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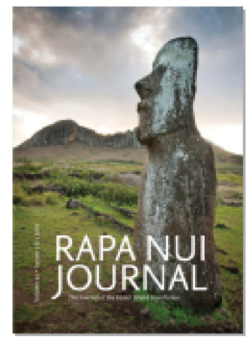

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The Many Uses of *Matā* on Rapa Nui

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Obsidian tools with a stem or tang attached to a blade and known as matā have been recovered from a broad range of archaeological contexts on Rapa Nui. Their highly variable morphology suggests that this class of artifact had multiple, but too few analyses of their use-wear have been conducted to be confident about the relationships between form and use. A sample of 22 matā from sealed archaeological deposits in a cave on the southern coast of Rapa Nui and ranging in age from ca. A.D. 1300–1800 were analyzed using high power magnification. The patterns of use-wear scarring, striations, polishes, and residues demonstrate that the tools were all hafted and were used in a broad range of activities including fish processing and the manufacture and/or decoration of wooden, bone, and shell artifacts. The results demonstrate the importance of additional comprehensive use-wear and residue studies for understanding the multiple roles of matā within ancient Rapa Nui society.

Keywords: Rapa Nui, *matā*, obsidian, use-wear, residues, hafting

Introduction

Among the most distinctive items of prehistoric Rapa Nui material culture are retouched obsidian artifacts known as *matā*. Although highly variable in shape and size (Lipo et al. 2016), the defining feature for *matā* is the presence of a protrusion known as a "tang" or "stem" (e.g., Mulloy 1961; Stevenson et al. 1984; Bollt et al. 2006; Mulrooney et al. 2014:302). The stem was created by making two notches on the periphery of a flake, but in most cases it was further shaped and more clearly discriminated from the body by the application of additional retouch (Fig. 1). Influenced by Captain Cook's observation in 1774 of an obsidian tool mounted on the end of a "spear" (Beaglehole 1969:344), scholars have speculated about the tasks for which *matā* were used and their roles within society (e.g., Métraux 1940; Church 1998; Bollt et al. 2006; Stevenson et al. 2013; Mulrooney et al. 2014; Lipo et al. 2016; Torrence et al. 2018). Given the paucity and potential unreliability of historic accounts based on first-hand observations about how *matā* were used, the task of reconstructing the function of this pervasive artifact type must be shouldered by archaeological research.

The oral history recorded by Métraux (1940:165), along with observations recorded by González (Corney 1903) and Geiseler (1883:36), describes the use of *matā* within the context of island conflict. In these accounts, *matā* were attached to wooden shafts and served as spears or short-handled javelins that were thrown at the enemy. In contrast, Lipo

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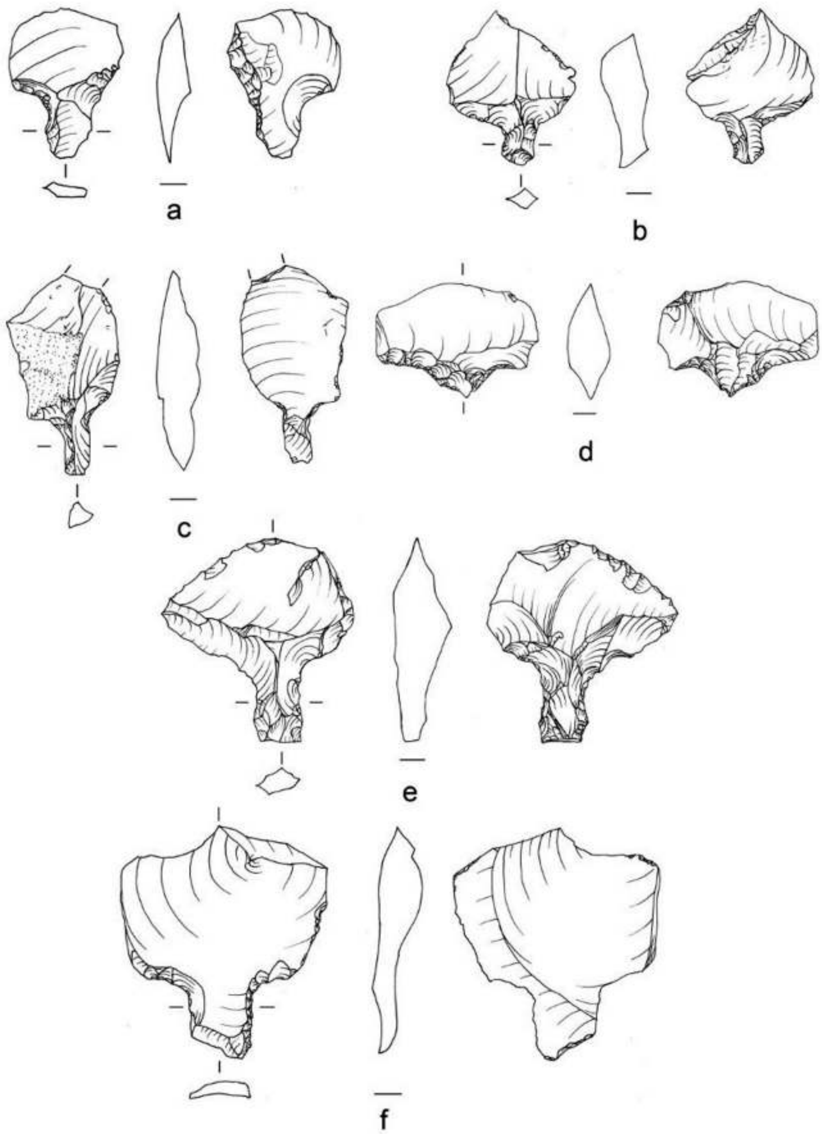

Fig. 1. Examples of *matā* from Site 6-58 illustrate wide variation in blank and stem sizes and shapes. (a) RBC-694; (b) RBC-681; (c) RBC-679; (d) RBC-686; (e) RBC-671; (f) RBC-685. Scale bars are 1 cm. Drawings by Angela Rosenstein.

et al. (2016) argue that due to their unstandardized morphology, the long-held assumption that *matā* had been used as spear points within conflict situations is incorrect. Unfortunately, their negative result does not contribute to an understanding of their roles in daily and/or ritual life on Rapa Nui. Based on microscopic use-wear studies of 13 *matā* from three sites, Church and Rigney (1994), Church and Ellis (1996), and Church

(1998) proposed the tools were used for plant processing. A serious limitation with these pioneering use-wear studies, however, is that the full data on use-wear traces were not provided and due to publishing restrictions, the interpretations of artifact function were not supported by detailed descriptions and photographic documentation. The scarcity of data about how *matā* were used in the past is also surprising since they were extensively used in the past. They are common finds at both domestic and ritual sites on Rapa Nui (Mulloy & Figueroa 1978; Stevenson & Haoa 2008) and there are sizeable museum collections (e.g., Mulrooney et al. 2014). To further address this problem, a more recent study by Torrence et al. (2018) analyzed a further 12 *matā* housed in the Australian Museum. The results expanded the types of worked materials to include bone, shell and, significantly, the cutting and piercing of skin or flesh, indicating a wide range of contexts in which these tools were employed. The aim of the current use-wear analysis of 22 *matā* recovered from Site 6-58, a cave located on the southern coast of Rapa Nui (Fig. 2) (Stevenson et al. *in prep.*), is to employ updated methodology to enhance the existing body of fully documented use-wear studies and therefore contribute to a better understanding of the functions and cultural contexts in which these distinctively retouched obsidian artifacts were used.

A key question raised by the morphology of the *matā* is why people invested effort in the manufacture of the stem. Is it primarily a stylistic character that was meaningful within Rapanui culture (e.g., Torrence et al. 2018:12), or did it have a largely mundane role, perhaps related to the character of tool use? From a functional point of view, the most

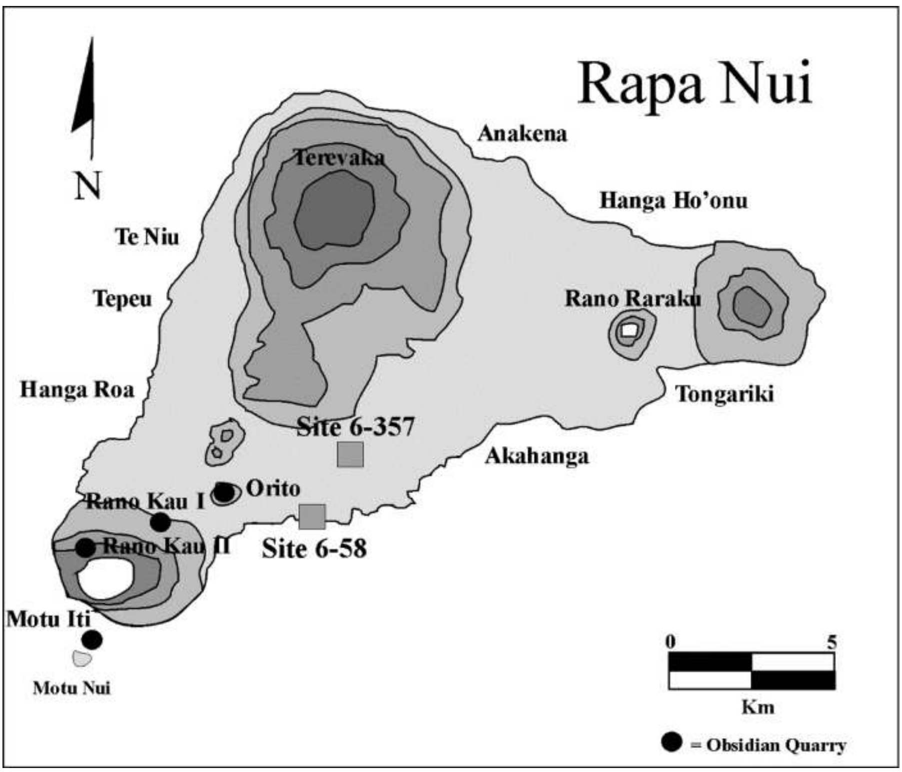

Fig. 2. Rapa Nui obsidian sources and Sites 6-58 and 6-357.

obvious hypothesis would be that stems were created specifically to be used as handles because they enable a secure grip leading to an increase in precision of tool use. The addition of a handle can also improve the force and accuracy of tool use by acting as a lever (Rots & Williamson 2004; Rots 2010; Kononenko et al. 2015). Used in this way, the *matā* stem could have been grasped directly by the hand or incorporated into some form of haft. For instance, the tang could have been covered by another material to improve traction and/or to offer protection from the sharp retouched edges of the obsidian (cf. Kononenko et al. 2015). In the latter case, the stem might have been wrapped with a soft substance (e.g., a pliable plant material or *tapa* cloth), as noted by Geiseler (1883), covered by a malleable material that later hardened, as in the case of obsidian daggers from the Admiralty Islands (e.g., Torrence 1993:474), or inserted into, or bound onto, a wooden handle (e.g., Golson 1977; Rots & Williamson 2004; Rots 2010:9; Kononenko et al. 2015).

Given the assumption that stems had a mundane, functional role as handles, we explore functional causes for the large variability in the shapes and sizes of *matā* stems and bodies. One might expect that the morphology would have been carefully selected to perform specific functions. In addition to evaluating the presence of hafting, the use-wear/residue analyses also investigated the relationship between the presence of a stem, the number and shape of the used edges, and the tasks in which this class of artifacts was employed. Finally, the study returns to the question of whether and to what degree *matā* represent a specialized tool form.

A second set of research questions derives from the archaeological context of the study sample. Since Site 6-58 was used at various times ranging from the fourteenth to the nineteenth century (Stevenson et al. *in prep.*), the analysis of the *matā* also provides an opportunity to address possible changes in the function of the tools through time. First occupied ca. 600 years ago, there is a clear break in the activities that took place at Site 6-58 about 200 years ago, when a white clay floor was deliberately laid down, effectively sealing the underlying deposits. Stevenson et al. (*in prep.*) argue that the emplacement of the floor marks a deliberate change in cave occupation from a coastal fishing camp to a place prepared for ritual, possibly linked to the Birdman Cult. The recovery of a large sample of *matā* from Site 6-58 provides an opportunity to investigate the broader issue of ritual caves on Rapa Nui (Stevenson et al. 2019).

