and functional preferences, which eventually enhanced and dictated relationships and interactions between humans and their environment, including flint and existing flint tools as material mediums. Our interpretations have been published in the past [23,37,50] and will be further elaborated in the discussion part in accordance with the manuscript's results.

4. Materials and Methods

A total of 18 assemblages from the three studied sites were selected for this study based on the availability of detailed lithic analyses and their good state of preservation. Each assemblage represents a distinct archeological context (for a complete list and description of assemblages, see Supplementary Information). All selected assemblages were techno-typologically analyzed using methodology and terminology from previous studies [2,55,74,120,121] and following established definitions [122,123].

Recycled 'old' patinated tools were identified using only the naked eye, separated, and counted. No additional microscopic tools were used. Tools were classified and counted as recycled from 'old' patinated items if they carried flaked surfaces covered in patina, as well as later scars that cut through the patinated modified surfaces. These later scars either revealed the fresh color of the flint or were covered with a different later patina. When 'old' flaked surfaces could not be confidently distinguished from old cleavage surfaces or natural surfaces (e.g., cortex/neo-cortex), the items were not included in the PPF category. Hence, the numbers presented should be regarded as minimum estimations of the phenomenon in each site. This methodology follows previous studies [35,36] and the definition of Goodwin [29] for 'double patina': items "that have been modified again, thus leaving newer scars in unpatinated, or less patinated, condition" [29].

In the case of Qesem Cave, a light translucent patina was formed on some of the "fresh" items knapped and left on-site, perhaps due to specific post-depositional conditions in the cave [102]. This type of patina can only be observed microscopically; hence, it was not included in our analysis. In addition, the data gathered from the Amudian and Yabrudian assemblages at Qesem cave will be presented separately and compared due to characteristic differences between the industries.

5. Results

The analyzed tool sample reveals that patinated 'old' items were extensively collected and recycled into various types of tools at all three sites (Table 1): at Revadim, where four distinct assemblages were analyzed (amounting to a total of 3436 analyzed tools), 754 items were identified as recycled patinated items, constituting 22% of the analyzed tools. The extent of the practice at Jaljulia was even more evident. Out of two distinct assemblages (n = 4036 tools), 1661 tools were identified as recycled patinated 'old' items, constituting 41% of the analyzed tools at the site. Finally, Qesem cave presented smaller quantities, where the tools of 12 distinct assemblages assigned to the Amudian (n = 3660) or Yabrudian (n = 2001) industries were analyzed. A total of 741 recycled patinated tools were identified at Qesem Cave, constituting 11% and 17% of total tools assigned to each industry, Amudian and Yabrudian, respectively.

The quantities of type-A versus type-B recycled patinated tools differ noticeably between the Late Acheulian sites and AYCC Qesem Cave (Table 1; Figure 10). At Revadim and Jaljulia, most recycled patinated items were made on 'old' blanks (type-B), constituting very high percentages (82% for Revadim and 90% for Jaljulia) of the recycled patinated tool category. At Revadim, this tool category comprises 18% of all the tools, and 3% of total

débitage, and at Jaljulia, 37% of all the tools and 11% of the total débitage. At Qesem Cave, however, most recycled patinated tools were detached from 'old' human-made blanks (type-A), constituting 49% (Yabrudian) and 83% (Amudian) of the recycled patinated tool category and a small percentage of the total debitage (0.2% and 2% for Amudian and Yabrudian, respectively).

Table 1. A general breakdown of recycled patinated tools (including a breakdown of types A–B) available in Revadim, Jaljulia, and Qesem Cave (Amudian and Yabrudian). The cells displaying data about types A–B are shown in greyscale to visually represent the capacity of each type across the different sites in comparison to one another.

Site	Revadim	Jaljulia	Qesem Amudian	Qesem Yabrudian
Débitage	24,342	13,094	29,811	10,028
Total number of tools	3436	4036	3660	2001
Recycled patinated tools	754	1661	407	334
Recycled patinated tools out of the tool category	22%	41%	11%	17%
Tools made from fresh flint	2682	2375	3253	1667
Fresh tools out of the tool category	78%	59%	89%	83%
Recycled tools knapped from old patinated items (type-A)	139	163	337	165
Type-A out of total débitage	1%	1%	1%	2%
Type-A out of the tool category	4%	4%	9%	8%
Type-A out of the recycled patinated tools	18%	10%	83%	49%
Recycled tools on patinated blanks (type-B)	615	1498	70	169
Type-B out of total débitage	3%	11%	0.2%	2%
Type-B out of the tool category	18%	37%	2%	8%
Type-B out of the recycled patinated tools	82%	90%	17%	51%