Artifact Sample

The *matā* included in this study were excavated from Site 6-58, an architecturally modified cave located on the southern coastline of Rapa Nui (Fig. 2). Conventionally known as refuge caves, or *ana kionga*, these kinds of sites have a restricted tunnel entrance of several meters in length that leads to a dark and damp interior room. Excavations at a similar cave (Site 6-357) located 1.5 km to the northeast (Stevenson et al. 2019) (Fig. 2) showed that sites of this type are characterized by interior stone platforms, side chambers built of stacked stone, and purposefully constructed white clay floors upon which deposits with high densities of faunal and shell material had accumulated (cf. Rorrer 1997, 1998). Radiocarbon and obsidian hydration dating place the peak usage of Site 6-357 at ca. A.D. 1788 with an occupational range of approximately A.D. 1700–1785. Due to the elaborate preparations within the cave, the excavators argued that architecturally modified caves were precincts for the enactment of rituals, potentially connected with the Birdman Cult, and not places of refuge in times of conflict (Stevenson et al. 2019). Since Site 6-58 has many parallels to Site 6-357, including a tunnel entrance and an installed white clay floor, it may also have been used for rituals.

The stratigraphic relationships at Site 6-58 which form the basis for reconstructing the history of site use are clearly shown in the soil profile from Test Unit F (Fig. 3). As described in detail by Stevenson et al. (*in prep.*), the early Phase 1 at Site 6-58 represents a relatively long period of site use roughly between A.D. 1300 and A.D. 1800, based primarily on five obsidian hydration dates from the deepest level of Test Unit F that ranged from A.D. 1297 to A.D. 1607. While obsidian dates have the underlying weakness of being skewed by recycled artifacts from other contexts, the early phase is supported by summed

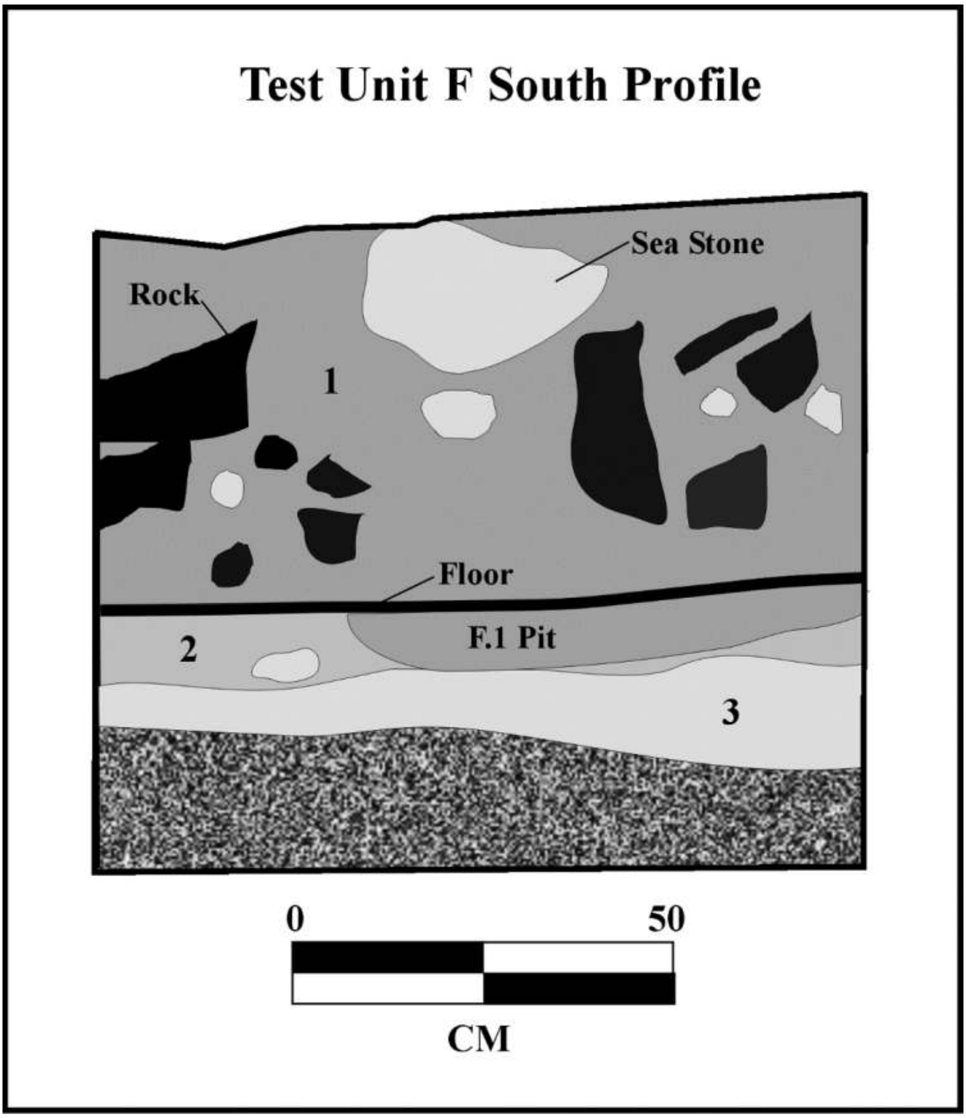

Fig. 3. South wall soil profile of Test Unit F at site 6-58 on Rapa Nui (see Fig. 2 for site location).

probabilities from five AMS dates on short-lived species that show a period of intermittent use between A.D. 1640 and A.D. 1730. The coastal location of the cave, high densities of fish remains, and the recovery of two fishhooks argues for the occupation of the cave in Phase 1 by people involved in fishing or littoral resource collecting (Rorrer 1997:Appendix D). In Phase 2 (ca. A.D. 1800) a white clay floor was laid down over the earlier layers, effectively sealing them in place. There are no artifacts associated with this phase. During Phase 3, dating to ca. A.D. 1800–1850 with peak usage around A.D. 1811, soil deposits containing artifacts accumulated on the surface of the installed floor. Finally, Phase 4 represents a period of post-abandonment sedimentation from rainwater runoff and occasional late nineteenth to twentieth century use of the cave.

Our study analyzed 18 *matā* from Phases 1, 3, and 4 together with four additional examples from unknown contexts (Table 1). In terms of the attributes reported in Table 2, the high level of variability in morphology noted in previous studies (e.g., Lipo et al. 2016) was replicated in this assemblage. Six unretouched flakes were also analyzed for comparison (Table 1). Although not a representative sample of the debitage at the site, the wear patterns preserved on the flakes are relevant for understanding if the *matā* had special uses not represented within the broader assemblage of obsidian artifacts.

Among the *matā* sample, 17 are complete tools and 5 are broken (3 bodies and 2 stem fragments). If the *matā* were considered as "specialist" tools restricted to certain tasks, it might be expected that they were produced using a specific blank form. Based on complete *matā* and body fragments, the major blank form used for the tools at Site 6-58 were *kombewa* (double-bulbed) flakes (55%) (cf. Bollt et al. 2006) as expected given the Stevenson et al. (1984) study of production at the Orito quarry, but a significant portion were also made using non-*kombewa* flakes (45%), three of which retained some cortex. All blanks are quite irregular both in plan-view and in cross-section. Given the results of the use-wear study reported below, it seems likely that the properties of the edges may have been more important in selecting a blank form than a standardized outline shape.

Geochemical Characterization

A geochemical characterization study was made to identify the raw material sources used to make the *matā* in the study sample, because choice of stone type could reveal social variables that structured access to the sources or physical factors that affected how the tools were used. The chemical composition of the raw material used to produce the 28 artifacts from Site 6-58 was compared with 114 source samples collected from the four obsidian sources on Rapa Nui (Stevenson et al. 2013) (Fig. 2). Elemental concentrations (ppm) for elements previously shown by Stevenson et al. (2013) and Mulrooney et al. (2014) to be useful for the discrimination of Easter Island obsidian sources (Mn, Fe, Zn, Ga, Th, Rb, Sr, Y, Zr, Nb) were obtained using a Bruker Tracer III-IV portable XRF (pXRF) spectrometer equipped with a Rh tube and a filter consisting of 6 mil copper (Cu), 1 mil titanium (Ti), and 12 mil aluminium (Al). Levels of accuracy and precision and the calibration used for this instrument are documented in Torrence et al. (2013). Analyses were conducted in air using a single beam at 40 kV and 20 μA with three locations on each sample analyzed for 180 s each. The full chemical results (ppm) obtained from the pXRF calibration are reported in Appendix 2.

The concentrations (ppm) for each specimen were averaged and statistical analyses were conducted using both the original and log10-transformed data. To match artifacts with the

Table 1. Summary of results from use-wear and residue study of artifacts from Site 6-58. RBC is a cataloguing convention which refers to the Richard Bland Collection.

Phase	Lab No.	Unit	Level	Artifact Type	Blank Form	Used Edge Location*	Used Edge Shape	Action	Material	Haft
1	RBC-673	A	7	*Matā*	*Kombewa* flake	Left margin, distal end	Margin-straight, distal-convex	Margin-sawing, some whittling; distal-scraping	Resinous woody plant	Wooden handle
1	RBC-674	A	7	*Matā*	Cortical flake	Right margin	Straight	Cutting/slicing	Meat/skin	Wooden handle
1	RBC-679	D	10	*Matā*	Cortical flake	Right margin	Convex	Cutting/slicing	Meat/skin	Wooden handle
1	RBC-680	D	10	*Matā*	*Kombewa* flake	Left margin, distal end	Margin-straight, distal-convex	Margin-whittling; distal-scraping	Resinous woody plant	Wooden handle
1	RBC-681	E	9	*Matā*	Flake	Left margin	Straight	Gutting/cutting	Fish	Wrapped and inserted into wooden handle or hand-held
1	RBC-682	E	9	*Kombewa* flake	*Kombewa* flake	Both margins	Straight	Both margins-sawing	Shell/bone	Unknown
1	RBC-683	E	9	*Matā*	Flake	Left margin, distal end	Margin-concave, distal-straight	Margin-sawing; distal-scraping	Siliceous woody plant	Wooden handle
1	RBC-686	F	6	*Matā*	*Kombewa* flake	Distal end	Convex	Scraping	Shell/bone	Unknown
1	RBC-687	F	6	*Matā*	*Kombewa* flake	Left margin	Straight	Gutting/cutting	Fish	Wooden handle
1	RBC-688	F	6	*Kombewa* flake	*Kombewa* flake	Not used	Not used	Absent	Absent	Unknown
1	RBC-689	F	6	*Kombewa* flake	*Kombewa* flake	Not used	Not used	Absent	Absent	Unknown
1	RBC-690	F	6	*Matā* body	Flake	Both margins	Left-irregular, right-convex	Sawing/whittling	Shell/bone	Unknown

Table 1 (*Continued*)

Phase	Lab No.	Unit	Level	Artifact Type	Blank Form	Used Edge Location*	Used Edge Shape	Action	Material	Haft
1	RBC-691	F	7	*Matā*	*Kombewa* flake	Right margin, distal end	Margin-straight, distal-concave	All edges-scraping	Siliceous woody plant	Wooden handle
1	RBC-692	F	8	*Matā*	*Kombewa* flake	Distal end	Convex	Cutting/slicing	Soft plant/tuber	Wooden handle
3	RBC-669	A	5	*Matā* body	Flake	Both margins, distal end	Left-straight, right-convex	Scraping	Woody plant	Unknown
3	RBC-670	A	5	Flake	Flake	Both margins	Distal-irregular, left-straight, right-convex	Both margins-cutting	Soft plant/tuber	Unknown
3	RBC-671	A	5	*Matā*	*Kombewa* flake	Left margin	Straight	Whittling	Siliceous woody plant	Wooden handle
3	RBC-672	A	5	*Matā* body	Flake	Not used	Not used	Absent	Absent	Unknown
3	RBC-677	C	3	Flake	Flake	Left margin, distal end	Left-straight, distal-concave	Both edges-sawing	Siliceous woody plant	Unknown
3	RBC-678	D	8	Flake	Flake	Left margin, distal end	Left-irregular, distal, irregular	Left-sawing, distal-scraping/ whittling	Woody plant	Unknown
3	RBC-684	F	5	*Matā*	*Kombewa* flake	Left margin, distal end	Margin-straight, distal-irregular	Margin-sawing; distal-scraping/ some whittling	Woody plant	Wooden handle
3	RBC-685	F	5	*Matā*	*Kombewa* flake	Left margin	Straight	Cutting/slicing	Soft plant/tuber	Wrapped in plant material
4	RBC-675	B	3	*Matā*	*Kombewa* flake	Distal end	Convex	Whittling/ chiseling	Woody plant	Wrapped in plant material
4	RBC-676	B	3	*Matā* stem	Unknown flake	Not used	Not used	Absent	Absent	Unknown

Table 1 (*Continued*)

Phase	Lab No.	Unit	Level	Artifact Type	Blank Form	Used Edge Location*	Used Edge Shape	Action	Material	Haft
Unknown	RBC-693	I	1	*Matā*	Flake	Both margins, distal end	Margins-straight, distal-convex	Left margin-sawing; right edge whittling; distal end chiseling	Woody plant	Unknown
Unknown	RBC-694	I	2	*Matā*	*Kombewa* flake	Distal end	Convex	Cutting/slicing	Meat/skin	Wooden handle
Unknown	RBC-695	J	4	*Matā* stem	Unknown flake	Absent	Absent	Absent	Absent	Wrapped and inserted into wooden handle
Unknown	RBC-696	J	4	*Matā*	*Kombewa* flake	Both margins, distal end	Margins-straight, distal-convex	All edges-cutting/slicing	Soft plant/ greens	Wooden handle

* Identification of left and right edges is based on the dorsal face. For *kombewa* flakes, an estimate was made.

Table 2. Metrics for *matā* from Site 6-58. Length is defined as the maximum dimension. Width is the maximum dimension measured along an axis perpendicular to length. RBC is a cataloguing convention which refers to the Richard Bland Collection.

Ref. No.	Length (mm)	Width (mm)	Weight (g)	Stem Length (mm)	Stem Width (mm)	Stem Thickness (mm)	Retouch on Stem	Stem Location on Flake	Stem Aligned in Middle of Tool	Skinner Typology	Bollt Typology
RBC-673	63.9	39.5	21.3	16.3	15.6	8.5	Unifacial	Lateral	Yes	4	1
RBC-674	64.1	50.6	27.4	26.7	17.8	8.3	Bifacial	Proximal	Yes	1	1
RBC-679	74.5	38.7	27.9	21.7	9	11.1	Unifacial	Platform	Yes	5	2
RBC-680	65.6	58.3	41.6	20.5	13.5	12.4	Bifacial	Lateral	Yes	1	1
RBC-681	61.8	49.9	28.9	14	12.1	8.3	Bifacial	Distal	No	5	2
RBC-683	75	36	41.7	23	10	13	Bifacial	Lateral	No	6	3
RBC-686	48	69	43.6	12	14	8	?Bifacial	Lateral	Yes	1	1
RBC-687	65.1	37	21.5	19	14	10	Bifacial	Proximal	Yes	1	1
RBC-691	59.6	70	31.7	31	18	10	Bifacial	Proximal	No	6	1
RBC-692	61.6	60	35.5	25	20	13	Bifacial	Lateral	No	1	1
RBC-671	80.3	77	69.6	29	18	12	Unifacial	Lateral	Yes	1	1
RBC-684	75.3	59	44.7	24	17	8	Unifacial	Lateral	Yes	2	2
RBC-685	82.5	74	62.1	24	22	5	Unifacial	Distal	Yes	3	1
RBC-675	28.9	25	6.1	22	16	9	Bifacial	Proximal	Yes	1	1
RBC-693	86.1	58	82.4	18	30	17	Unifacial	Proximal	Yes	4	3
RBC-694	52.7	42	16.5	19	16	5	Unifacial	Lateral	No	1	1
RBC-696	58.8	40	21	17	15	7	Bifacial	Lateral	No	1	1

Table 3. Results from classifying known obsidian source samples from Rapa Nui using discriminant analysis.

	Percent Correct	Orito	RKI	RKII	Motu Iti
Orito	100.0000	31	0	0	0
RKI	96.5517	1	28	0	0
RKII	100.0000	0	0	29	0
Motu Iti	100.0000	0	0	0	25
Total	99.1228	32	28	29	25

RKI, Rano Kau I; RKII, Rano Kau II.

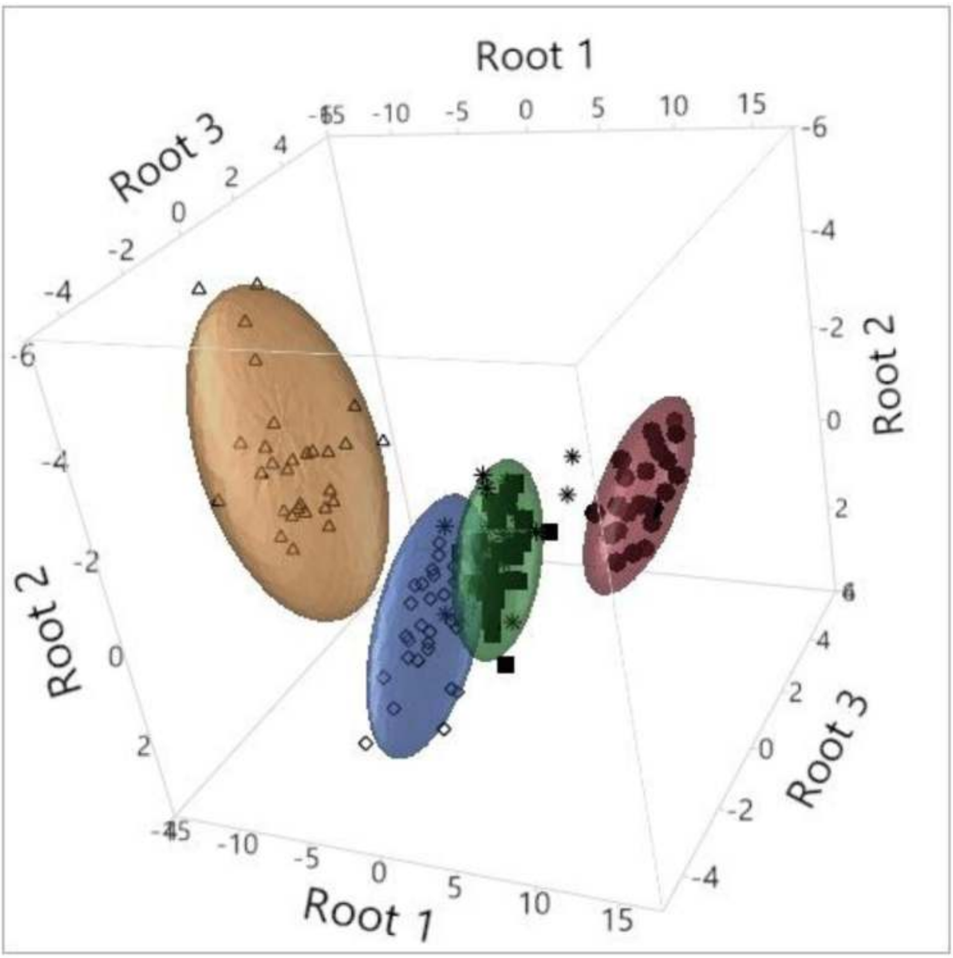

Fig. 4. A comparison between discriminant scores on the first three roots for artifacts from Site 6-58 (asterisks) and source samples: solid squares, Orito; open diamonds, Rano Kau I; open triangles, Rano Kau II; solid circles, Motu Iti.

geological source of the obsidian used in their production, discriminant analysis (DA) and principal component analysis (PCA) were performed using Statistica (Version 7) with Microsoft Excel used to prepare data and JMP (Version 14 PRO) to create plots. The source samples could be largely separated using the elemental compositions obtained, although there is some overlap between Orito and Rano Kau I, as previously reported (Stevenson et al. 2013; Mulrooney et al. 2014). DA using untransformed concentrations was successful in correctly identifying all except one source sample (EI-RKII-C6) to the correct group (Table 3), indicating that the artifacts can be assigned to their source group with very high confidence.

DA and PCA were also used to match the 28 archaeological samples from Site 6-58 with the sources. Figure 4 presents a plot of the three DA roots resulting from forward stepwise analysis of the source samples and the artifacts. With the exception of four artifacts which group with Rano Kau I (RBC-673, RBC-675, RBC-676, and RBC-689), all the artifacts can be assigned to the Orito source located 2 km to the WSW of the site (Fig. 2). There are two potential outliers (RBC-693 and RBC-683), but we conclude that their geochemical composition is closest to the Orito source. These results match the much larger study by Mulrooney et al. (2014), which found that 96 percent of 332 *matā* from the Bishop Museum collections were composed of obsidian derived from the Orito source.

In terms of the present study, the confirmation that 86 percent of the sample originated from the same source indicates that the majority of the tools will have the same physical attributes in terms of surface texture, glass hardness, shearness, and density. The results of the characterization study mean that the use-wear traces derived from the materials, motions, and pressures of the craftsman have not been affected by raw material variation.

Use-Wear Methodology

The first stage of the use-wear analysis entailed the removal of loosely adhering dirt, dust, and grease potentially acquired during recent handling. The artifacts were placed in an ultrasonic bath (Visage GT-7810a) for 3–5 minutes with warm water and a few drops of liquid detergent. They were then air dried and wiped with diluted ethanol (30%) using a Kimwipe©. Next, the artifact edges and surfaces were scanned using a combination of low- and high-power microscopic magnifications. Employing a digital Dino-Lite™ (AM413ZT) microscope, an initial scan was made at magnifications from 10× to 50× using direct vertical light combined with an additional oblique light from an external source. A metallurgical Olympus BX60M microscope fitted with both vertical incident and transmitted light sources, bright and dark field illuminations, and cross-polarizing filters was employed as the main instrument for detecting use-wear traces and residues under magnifications ranging from 100× to 1000×. To record the observations, a photographic record was made with an Olympus DP72 camera and the GmbH Soft Imaging System.

The interpretation of tool function is based on characteristic wear attributes that have been shown to be diagnostic in previous experimental studies using obsidian (e.g., Spear 1980; Kamminga 1982; Lewenstein 1987; Hurcombe 1992; Fullagar 1998, 2006; Stemp 2016a, 2016b, 2016c), as well as those by the authors (Kononenko 2011; Kononenko et al. 2015, 2016), to be especially valuable for reconstructing patterns of use-wear. These include edge scarring, edge rounding, attrition, striations, polish, and residues (e.g., Hurcombe 1992; Aoyama 1995; Kononenko 2011; Stemp 2016c). A comparison of the wear attributes recorded for the artifacts with data obtained through published experimental studies (e.g., Hurcombe 1992; Aoyama 1995; Kononenko 2011; Stemp 2016a, 2016b, 2016c) was employed to identify the mode of use, the material worked, and the presence/absence of hafting. The full record of observations is presented in Appendix 1.

An important part of the analysis is the recognition of traces relating to post-depositional damage (scars, abrasion, and striations), which can be detected with high precision. First, irregular scars with very fresh flaked surfaces clearly contrast with unaffected parts of the

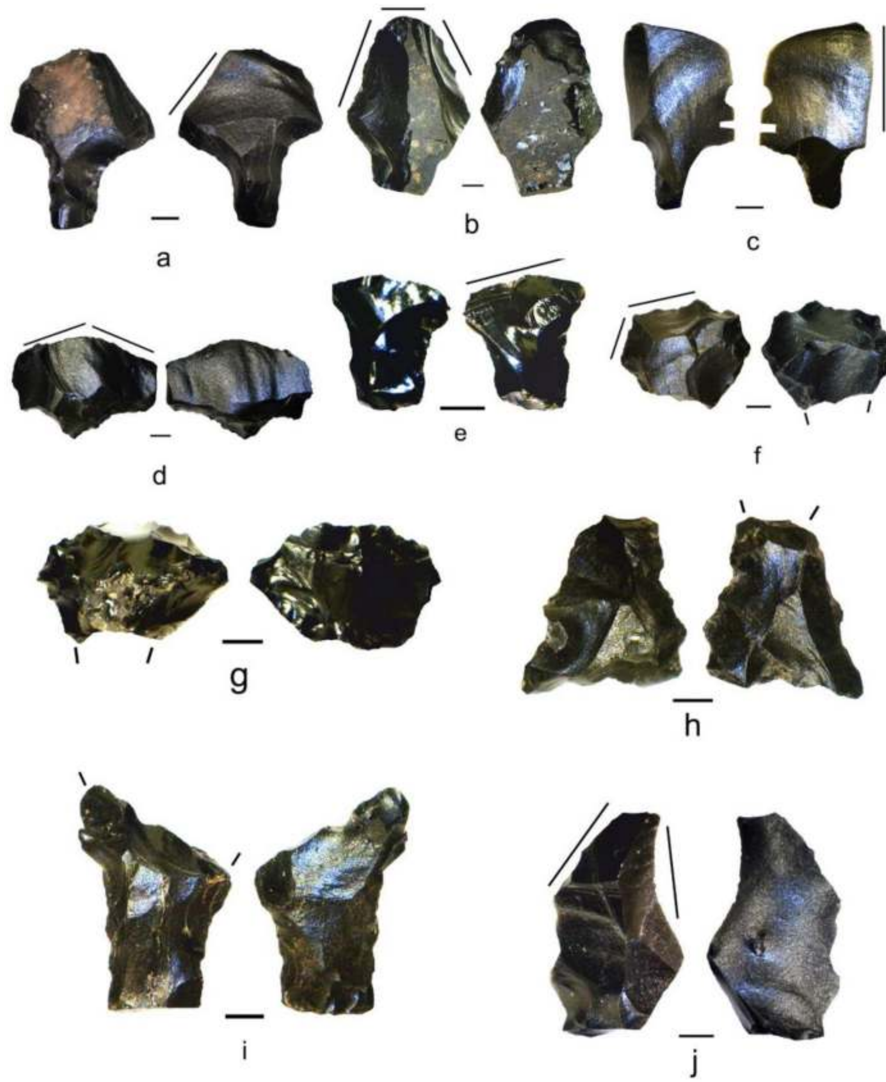

Fig. 5. Obsidian artifacts from Site 6-58. (a) RBC-674; (b) RBC-693; (c) RBC-687; (d) RBC-686; (e) RBC-675; (f) RBC-669; (g) RBC-672; (h) RBC-676; (i) RBC-695; (j) RBC-670. Lines indicate used edges. Scale bar is 1 cm.

artifact surface. Second, abrasion and striations derived from taphonomic factors are not normally distributed in a regular fashion and are unlikely to be regularly aligned with the flake edge. Chemical damage in the form of roughly hemispherical pits unequally distributed on the surface have been widely observed on obsidian artifacts (Hurcombe 1992:48, 81; Kononenko 2011:47–48), but were rarely noted in the Site 6-58 assemblage.