Jaljulia has the most type-B recycled patinated tools (n = 1498) compared with the analyzed samples from the other sites. Revadim (n = 615) and the Yabrudian assemblages (n = 169) at Qesem follow, while the Amudian assemblages of Qesem have the smallest number (n = 70; Table 1). A comparison of the percentage of these recycled tools out of the entire tool category in each assemblage from each site further emphasizes this finding (Table 2): Jaljulia and Revadim have the highest percentage out of the entire tool category, ranging from 27 to 47% for the Jaljulia assemblages and 14 to 35% for Revadim. The Yabrudian assemblages of Qesem follow; however, they are still far behind, as type-B recycled patinated tools in the Yabrudian assemblages comprise only 6–10% of the tool category, with the Amudian assemblages showing the lowest percentages (1–6%). Most type-B recycled patinated tools in Jaljulia and Revadim are ad hoc tools: retouched flakes, notches, varia tools, and retouched fragments (Table 3). Although the percentages for these categories vary between Revadim and Jaljulia, both sites show much higher percentages than both the Amudian and the Yabrudian assemblages at Qesem.

Most type-B recycled patinated tools at Qesem Cave are scrapers, and most are found in the Yabrudian assemblages (Table 3; Figure 11). However, while the Yabrudian assemblages contain the highest percentage of type-B recycled patinated scrapers, the percentages of these scrapers at Revadim and Jaljulia (about 1% out of the entire tool category and 3% out of the recycled patinated tools) are similar to the Amudian assemblages of Qesem. However, if we look at the percentage of these scrapers out of the entire scraper category at each site, we see that it is higher in the Revadim and Jaljulia assemblages than in the Amudian assemblages at Qesem (44% and 43% at Revadim and Jaljulia, respectively, as opposed to only 12% at Amudian Qesem; Table 3).