The surface of the Orito obsidian used in the manufacture of most of the tools ranges from a bumpy to a slightly irregular texture (e.g., Fig. 5c). During use, these irregularities are the first parts of the surface to be modified, often resulting in a patchy distribution of microscopic wear attributes such as edge rounding, attrition, striations, and polish. Consequently, the level of confidence for the identification of use-action and contact material, recorded as "definite," (all wear attributes are identifiable and in many cases are associated with residues) in contrast to "probable" (some wear attributes not readily identifiable, some residues present) and "uncertain" (wear attributes not well-defined and residues are absent) was quite high in this study. The full results of the use-wear analysis are reported in Appendix 1 and summarized in Table 1.

Inferred Tool Uses

Use-wear traces and residues were preserved on all except four artifacts in the assemblage. Two unmodified *kombewa* flakes (RBC-688 and RBC-689) may have been blanks imported to the site for conversion into *matā* (cf. Stevenson et al. 1984), but these were never used. Perhaps they were considered unsuitable. Alternately, they might have been deliberately cached at the site for future use, but ultimately abandoned. Two fragments of *matā* were possibly broken during manufacture or in the early stages of use: a body (Fig. 5g, RBC-672) and a segment of a retouched stem (Fig. 5h, RBC-676). The most common use for the *matā* at Site 6-58 was working woody plants such as, for example, siliceous softwood, palms, and hard-stemmed grasses such as bamboo (see e.g., Floyd 1954; Liese 2002), but the assemblage also preserves evidence for plant processing, working bone and/or shell, and cutting soft elastic materials such as flesh or skin.

Woodworking

As shown in Appendix 1 and Table 1, the most common patterns of use-wear on the *matā* from Site 6-58, represented by nine examples, were created in the process of working a range of plant types, which for simplicity we term "woodworking." These include both soft and hard woods as well as other plants such as grasses or reeds. The wear traces from these activities are largely preserved on surface irregularities such as flake scar ridges, because these regions experience the most forceful contacts with the use material (Hurcombe 1992:40–41; Kononenko 2011:20–28). Diagnostic traits include relatively intensive edge damage comprised of continuous, small and medium-sized scars, and microscars. These were initiated from one or both sides of the edge depending on the nature of the use-motion. Consequently, the edge profile of woodworking tools is usually irregular. Intensive working of plant materials leads to a patchy distribution of moderate to intensive edge rounding, pronounced and sometimes severe attrition, and developed or well-developed polish on the working edge. Patches of edge rounding, attrition, and polish are also observed at the intersection of microscars and at the higher peaks of surface topography along the edge. Distinctive striations are generally well-separated from each other and dense clusters of long, thin, deep, and sometimes rough striations are observed on the artifact surface and often within the scars on the edge.

Within the group of woodworking tools, only three *matā* have an edge used for a single action: whittling (RBC-675, Fig. 5e; RBC-671, Fig. 7e and f) or scraping (RBC-691, Fig. 6e and f). These transverse actions generated the formation of continuous small scars and microscars with step terminations mixed with some feather and bending scars. The scars are mainly restricted to one face, although some isolated small scars may occur on the opposite side. Intensive edge damage by the scarring has removed most of the microscopic wear traces and created a patchy distribution of attrition, edge rounding, polish, and striations on the immediate edge. The perpendicular striations observed on RBC-691 (Fig. 6f) are characteristic of a forceful scraping action with a high working angle to the use-material. In contrast, the whittling mode of use associated with RBC-671 (Fig. 7f) is distinguished by the orientation of striations; a low working angle and the force directed to the use-material at a slight angle produce striations that are mainly diagonal in orientation (cf. Kononenko 2011:17). Patches of moderate to intensive edge rounding, well-developed polish (Fig. 6f), and a high density of striations indicate use for working relatively soft, siliceous plants. The presence of spots of attrition with embedded residues such as plant tissue and starch grains adds further support to this interpretation.

Most of the plant or woodworking tools were used on two edges with different actions performed on each edge (Appendix 1). Although the broken body of *matā* RBC-669 (Fig. 5f) was rejuvenated by bifacial retouch that removed most wear traces, the distal end and one margin preserved patches of slight edge rounding, light attrition, light to developed polish, and numerous perpendicular or slightly diagonal and sometimes crossed striations. The plant debris and residues associated with wear traces on the edge suggest that this tool was intensively used for scraping siliceous plant material.

In another example, sawing and whittling or scraping (Table 1, RBC-673, RBC-683, RBC-684) were most commonly represented on tools with two utilized edges (Figs. 6a–d, 8a–d and 9a–c). For example, dense, long and parallel striations, light to developed polish, and embedded resinous residues derived from sawing were observed on the marginal edge of tool RBC-673 with evidence for occasional whittling actions documented by the presence of isolated crossed striations (Fig. 6b and c). The distal end of the tool preserves perpendicular and slightly diagonal striations and light to developed polish. A dense deposit of colored, resinous residues was also noted on the surface and embedded into the used edge (Fig. 6c and d). The combination of scars, edge rounding, polish, striations and residues indicates that this working edge was used for scraping a resinous, woody substance.

Both edges of *matā* RBC-680 (Fig. 7a–d) were used in transverse actions, but based on the orientations of the striations, the contact angle between the edge and use-material shows that one margin was used in whittling and the distal end was used for scraping. The scraping edge also includes patches of embedded residues that contain plant fiber and narrow, elongated, needle-shaped raphides (e.g., Crowther 2009) and starch granules (Fig. 6d). These attributes are characteristic of resins (e.g., Robertson 2005:59–60; Fullagar 2006; Barton et al. 2009; Crowther 2009; Hayes 2015:86–87). Finally, three edges of *matā* RBC-693 were used to process a siliceous plant material (Fig. 5b) by sawing and whittling on the margins and scraping with the convex distal end.

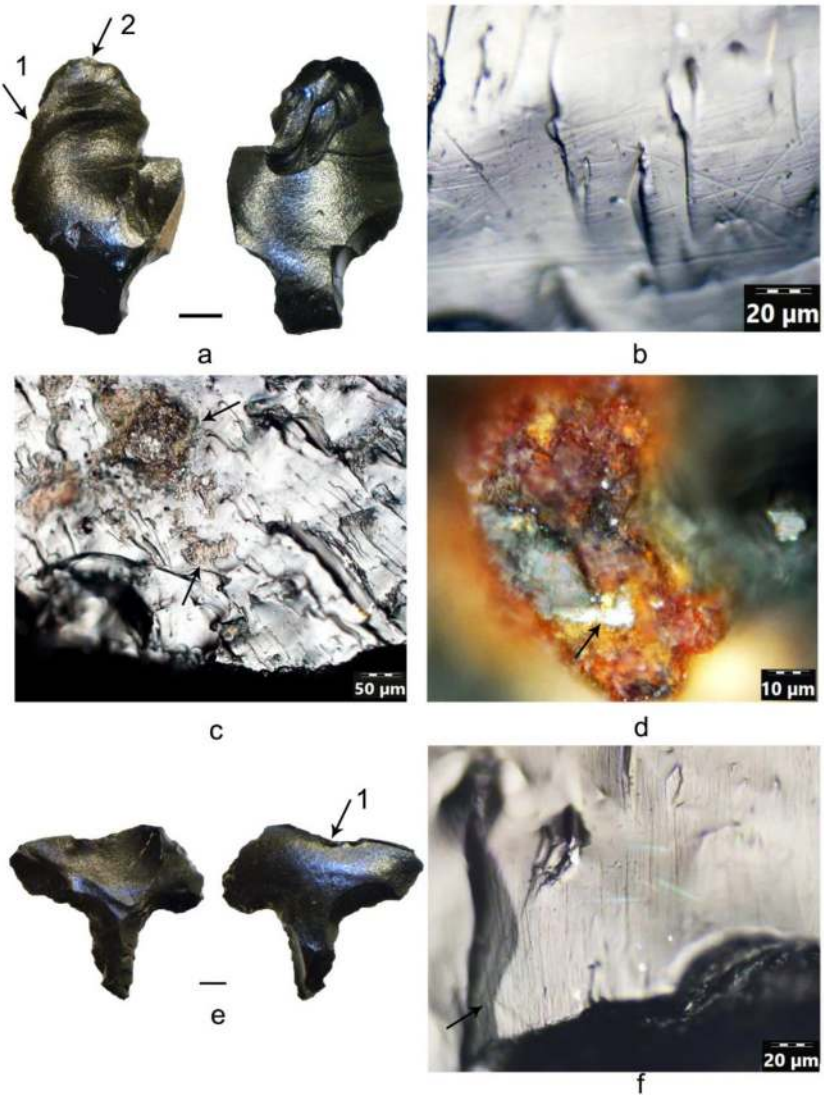

Fig. 6. Wear patterns and residues on *matā* used for woodworking. (a) RBC-673 with two used edges indicated by arrows, scale bar is 1 cm; (b) point 1, sawing actions, polish, parallel, and crossed striations; (c) point 2, wear and embedded resinous residues indicated by arrows; (d) resinous residues with plant material indicated by arrow, polarized light; (e) RBC-691 with used edge indicated by arrow, scale bar is 1 cm; (f) point 1, scraping actions; edge scarring and rounding; polish and perpendicular striations indicated by arrow.

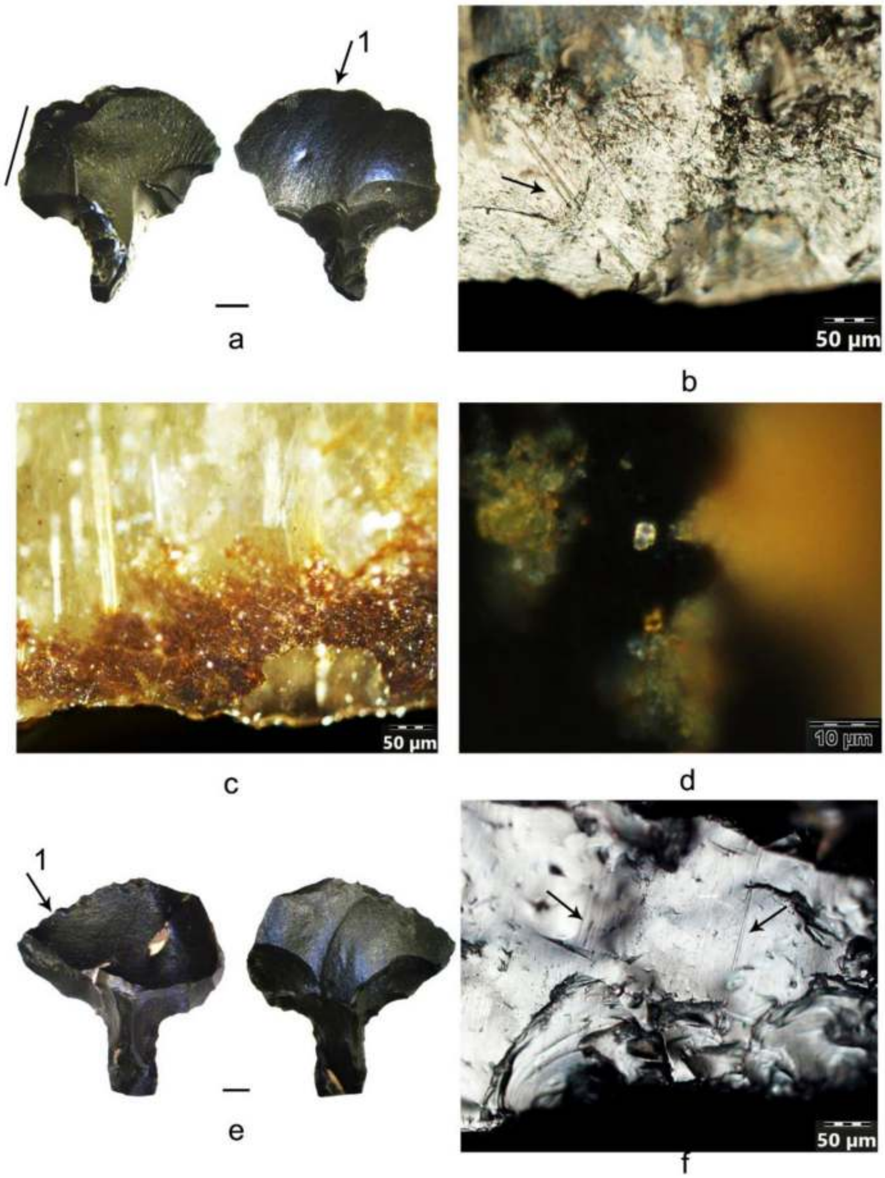

Fig. 7. Wear patterns and residues on *matā* used for woodworking. (a) RBC-680 with two working edges indicated by line and arrow, scale bar is 1 cm; (b) point 1, whittling and scraping actions; residues and diagonal striations indicated by arrow; (c) point 1, residue distribution on the edge, polarized light; (d) point 1, plant tissue and starch grains, polarized light; (e) tool RBC-671 showing point 1 where images were taken, scale bar is 1 cm; (f) whittling actions; scars and diagonal striations indicated by arrow.