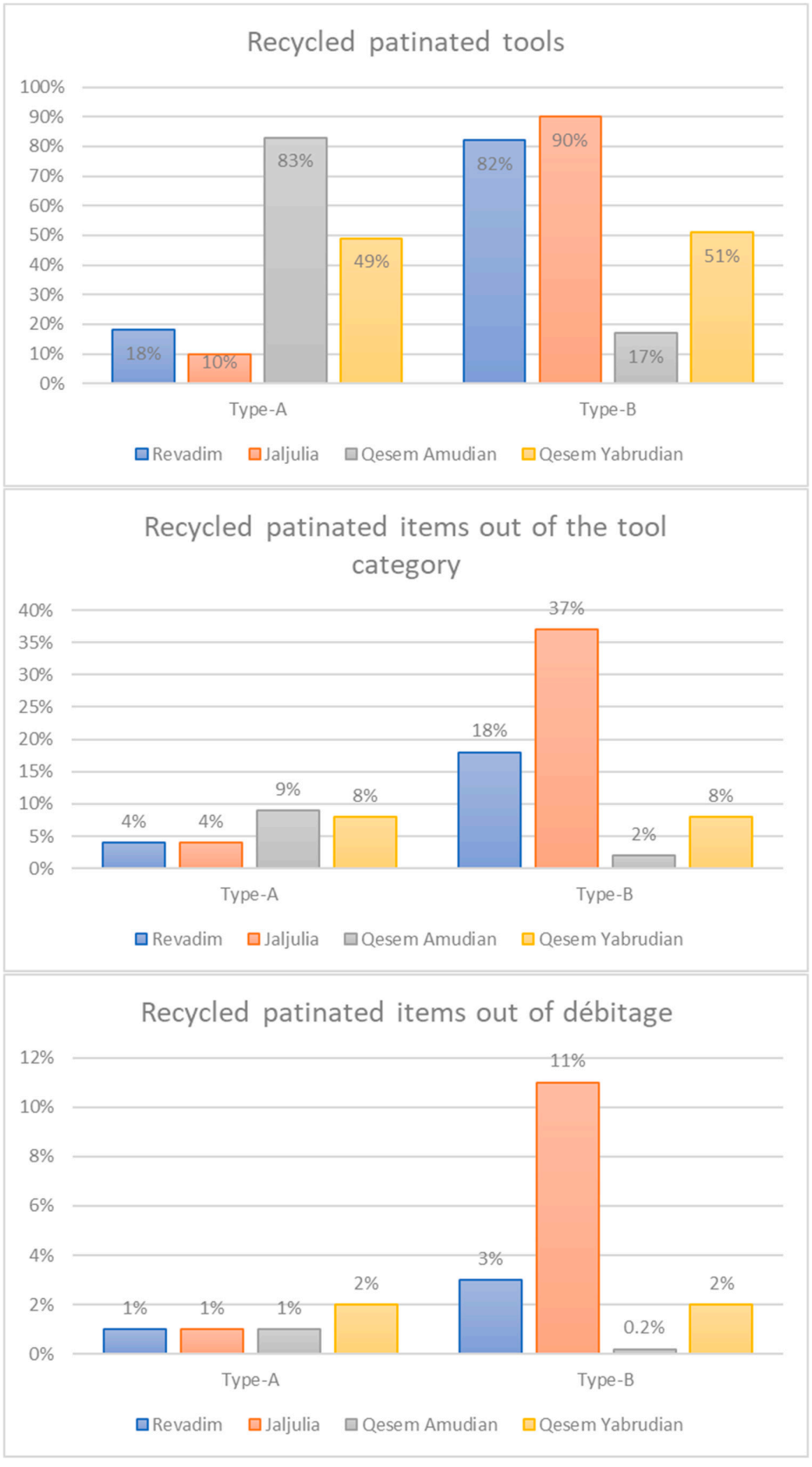

Figure 10. A visual representation of type-A versus type-B recycled 'old' patinated tools at each site. (**top**) A general breakdown of type-A and type-B recycled tools at each site. (**middle**) The capacity of type-A and type-B within the tool category at each site. (**bottom**) The capacity of type-A and type-B within the débitage of each site.

Table 2. Breakdown of recycled patinated tools made on patinated blanks (type-B) from Revadim, Jaljulia, and Qesem Cave. The cells displaying data about type B are shown in greyscale to visually represent the capacity of each type across the different assemblages and sites.

Site	Context	Débitage	Tools	Recycled Patinated Tools	Recycled Tools on Patinated Blanks (Type-B)	Type-B out of Total Débitage	Type-B out of the Tool Category	Type-B out of Patinated Tools
Revadim	Area B, Locus 20	3571	558	204	196	5%	35%	96%
	Area B, Locus 21	984	108	34	30	3%	28%	88%
	Layer C-3	18,048	2546	461	345	2%	14%	75%
	Layer C-5	1739	224	55	44	3%	20%	80%
Jaljulia	Area B	6998	2018	623	543	8%	27%	87%
	Area DII	6096	2018	1038	955	16%	47%	92%
Qesem Cave	Unit I (Amudian)	2889	363	44	15	0.5%	4%	34%
	K/10 (Amudian)	1278	178	20	1	0.1%	1%	5%
	G/19–20 (Amudian)	1582	380	46	2	0.1%	1%	4%
	Hearth (Amudian)	3307	283	27	3	0.1%	1%	11%
	South of Hearth (Amudian)	2877	158	24	10	0.3%	6%	42%
	Southern Area (Amudian)	6145	597	93	12	0.2%	2%	13%
	Shelf (Amudian)	7396	1199	68	10	0.1%	1%	15%
	Deep Shelf (Amudian)	4337	502	85	17	0.4%	3%	20%
	Unit I (Yabrudian)	455	109	23	8	2%	7%	35%
	Southwestern Area (Yabrudian)	1394	294	32	19	1%	6%	59%
	Shelf (Yabrudian)	4305	887	156	89	2%	10%	57%
	Deep Shelf (Yabrudian)	3874	711	123	53	1%	7%	43%

Table 3. Breakdown of six selected tool categories made on patinated blanks (type-B) from Revadim, Jaljulia, and Qesem Cave. Some of the cells displaying data about type B are shown in greyscale to visually represent the capacity of items across the different tool categories at each sites.

Site	Revadim	Jaljulia	Qesem Cave Amudian	Qesem Cave Yabrudian
Tools	3436	4036	3360	2001
Recycled patinated tools	754	1661	407	334
Recycled tools on patinated blanks (type-B)	615	1498	70	169
Retouched flakes	1385	1660	1163	500
Recycled patinated retouched flakes	265	738	147	69
Recycled retouched flakes on patinated blanks (type-B retouched flakes)	206	666	15	24
Type-B retouched flakes out of the tool category	6%	17%	0.4%	1%
Type-B retouched flakes out of the recycled patinated tools	27%	40%	4%	7%
Type-B retouched flakes out of the retouched flakes category	15%	40%	1%	5%
Type-B retouched flakes out of the recycled patinated retouched flakes	78%	90%	10%	35%
Notches	554	335	70	52
Recycled patinated notches	157	163	1	10
Recycled notches on patinated blanks (type-B notches)	137	144	0	4
Type-B notches out of the tool category	4%	4%	0%	0.2%
Type-B notches out of the recycled patinated tools	18%	9%	0%	1%
Type-B notches out of the notches category	25%	43%	0%	8%
Type-B notches out of the recycled patinated notches	87%	88%	0%	40%
Retouched fragments	750	848	767	378
Recycled patinated retouched fragments	155	242	79	31
Recycled retouched fragments on patinated blanks (type-B retouched fragments)	118	207	12	14
Type-B retouched fragments out of the tool category	3%	5%	0.3%	1%
Type-B retouched fragments out of the recycled patinated tools	16%	12%	3%	4%
Type-B retouched fragments out of the retouched fragments Category	16%	24%	2%	4%
Type-B retouched fragments out of the recycled patinated retouched fragments.	76%	86%	15%	45%
Varia tools	212	503	57	43

Table 3. *Cont.*

Site	Revadim	Jaljulia	Qesem Cave Amudian	Qesem Cave Yabrudian
Recycled patinated varia tools	54	292	10	5
Recycled varia tools on patinated blanks (type-B varia)	46	276	2	4
Type-B varia out of the tool category	1%	7%	0.1%	0.2%
Type-B varia out of the recycled patinated tools	6%	17%	0.5%	1%
Type-B varia out of the varia tools category	22%	55%	4%	9%
Type-B varia out of the recycled patinated varia tools	85%	95%	20%	80%
Scrapers	59	108	170	461
Recycled patinated scrapers	29	52	40	153
Recycled scrapers on patinated blanks (type-B scrapers)	26	46	21	115
Type-B scrapers out of the tool category	1%	1%	0.6%	6%
Type-B scrapers out of the recycled patinated tools	3%	3%	5%	34%
Type-B scrapers out of the scrapers category	44%	43%	12%	25%
Tpe-B scrapers out of the recycled patinated scrapers	90%	88%	53%	75%