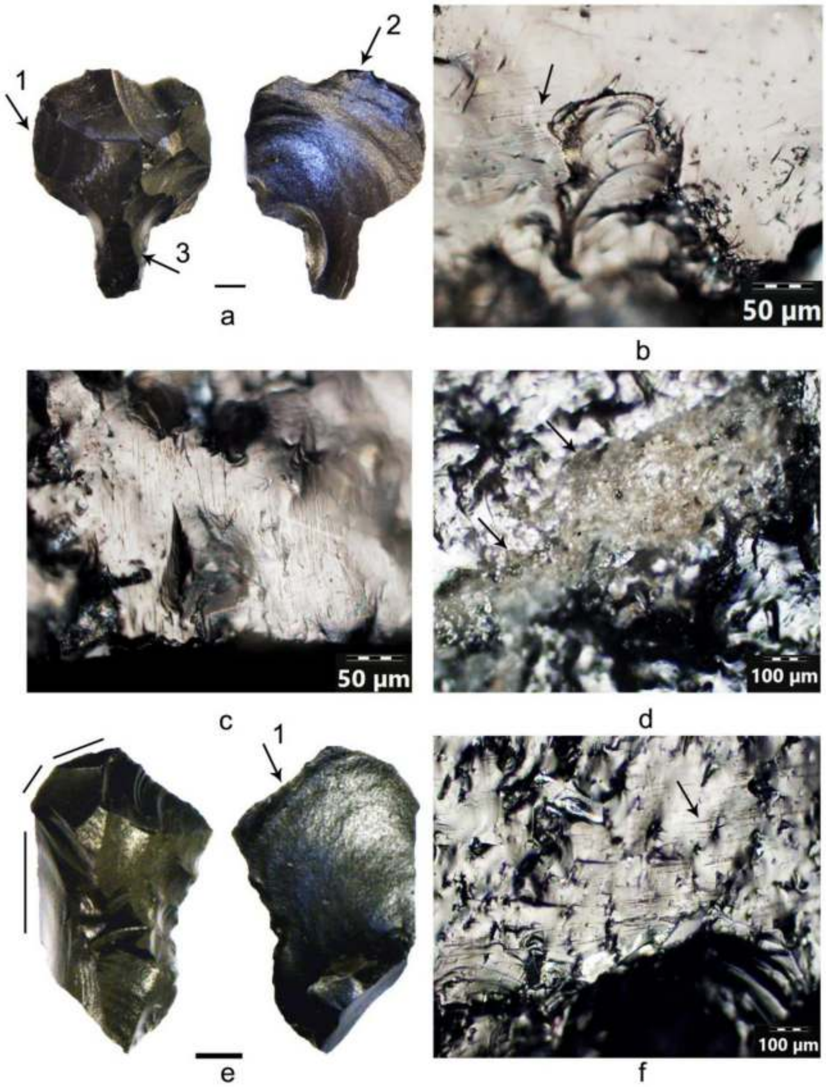

Fig. 8. Wear patterns and residues on woodworking *matā* and flake with two working edges. (a) RBC-684 with two working edges indicated by arrow, scale bar is 1 cm; (b) point 1, sawing actions; scars and parallel striations indicated by arrow; (c) point 2, scraping actions; edge rounding, polish, and dense perpendicular striations; (d) point 3, hafting wear with grey resins indicated by arrows; (e) RBC-677 with two working edges indicated by lines and arrows, scale bar is 1 cm; (f) point 1, sawing actions; scars and parallel striations indicated by arrow.

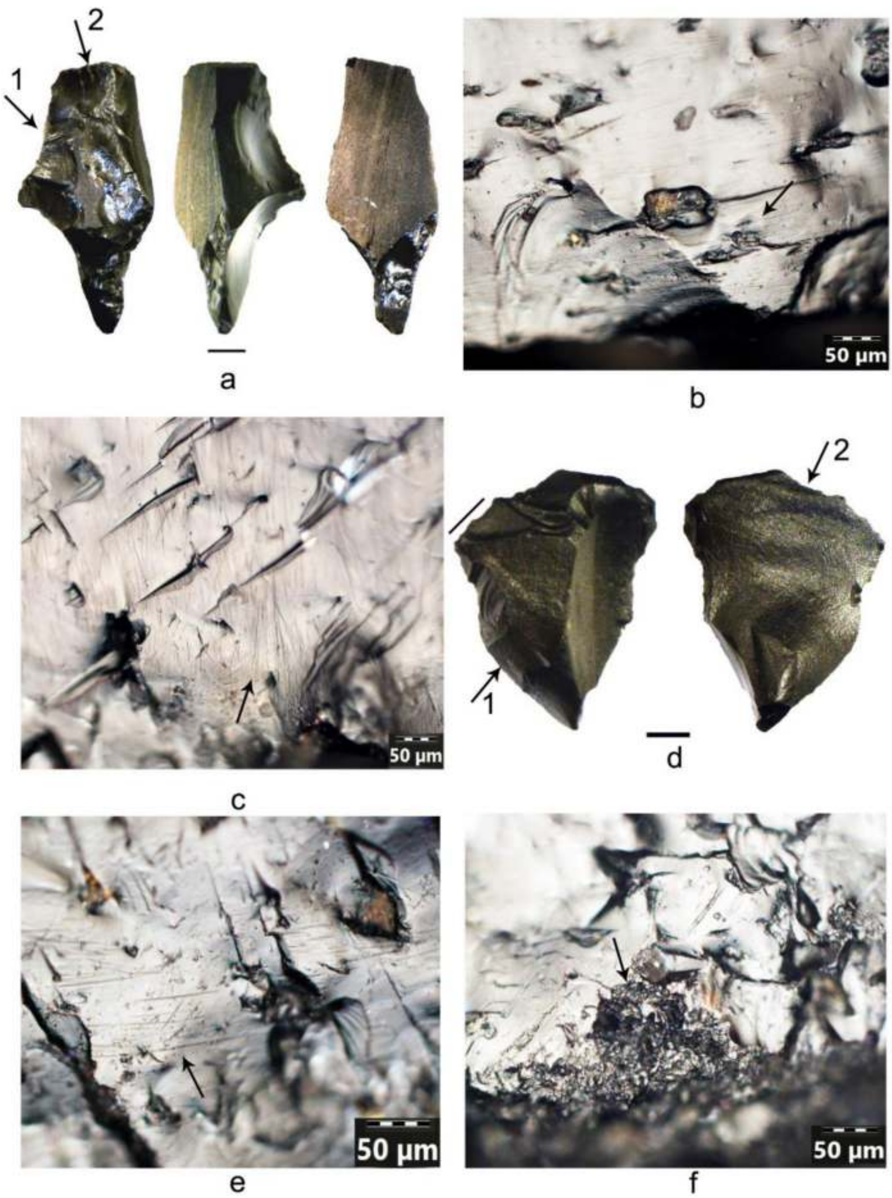

Fig. 9. Wear patterns and residues on woodworking tools with two working edges. (a) RBC-683 with used edges indicated by arrow, scale bar is 1 cm; (b) point 1, sawing actions resulting in diagnostic scars; edge rounding; dense parallel striations and polish indicated by arrow; (c) point 2, scraping actions with perpendicular and crossed striations indicated by arrow; (d) RBC-678 with two used edges indicated by arrows and lines, scale bar is 1 cm; (e) point 1, sawing actions with parallel and crossed striations indicated by arrow; (f) point 2, scraping and whittling actions with perpendicular and slightly diagonal striations and attrition indicated by arrow.

Processing Soft Elastic Material

The second most common use of the *matā*, represented by five examples, was for processing soft elastic materials including meat, skin, or fish (Appendix 1). The wear pattern generally consists of edge damage in the form of microflaking (mainly microscars and, to a lesser extent, small scars) (Figs. 10e and 11d), light edge rounding supplemented in some cases by light attrition that was probably a result of accidental contact with bone (Fig. 10b and e), very light to light, smoothed, invasive polish (Figs. 10b and 11b), and a few fine, narrow striations (Fig. 10b and e) formed by abrasive particles initiated by the microchipping (e.g., Kamminga 1982:34–35; Fullagar 1986:186–187; Hurcombe 1992:43–44; Aoyama 1995; Kononenko 2011:32–33; Stemp et al. 2015; Kononenko et al. 2016; Stemp 2016a, 2016b, 2016c). The distinctive wear patterns are very slow to form on tools used for cutting, slicing, and piercing soft, pliable materials such as meat, skin, and fish (Hurcombe 1992; Kononenko 2011; Stemp et al. 2015; Stemp 2016a, 2016b). Based on experimental data, more than 30–60 minutes of use is required to display the identifiable wear attributes (e.g., Kamminga 1982:34–35; Fullagar 1986:186–187; Hurcombe 1992:43–44; Kononenko 2011:32–34; Stemp et al. 2015). Since the wear traces on these *matā* are relatively pronounced, they had been used intensively and/or for a prolonged period of time.

In particular, two *matā* made on cortical flakes (RBC-679, RBC-674, Fig. 10a–c, Fig. 5a) and one on a *kombewa* flake (RBC-694, Fig. 10d–f) preserve a working edge with signs of use for cutting/slicing a soft pliable material that is probably meat or skin, based on experimental replication studies (e.g., Hurcombe 1992:43–44; Aoyama 1995; Kononenko 2011:32–33; Stemp & Awe 2014; Kononenko et al. 2016; Stemp 2016a, 2016b, 2016c). The used edges display slight damage by continuous and sometimes discontinuous microscars as well as a few small scars with bending and feather terminations (Fig. 10b and e), patches of light attrition (Fig. 10b), light to moderate edge rounding, and light polish in association with a small number of isolated, fine, and long diagonal and crossed striations (Fig. 10b and e).

The combination of light to moderate edge rounding, patches of attrition, light to developed polish, and slightly diagonal and crossed striations indicates cutting/slicing motions were applied to a soft elastic material that incorporated a harder substance, probably fish scales. For example, RBC-681 and RBC-687 (Fig. 5c) have relatively pronounced edge damage comprised of a combination of microscars and small scars (Fig. 11b and d), together with numerous, well-isolated, long and thin striations on the worn surface (Fig. 10b and d) and within scars (Fig. 11e). Some spots on *matā* RBC-681 (Fig. 11c) preserve an embedded, rainbow-colored tissue, possibly fish. This artifact has a pointed tip that was deliberately shaped using an elongated spall that could have been designed to assist with its function in butchering fish (Fig. 2b, Fig. 11a). This combination of use-wear traces is comparable with wear and residues on experimental obsidian tools used for gutting fish (Hurcombe 1992:44–45; Kononenko 2011:39, Plates 208, 209).