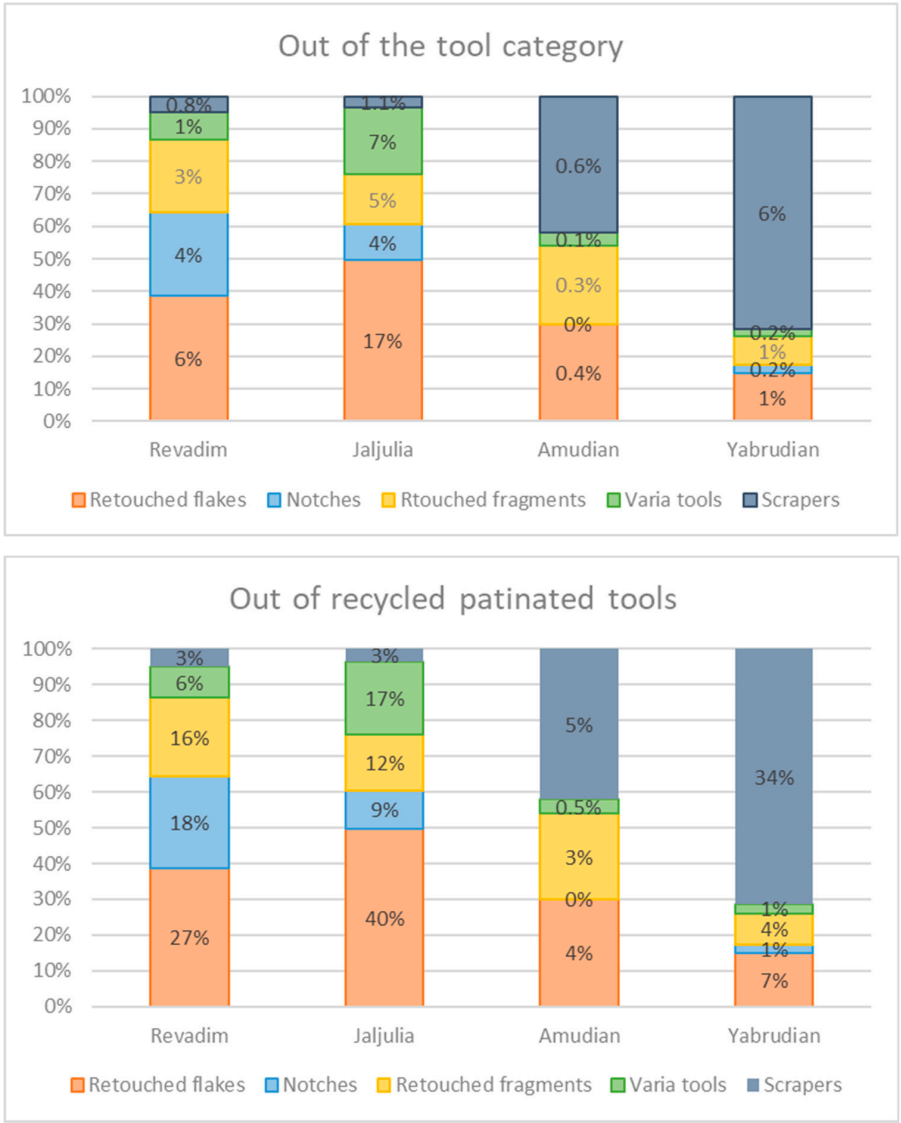

Figure 11. A visual representation of type-B recycled patinated tools from selected tool categories: retouched flakes, notches, retouched fragments, varia tools, and scrapers. (**top**) General breakdown of type-B recycled patinated tools within each tool category at each site, (**bottom**) General breakdown of type-B recycled patinated tools out of the total of recycled patinated tools at each site.

Overall, we can see from these results that, although the majority of tools at each site were made from fresh unpatinated flint (Table 1), recycled flaked patinated items comprise a significant portion of the tools in all the studied assemblages from all three sites.

6. Discussion and Conclusions

The study shows that old, patinated items were regularly collected and recycled into new tools at the following three late Lower Paleolithic sites in Israel: Revadim, Jaljulia, and Qesem Cave. These recycled flint items, which exhibit two life cycles with a clear time gap between them [2,36,37,50,89], were used alongside fresh flint and other items made by various technological means of recycling, such as the production of small flakes/blades from "parent" flakes, and the recycling of handaxes and scrapers into cores [2,7–11,24,59,66,85,100–102]. The current, more extensive sample is a significant addition to previously presented evidence from Revadim and Qesem Cave [36,37,50]. The results add important new evidence for the prevalence of the practice in different archeological contexts of the sites and throughout time.

As previously suggested [37], the items could have been collected during recurrent or extended stays at each site and locality, brought to the site from elsewhere during excursions, or selected from the arsenal of old flaked flint items available on-site from prior older settlements. We suggest that a combination of different collection strategies of old patinated items were practiced at each site. For example, in Qesem Cave, 'old' flaked patinated items are assumed to have been collected from the surroundings outside of the cave and brought in to be recycled and used again, most probably from older sites in different environments and localities. The collection of old blanks from within the cave does not seem to have been an option in the case the items discussed here, as the cave's patina is a light translucent patina that could not be identifiable using the naked eye [36,102] and could not be matched with the very distinct and present variations in patinas identified on the 'old' patinated blanks that were chosen to be recycled into tools. The considerable variation in color of the patinated surfaces found at Qesem may also support this assumption (Figure 7a) [36,50].

However, in the case of Revadim and Jaljulia, which are both open-air sites composed of multiple localities that were inhabited recurrently throughout the Late Acheulian, it is more likely that patinated flaked items were also collected from older localities within the sites themselves, alongside collection of old items from the vicinity of the site, and then brought to the designated contexts studied here [37]. The slight variation in color of the patinated surfaces (mainly yellow to orange in hue) suggests that the items were collected from similar environments (Figures 3 and 5). As the same types and colors of patina cover most of the lithic assemblages of both sites that are not considered recycled, we suggest that the option of collecting 'old' patinated blanks from older localities within the area of the sites is the most probable in the case of both Revadim and Jaljulia. Since lithic material was not in short supply, and fresh items that show no signs of patina or post-patina modifications are abundantly present in the same contexts and make the majority of the assemblage, we argue that these items were selected intentionally, especially given that conceiving and creating a new tool from an existing patinated item, whose shape and size are already fixed, is not necessarily an easier task and would have posed challenges to the knapper that would not be encountered when creating a tool from fresh material [37,50].

The variation in types/categories of tools in the samples from each site strengthens our previous suggestion that 'old' patinated items were considered workable materials. At both Revadim and Jaljulia, old patinated items served as blanks for new tools more often than they served as material from which new blanks were created, whereas Qesem Cave represents a different pattern, where the type-A recycled tools are far more common. The significant variations in recycling 'old' tools and in the frequency of recycled tools detached from old patinated items (type-A) versus that of recycled tools made on old patinated blanks (type-B) at Qesem in comparison to the Late Acheulian sites can perhaps be explained as a matter of preference, as the recycling practice and both trajectories were

available in both studied cultural complexes. The variations may also have stemmed from differences in cultural settings of prehistoric Late Acheulian people versus Acheulo-Yabrudian, which also dictated a change in worldviews and practices. However, a more holistic comparison of additional Acheulian and Acheulo-Yabrudian sites is required to more confidently support this hypothesis, which would also benefit from a comparison of open-air versus cave sites to examine whether the nature of the site was a component in the cultural preferences of the inhabitants. Nevertheless, the presence of both types of recycling old patinated items at all three sites and the quantitative differences in the modes of recycling at each site indicate that such preferences did exist, and we believe that cultural worldviews and practices played a role in dictating the preferred recycling trajectory—inter and intra-site alike.

The type-B trajectory is the most curious mode of recycling old patinated blanks. Made on completely patinated flaked blanks, the new tools underwent precise and minor modifications aimed at creating a new working edge while still preserving the old items' original morphology and appearance (Figure 9). The question of why the 'old' items were so minimally reworked cannot be definitively answered. We give our interpretation that does not contradict the item's functional aspects in the collection process of potential workable 'old' blanks or in their manner of recycling to achieve a new tool. We suggest that minimal reworking of the 'old' blanks might have also stemmed from the desire to preserve memories and experiences in a multidimensional sensorial manner that allows the new users to participate and engage with the past and present through seeing, touching, relating, and using [23,37,50,124]. The preservation of memory and mindful experience were both visual and physical: the old item's original appearance, old scars, and colorful patinated surfaces were preserved as much as possible, as was their new functionality [23].

Whether appearing in high or low quantities, this group of recycled tools presents interesting inter and intra-site quantitative patterns. At Revadim and Jaljulia, most type-B tools are ad hoc (fragments and retouched notches), as further evidenced by the large quantity of retouched tool fragments found at both sites. The intra-site differences are more clearly manifested in the complete pieces: Jaljulia is oriented towards more notches recycled in this manner, while Revadim is oriented towards more retouched flakes. Qesem, where almost all the recycled patinated type-B tools are scrapers from the Yabrudian assemblages, presents a completely different pattern. Their frequency in comparison to the Amudian assemblages is too great to be attributable merely to the characteristic dominance of scrapers in Yabrudian contexts. They might, thus, represent a preference of past people rather than a known bias. By choosing to recycle most patinated 'old' blanks at Qesem into scrapers in a manner that preserves the old item's morphology as well as the color and texture of the patina, the Qesem knappers might have been paying tribute to the vital role of this tool, in their daily practice as well as in their perception and worldviews. In addition, it seems that the inhabitants of Qesem Cave made some of the recycled patinated scrapers from old scrapers. Figure 12 shows two scrapers from Qesem Cave that show clear evidence of an older, patinated Quina retouch, which the new Quina retouch cuts. A future technological study coupled with functional analysis may be able to suggest if the recycled scrapers were recycled to pay tribute not only to the memory of the 'old' tool and its history but also regarding its function during its multiple life histories [37].