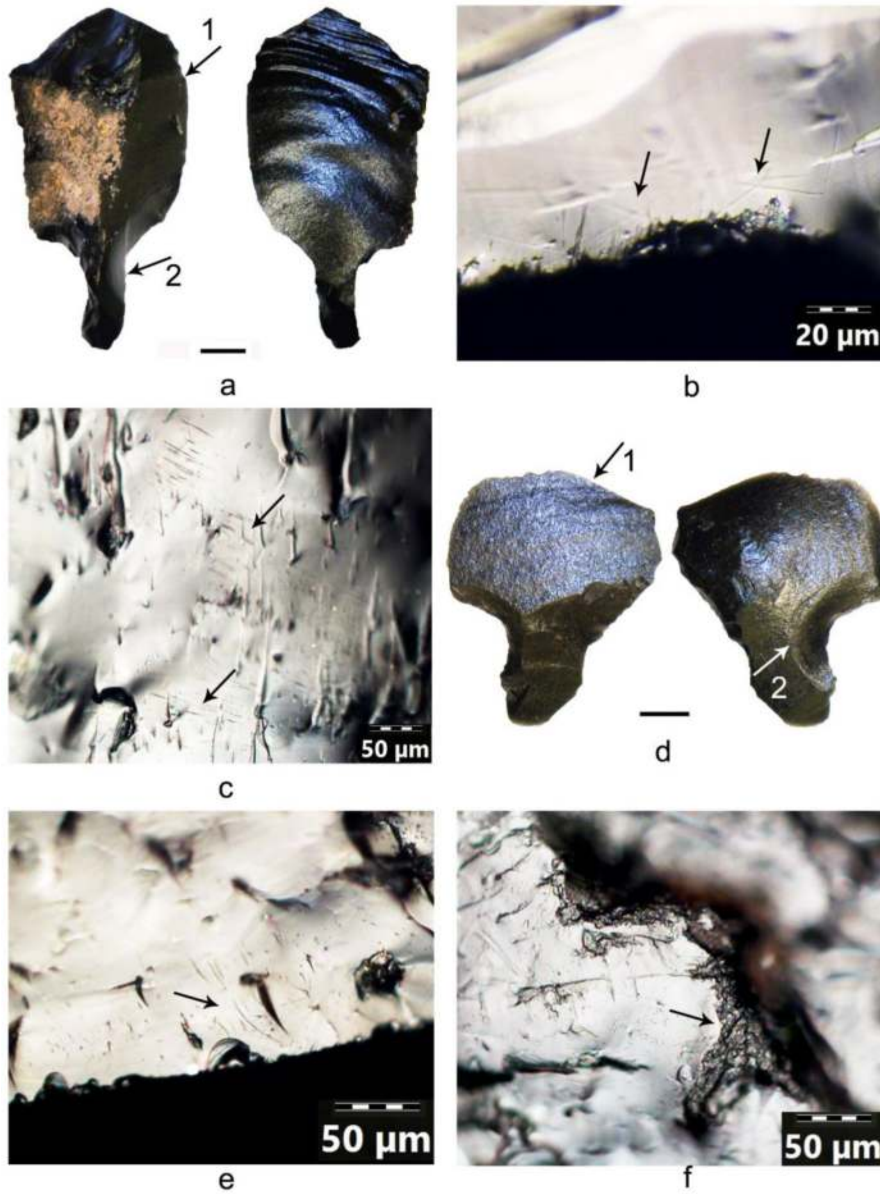

Fig. 10. Wear patterns and residues on tools used for processing meat or skin. (a) RBC-679 with arrows indicating points 1 and 2 where images were taken, scale bar is 1 cm; (b) point 1, cutting/slicing action; microscars; edge rounding and isolated crossed striations indicated by arrow; (c) point 2, striations derived from hafting; (d) RBC-694 with arrows indicating points 1 and 2 where images were taken, scale bar is 1 cm; (e) point 1, cutting/slicing action, microscars and isolated striations indicated by arrow; (f) point 2, attrition derived from hafting.

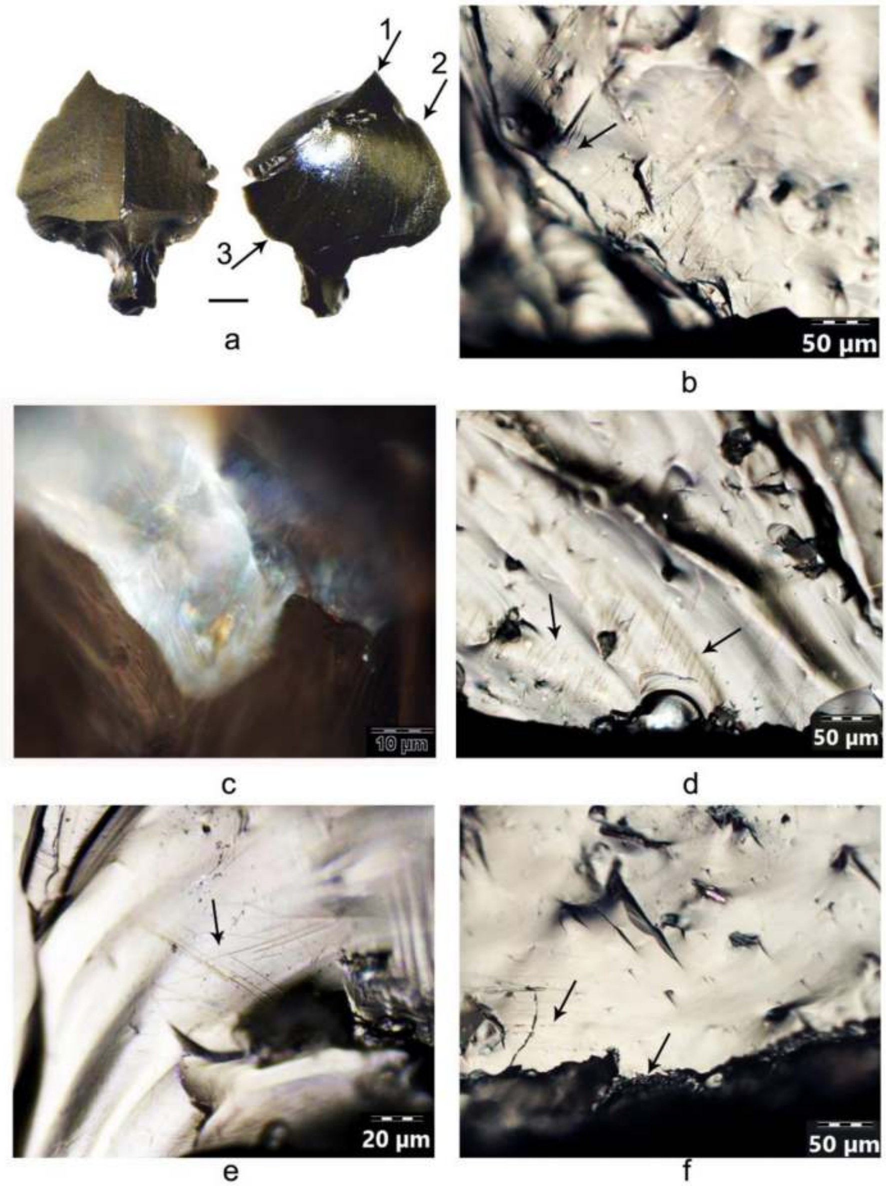

Fig. 11. Wear patterns and residues on tools used for processing fish. (a) RBC-681 with points 1–3 where images were taken, scale bar is 1 cm; (b) point 1, gutting/cutting action, edge scarring, diagonal and crossed striations and embedded residues indicated by arrow; (c) point 1, embedded, rainbow-colored tissue, probably fish, polarized light; (d) point 2, scars and diagonal striations indicated by arrows; (e) point 2, crossed striations within scars; (f) point 3, attrition and striations related to hafting.

Processing the Soft Parts of Plants (Leaves, Stems, and Bark)

Processing the soft parts of plants (e.g., leaves, stems, outer and inner bark), grasses such as reeds or bulrushes (*Scirpus riparius* var. *paschalis*), ferns, sugar cane (*Saccharum officinarum*), bananas (*Musa* spp.) (Métraux 1940:160), and tubers can often be distinguished from processing the harder, woody parts of plants (Kononenko 2011:31). Good examples include a group of three *matā* (RBC-685, RBC-692, RBC-696). Edge damage in the form of microscars and small scars (Fig. 13d) is less extensive than observed with woodworking. The attrition on the edge is commonly light and is only observed at a few spots (Fig. 13b and d). Edge rounding is noticeable as a thin or irregular band along the edge and is generally light to moderate, but occasionally intensive (Figs. 11d and 12b). The polish is light to developed, smooth, flat, more even and has a whiter aspect than on woodworking tools due to its different reflective quality (Figs. 12d, 13b and 13f). The distribution of polish is generally patchy with a tendency to extend well into surface depressions and scars. Striations are relatively numerous, well-separated or dense, and are generally short with parallel or slightly diagonal orientations (Figs. 12d, 13b and 13f). The orientation of striations reflects a longitudinal action with a parallel (cutting) or slightly angled (slicing) movement of the tool involved.

Two *matā* have a single working edge used for combined cutting/slicing actions (RBC-685, RBC-692, Figs. 12a–f, 13a and 13b) and a third (RBC-696) has three working edges used for the same purpose (Fig. 13c–f). Based on the polish development and comparison with experimental data (Kononenko 2011:31), *matā* RBC-692 (Fig. 12) was used for cutting/slicing relatively non-siliceous tubers, such as taro (*Colocasia esculenta*) and yam (*Dioscorea alata*). In contrast, patches of developed and well-developed polish in combination with edge scarring, rounding, and relatively numerous shallow and deep striations on RBC-685 and RBC-696 (Fig. 13) are comparable with those on experimental tools used for cutting/slicing siliceous plants such as a fern (*Asplenium nidus*), croton (*Codiaeum variegatum*), ginger (*Zingiber officinale*), sugar cane (*Saccharum* spp.), or rattan leaves and stems (Kononenko 2011:Plates 48–50, 58–59, 62–66, 68–69, 71). Embedded residues such as tissue and starch grains support the identification of plant processing (Fig. 12c, e–f).

Working Bone or Shell

The wear on the tools used to work dense, hard materials like bone or shell by scraping, sawing, and whittling is recognized by intensive edge damage consisting of continuous medium and small scars visible to the naked eye, together with a series of microscars (Fig. 14b). Numerous patches of severe or pronounced attrition and moderate to intensive edge rounding (Fig. 14b and f) are also characteristic wear variables for this group of tools. In combination with these traits, developed smooth or flattish polish and numerous shallow and deep striations (Fig. 14b and c) are diagnostic of shell or bone (Hurcombe 1992:47; Kononenko 2011:34; Stemp 2016c). Finally, residues embedded into the used edges support the identification of bone or shell (Fig. 14d). Working shell produces granular, powdery and multicolored material that is preserved on the working edges (Fullagar 1986:189; Robertson 2005:82; Fullagar 2006; Kononenko 2011:Plates 92–97; Hayes 2015:98). Similarly, whitish residues with the inclusion of a blue vivianite mineral and a flaky texture represent the products of working bone (Robertson 2005:72; Fullagar 2006:221; Lombard & Wadley 2007; Hayes 2015:95–97; Hayes & Rots 2018).