We previously suggested that collecting and recycling 'old' patinated items into new tools in such a specific manner was an intentional behavior not motivated solely by functional reasons or shortage, but also for their perceived potency and the experiences they may have evoked during the encounter with them [23,37,50]. In this paper, we presented new evidence on the practice of collecting and recycling 'old' patinated items into tools from Jaljulia. These new data strengthen the understanding of the magnitude and capacity of the practice during the Lower Paleolithic. As mentioned, we suggest that this mode of lithic recycling should also be viewed in cultural and social terms, in the framework of ancient ecological knowledge and use of resources and as a set of behaviors that combined necessities and cultural choices [24,27,105–108,116–119], based on cultural settings, world-

views, perceptions, and economic and functional preferences, which eventually dictated relationships and interactions between humans and their environment, including flint and existing flint tools as material mediums [23,37,50]:

First, we suggest that collecting and recycling existing old items, specifically in the type-B method, is a different endeavor than conceiving and creating a new tool from an existing patinated item of predetermined size and shape. We do not contend that one recycling trajectory is more straightforward to create than the other, nor that collecting and recycling older patinated items, in general, is an easier or harder task than making tools from fresh material. Rather, creating a tool from fresh versus existing material is different. Each affords the knapper different options for shaping the material as desired, correcting mistakes, and overcoming any material faults. Thus, we suggest that there was a shift in perception, a conscious decision-making process behind the recycling process of type-B tools, which, in our opinion, suggests the practice was not solely driven by mere practicality and efficiency. Producing a technologically identical end product that is functional yet visually preserves the original, with its multiple types of memories and experiences, requires a mindful shift from the standard technical procedures and decisions a knapper will follow to create a tool from fresh unaltered flint. The material from which the knapper begins the creation process is already a finished product, with limited options for styling and reshaping. The case of type-B Quina and demi-Quina scrapers made from older scrapers from Qesem Cave (Figure 12), as well as examples from Revadim [37], can further strengthen the conscious choice of old blanks wished to be recycled for functional reasons as well as reasons that stem from cultural worldviews.

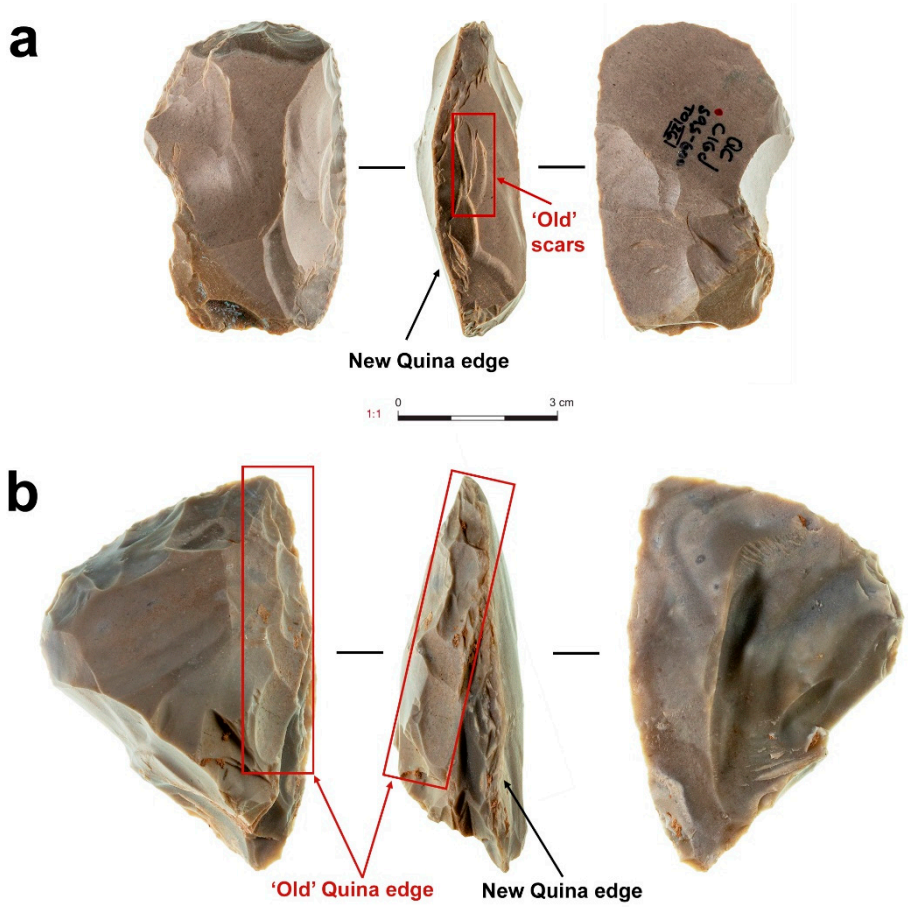

Figure 12. Recycled patinated Quina scrapers from Qesem Cave, made from 'old' patinated Quina scrapers (items **a**,**b**). Both scrapers show clear evidence of the presence of an older, patinated Quina retouch (marked in red), which the new Quina retouch cuts (marked with a black arrow).

Thus, we see this required shift from the standard procedure as a conscious and mindful cognitive process along the lines of Wynn et al. [125] and Malafouris [126,127]. We suggest that the process of recycling existing old items was a conscious process that was not internal but rather very much embodied, embedded, enactive, and extended (4E cognition), having very much to do with the engagement with the old object's features and properties to afford a successful end product from an already finished product. While 4E cognition is relevant in the case of flint knapping in general, starting from the Lower Paleolithic Period, we suggest that the case of recycling existing old objects into new tools using minimal procedure (type-B tools) makes somewhat of an extreme example of how the cognitive process is equally dependent on the material, how perception and mind are shaped during human–material co-engagement, and perhaps even how we can think about mindful consciousness and perception in early prehistoric periods, as, again, in the case of this study the material is already a finished product that may limit if the traditional thinking process and technical procedures of flint reduction and knapping were used.

Second, we further consider the technical process of the type-B recycling trajectory to be conceptually and technically analogous to the Readymade technique, known from the world of modern plastic art [50], where existing objects are given new meaning and function. In collecting 'old' items and recycling them using readymade-like concepts and techniques into new tools, prehistoric people during the Late Lower Paleolithic exhibited a complex and conscious decision-making process that went well beyond mere practicality and efficiency.

Third, we further suggest that the practice served as a preservation technique. Readymade-like in its approach, it reflects a complex interplay of necessity, cultural choices, and memory preservation. The aim of preservation in the new tools was potentially the deep past, whether of old private/communal memories, to pay homage to older groups and entities (human or natural), or to mark familiar and important locations. We propose that the practice served to preserve old memories through attention to and acknowledgment/awareness of old makers and users or even the mnemonic memories the item may have evoked in the new collector. Imbued with potency due to the deep impression they made on the collector at the moment of encounter, these items would also have evoked consequent experiences that the collector might have wished to acknowledge [23], while attributing new meaning and function to the collected patinated items through their insertion into a new functional and cultural sphere. By preserving the properties of the 'old' patinated items in the new tool, past people may also (alongside the functional purpose of the tool) have been trying to preserve and highlight the item's itineraries and accumulated significance [128–130]. This purposeful pattern might have stemmed from the inhabitants' desire to preserve the memory of older groups and entities (cosmological or natural) [6,17,22,41,43–47,50], familiar/important locations (even their own settled locality, as is the case of Revadim and Jaljulia, where 'old' flaked items were likely collected from the sites themselves) [17,37,43,47,50,130–133].

Fourth, the 'old' blanks preserved in type-B recycled tools might have been imbued with a perceived potency and chosen for their evoked experiences, connecting the past and present through a multidimensional sensorial manner. Therefore, we also suggest that 'old' patinated items were intentionally selected and integrated into the practical tool sets of the site's inhabitants due to items' perceived potency and the experience [22] gained during their previous life cycle [23,37,50]. Additionally, these items may have captured the attention of the collector and user due to their personal memories, practices, and preferences. In other words, "old" items may have been chosen, collected, and recycled to be preserved and reintegrated into functional and social realms for personal sentimental, mnemonic, esthetic, or cultural significance that the collector and/or user may hold [18,50,134–137].

We, thus, see the collection and recycling of double-patinated items as a functional process as well as a preservation technique that is readymade-like in that it "protects" the old features of the collectible item while also creating its new functional and visual attributes [23,37,50]. The intensity of the practice and the visual appearance of the items

(i.e., preserving old with new) speak for themselves. Moreover, variations in recycling practices across the three sites may suggest that cultural settings, worldviews, perceptions, and economic and functional preferences can influence these practices.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/quat7040058/s1, SI text: The studied assemblages; Figure S1: Site plan of Revadim showing the location of the excavated areas and the studied contexts (numbered as in text); Figure S2: Top plan of Revadim Area B, Layer B2 showing the location of loci 20-21 (numbered as in text); Figure S3: Stratigraphic plan of Area C, showing the stratigraphic location of Layers C3 and C5 in the sequence; Figure S4: Site plan of Jaljulia, showing the location of the excavated areas and the studied contexts (numbered as in text); Figure S5: Site plan of Qesem Cave, showing the location of the studied areas (numbered as in text); Table S1: A list of the studied assemblages and additional information.

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Data Availability Statement: The data supporting this study are included in the article and the Supplementary Material.

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