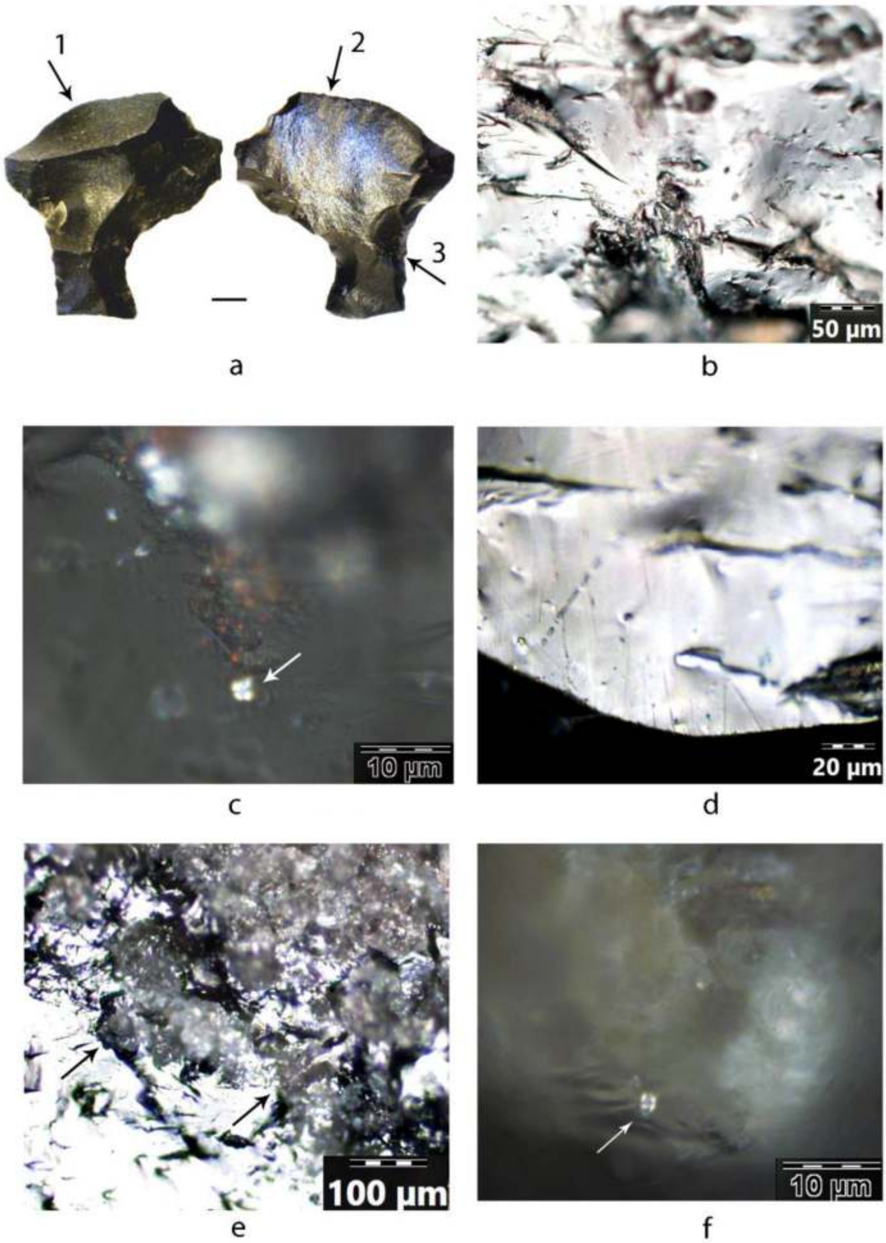

Fig. 12. Wear patterns and residues on tools used for cutting/slicing soft plant, probably tubers. (a) RBC-692 dorsal and ventral faces of the tool with points 1–3 where images were taken, scale bar is 1 cm; (b) point 1, scars, attrition and striations within scars indicated by arrow; (b) point 1, residues with starch grain indicated by arrow (polarized light); (d) point 2, microscars, edge rounding, polish and striations; (e) point 3, hafting wear and resin residues indicated by arrow; (f) point 3, plant tissue and starch grain within resin residue, polarized light.

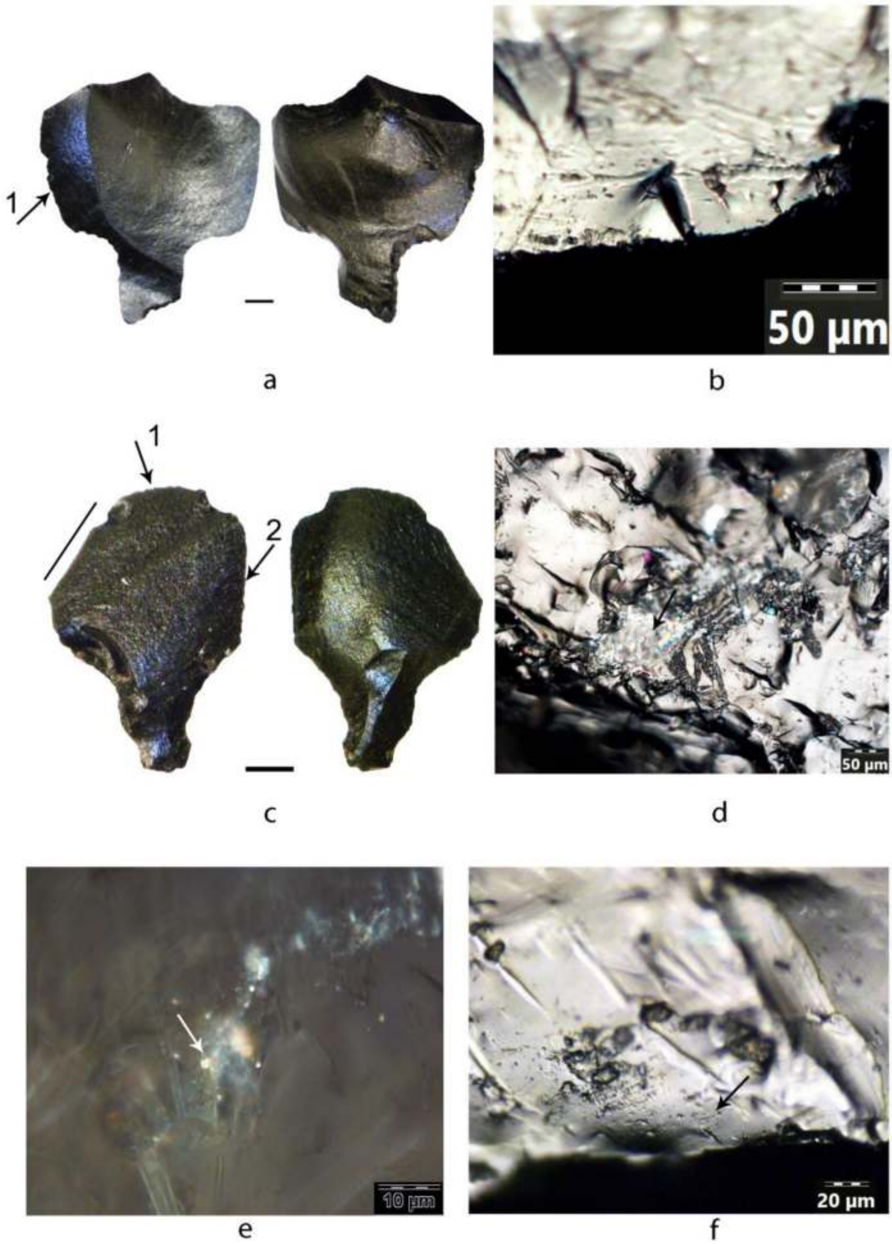

Fig. 13. Wear patterns and residues on tools used for cutting/slicing soft material, probably greens. (a) RBC-685 with one working edge indicated by arrow, scale bar is 1 cm; (b) point 1, edge scarring and parallel and crossed striations; (c) RBC-696 with three working edges indicated by line and arrows, scale bar is 1 cm; (d) point 1, attrition with embedded residues indicated by arrow; (e) point 1, plant tissue and starch grains indicated by arrow, polarized light; (f) point 2, polish and striations indicated by arrow.

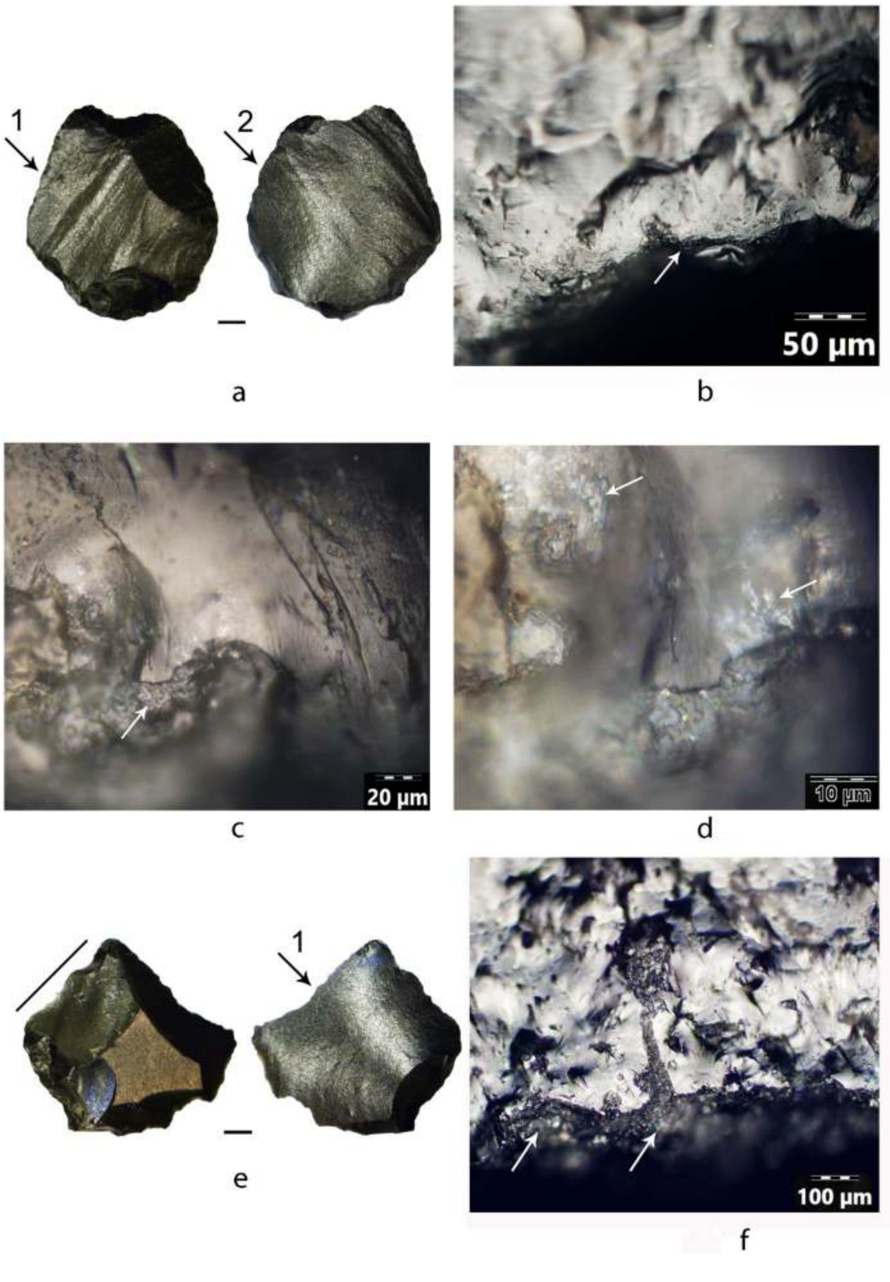

Fig. 14. Wear patterns and residues on tools used for working shell and bone. (a) RBC-682 with two working edges indicated by arrows, scale bar is 1 cm; (b) point 1, sawing actions, edge rounding, polish and parallel striations; (c) point 2, scraping/whittling actions; attrition; perpendicular and slightly diagonal striations; polish and embedded residues indicated by arrow (×500); (d) point 2, multicolored granular residues; (e) RBC-690 with two working edges indicated by lines and arrows, scale bar is 1 cm; (f) point 1, scraping/whittling actions, attrition and embedded residues with vivianite inclusions indicated by arrows.

Based on these characteristics, two *matā* from Site 6-58 were used to process bone or shell. RBC-686 has a short stem that had probably been re-worked after the original one broke (Fig. 5d) and RBC-690 is represented by a broken body (Fig. 14e). The latter has two working edges, one of which was used for sawing and the other for scraping/whittling. Some areas with attrition also preserved diagnostic bone residues (Fig. 14f). It is notable that fragments of human bone were also found in deposits also dating to Phase 1. In combination, the wear patterns and residues indicate that the artifact was used to carve bone and was perhaps used to manufacture bone needles or fishhooks like those found at Site 6-58 (Stevenson et al. *in prep.*; cf. Métraux 1940:178–182; Beardsley 1996). There is, however, no evidence that the *matā* were used in drilling bone, as proposed by Métraux (1940:179). The working edge of a tool with a rejuvenated stem, RBC-686 (Fig. 5d) has a combination of wear traces resulting from scraping and occasional whittling actions. It also preserves a granular, powdery, and multicolored material that is likely to be a shell residue (Robertson 2005:82; Fullagar 2006), as observed in scraping shell experiments (Kononenko 2011:Plate 97A).

Intensity of Use

A striking character of this assemblage of *matā* is the high intensity of use indicated by the wear traces. First, multiple edges were used on most of the tools (Appendix 1, Table 1). Either the tasks demanded a combination of actions (i.e., scraping and sawing) or when one suitable surface was worn out, the user rotated the tool and employed another edge. Second, since the wear traces are extremely well-defined, the tools must have been used for a substantial length of time, illustrating the benefit achieved from creating a secure handle. As noted above, this is especially clear in the case of use-wear formed as a result of processing soft elastic material. A similar case is found on the intense use-wear associated with RBC-681, which was employed for scaling and gutting fish. Finally, although wear traces form much faster when used on wood, shell, and bone than soft elastic material, the highly developed wear and multiple used edges on tools for processing hard substances also indicate long periods of use and/or multiple incidents.

Hafting

The majority of the *matā* stems preserve use-wear indicating that they had been placed within a haft (Appendix 1 and summarized in Table 1). The use-wear traces are largely in the form of attrition and/or striations resulting from contact with a hard substance such as a wooden handle. These are commonly preserved on one or more edges or distributed across the faces of the stem. Occasionally, unidentified resinous material is also present. Since freshly flaked obsidian is extremely sharp, it seems reasonable to assume that *matā* stems were not held in the bare hand during use. Detecting hand-held use, however, is extremely difficult so where use-wear was absent, the method of hafting has been recorded in Table 1 as “unknown.” The most likely possibility is that a soft plant material was wound around the stem to protect the hand and improve the grip. Based on experimental studies, use-wear traces of wrapping are unlikely to be detected through microscopic wear traces except when plant residues such as starchy material are still adhering (e.g., Parr 2002; Kononenko 2011:37).

In the most common hafting method, noted in twelve examples, the stem was secured within a wooden handle. Spots of rough, flattened attrition (Fig. 10f) and relatively numerous, but randomly distributed, striations on the surface (Figs. 8d, 10c and 10f) or edges (Fig. 11f) of the stem are comparable with hafting wear on obsidian tools produced experimentally (Kononenko et al. 2015). Another method for securing the tool is illustrated by the short stem on tool RBC-681. It retains patches of smooth attrition and a few striations located on the contact zone between the body of the tool and the flaked stem (Fig. 11a and f). As described in Kononenko et al. (2015:261, Fig. 2a and b), this combination of traces is comparable to those formed on the haft of an experimentally used tool in which the stem was wrapped with a soft material and then inserted into a wooden handle.

Additional support for hafting is provided by the presence of plant residues which are not removed by cleaning with water. Under high power magnification they have a reflective and glassy appearance and often contain charred plant, woody tissue, and starch granules, which can in some cases be used for taxonomic identification of plant species (Parr 2002; Robertson 2005:65–70; Hayes 2015:89–91). For example, patches of pronounced attrition in association with isolated striations and traces of embedded resin were noted on the surface of *matā* stems for RBC-680 and RBC-684 (Fig. 8d). A grey, granulated, resinous material with embedded plant tissue and starch grains was also preserved on tool RBC-692 (Fig. 12e and f). The combination of diagnostic wear traces with colored and grainy textured residues suggests that a mixture of resin and ochre may have been used to help secure these stems within a wooden handle.

In the four cases where no wear traces were observed on the stem (RBC-675, RBC-676, RBC-693, RBC-686), it nevertheless seems likely that the hand was protected in some manner during tool use. The probability the handle was wrapped with some soft material is quite high since three *matā* lacking use-wear on the stems had been used for working hard materials (i.e., bone, shell, or wood). This action would require a tight grip that could have resulted in injury to the hands unless protected. For the tools lacking hafting wear traces, there are additional circumstances to consider. Stem RBC-676 was probably broken during production and never used. It also seems likely that the extremely short stem on RBC-686 represents the remnant of a larger tang that had broken. If that was the case, then the wear patterns on the body may have been acquired prior to the production of the new stem, which may not have been used for any considerable length of time because it was unsuitable.

Unhafted Tools

As summarized in Table 1, four of the six unretouched flakes in the sample performed many of the same functions as the retouched *matā*. First, two of the flakes (RBC-677, RBC-678) preserve evidence for sawing, scraping, and occasional whittling of plant material. The distal end and left margin of elongated flake RBC-677 were used to saw siliceous plant material (Fig. 8e and f). The sawing action can be clearly identified through the orientation of striations and the distribution of scars formed during use. Patches of moderate to intensive edge rounding, light to pronounced attrition, and developed to well-developed polish are present on the most well-preserved edge areas (Fig. 8f). The smoothed polish created by sawing does not extend from the highest peaks into the surface depressions but is more widespread on one face than on the other (Fig. 9d). In addition, deep, long striations running parallel to the edge and some isolated crossed striations are present (Figs. 6b and 9e). These tend to extend from the higher peaks of surface topography down to the lower surface and often spread inside microscars (Fig. 8b).

As recorded on elongated flake RBC-670 (Fig. 5j), a second type of use for the flakes was the cutting and slicing of soft plant material. In this case, a continuous distribution of microscars and small scars with bending and feather terminations are present on both edges, together with some patches of light to moderate edge rounding, a few spots of light to pronounced attrition, and light to developed polish. In addition, relatively numerous thin, long, and well-isolated striations that are oriented diagonally to the edge and sometimes crossed occur on both faces.

In a third type of use, both the wear patterns and residues show that an unretouched *kombewa* flake was used for sawing shell (Fig. 14a–d, RBC-682). Both working edges display a pronounced blunting by scars and edge rounding. Numerous short, shallow striations with parallel orientations on both faces are associated with a well-developed polish (Fig. 14b), although a few patches with perpendicular striations indicate occasional scraping (Fig. 14c). Spots of embedded opaque and multicolored residues associated with the use-wear (Fig. 14c and d) resemble those identified on experimental tools used for working shell (Robertson 2005:82; Fullagar 2006; Kononenko 2011:Plates 92–97; Hayes 2015:98; Hayes & Rots 2018). In contrast to the *matā*, the analyzed flakes did not provide evidence for working skin, meat, or fish, but this absence may be due to the small sample size.

The unretouched flakes were primarily used in carving rather than encompassing the entire range of tasks in which *matā* were used. It is, however, highly likely that the flakes were wrapped in a soft material to protect the hand during use, but, unfortunately, this practice creates detectable use-wear traces only in rare cases. It is therefore not possible to be confident about whether these flakes were used in identical tasks as the hafted tools or if they had a specialized role in the wider suite of craft activities taking place at the site.

Discussion

Site 6-58

A total of 22 complete and partial *matā* were recovered from Site 6-58. Only three complete *matā* were in the Phase 3 deposits compared to the ten complete items in the earlier Phase 1 contexts. Thus, tracking change in behavior through time at Site 6-58 is hampered by the small sample size of *matā*, particularly from the most recent phases. Given the combination of actions reflected by the majority of use traces on the *matā* (e.g., cutting, sawing, scraping, whittling), it is likely that most of these artifacts were employed for producing and decorating wooden items, with a smaller number applied in the same manner to shell or bone (Table 1; cf. Kononenko 2011:24, Plates 25, 26). The tools from Phase I provide evidence for processing fish that would fit well with the hypothesis that the site was a fishing camp. Craft activities such as the preparation, repair, and decoration of tools made from woody plant material, bone, and shell would also have been compatible at a place where people might be preparing and repairing gear before procurement activities or resting and socializing in between active bouts of fishing. In the later Phase 3, evidence for processing fish or meat is absent among the assemblage of *matā* and this observation is reinforced by the very significant reduction in fish remains with only 1214 specimens recovered from above the floor compared to 18,519 specimens recovered from Phase 1 contexts (Rorrer 1997: Appendix D). These findings suggest the focus of the activity was now on processing a range of plant materials. In the post-abandonment Phase 4, one *matā* stem was unused and a complete *matā* bears evidence of whittling/chiselling a woody plant; but these items may represent loss of items used at another location since the stratigraphy in the upper part of the soil profile does not preserve evidence of living surfaces or cultural features. The range of both subsistence and craft activities may have been reduced during Phase 3 when the site was used primarily in conjunction of ritual activities, but the smaller sample size in the later periods may also account for the absence of rarer activities. In addition, *matā* comprise a small proportion of the total assemblage of flaked stone tools from Site 6-58. A fuller use-wear study that incorporates the unretouched obsidian artifacts is required to reconstruct the full range of activities that took place at the site.

Adjusting to Obsidian

When the diverse forms of *matā* blades are matched with the range of tasks in which they were used, it is clear that this distinctive Rapa Nui artifact type maximized the properties of the only easily flaked raw material available on the island. The makers of *matā* were certainly aware of the benefits (predictable flaking properties and sharp edges) and limitations (highly fragile, dangerously thin edges) of making tools with a volcanic glass. Whereas obsidian is ideal for cutting soft material such as skin and was widely used in the past for tattooing and blood-letting (e.g., Kononenko et al. 2016; Stemp 2016a, 2016b, 2016c; Torrence et al. 2018), this volcanic glass creates major challenges for tasks that require a strong, resilient edge, as confirmed by Kononenko et al. (2015).

In order to create tools with sturdy edges capable of processing relatively hard materials and/or to maximize the use-life of the tool, people on Rapa Nui employed the *kombewa* technique, which uses the bulbar side of a large flake as a core to produce tool blanks (cf. Stevenson et al. 1984; Bollt et al. 2006). The resulting flakes have relatively thick and strong edges and a long periphery, traits that when combined, enable the user to maximize the potential working area of the flake. Consequently, it is easier to perform a range of actions with a single tool. So, for example, both the long, straight edges on the margins of many of the carving tools were used for lateral motions such as cutting and sawing, whereas the shorter thicker edge on the distal end was applied in a scraping motion (Fig. 5a). For some tasks, the continuous, smooth edges of the *kombewa* flakes have an advantage over the rough irregular surface of a retouched edge. Although they were clearly preferred for *matā*, other flake types were also selected based on the demands of the desired task, for example, when long, straight edges were required, as in the case of cutting soft, elastic material (Fig. 12a).

As demonstrated by Bollt et al. (2006) and through experimental replication by Kononenko (n.d.), it is difficult to produce "classic" *kombewa* flakes (i.e., round shape) in a consistent manner. Many of the blanks produced would have had more irregular shapes. Stone users on Rapa Nui nevertheless made the best of these by selecting edges that were most suitable to the intended task. The importance of the edge is also highlighted by examining the location on the flake where the stem was fabricated. Although the striking platform would seem to be the most desirable location because it lacks a good edge, other parts of the flake were selected so that the appropriate edges were the most accessible (see Table 2).

In addition to producing strong edges, another problem faced by Rapa Nui users of obsidian was how to protect the hand from the sharp edges, especially when a strong grip was required for precision work or use on hard materials. The stems added to the *matā* provided a better handhold, one that would increase the force and accuracy of tool use, but again the sharp edges of the retouched surface on the tang constituted a further obstacle to use. A further innovation was the creation of a haft to cover the irregular, sharp surface and further strengthen the grip. The resulting tool was strong and effective. It would have been particularly appropriate for making objects like fishhooks, needles, or other objects whose manufacture require a combination of sawing, chiselling, and carving.

When combined with the results from previous studies (Church & Rigney 1994; Church & Ellis 1996; Church 1998; Torrence et al. 2018), our analysis of the *matā* from Site 6-58 demonstrates the diverse range of tasks in which this artifact type was employed: scraping, cutting, sawing, and whittling motions applied to hard and soft woods, softer parts of plants, flesh, shell, and bone. We hypothesize that the *matā* may have been initially devised for a specific task, but once the package of a strong edge, a precision grip, and a protective handhold was created, the tool form proliferated and was extended to many other activities. Eventually, creating a handle on obsidian tools became the cultural norm for many different tasks. Furthermore, the addition of a wooden handle might have become extended because it created a space that could be decorated and used for communicating cultural affiliation and/or ownership.

Conclusions

The application of high-power use-wear analysis to 22 *matā* and 6 flakes from cave deposits at Site 6-58 on the southern coast of Rapa Nui has shown that various kinds of plant material, bone, shell, and flesh were processed by a range of actions using tools with purposely constructed handles. Although *kombewa* flakes were preferred for the manufacture of *matā* because of their large periphery and robust edges, the tool-users also selected irregular flakes with edges that matched the requirements of specific tasks. Clearly, there is still much more to learn about the myriad roles that *matā* played in daily, social, and ceremonial life on Rapa Nui. Use-wear studies are an essential and highly valuable step, but much further work is required to compare the uses of *matā* with those of unretouched obsidian tools. Additional studies should also explore the contextual associations of *matā* with other material types and better document their occurrences within ritual and secular archaeological contexts across the island.

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Appendix 1.

Part A											
ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
Woody plants											
RBC-669	2: both margins	Mixed s, b, f, some fresh	Continuous	Light, some spots on edge	Perpendicular and slightly diagonal	Numerous, one face	Light	Patchy	Light to developed	Patchy	Plant, raphide-like
RBC-671	1 margin	b, f, s, some fresh	Continuous	Few spots	Dense, shallow and deep, diagonal	Both faces	Moderate	Patchy	Well developed	Patchy	None
RBC-673	2: a margin and distal end	Margin: b, f, some fresh; distal end: s, b, some fresh	Continuous	Light, few spots on both edges	Margin: numerous, long, parallel, some crossed, on both faces and diagonal on ventral face; distal end: perpendicular and slightly diagonal	Both faces, distal end	Margin: light to moderate; distal end: moderate	Patchy	Both edges: light to developed	Patchy	Resinous plant tissue
RBC-675	1: distal end	b, f, some fresh	Continuous	Few spots	Dense, deep and shallow, diagonal	Both faces	Light to moderate	Patchy	Developed to well developed	Patchy	None

Appendix 1 (*Continued*)

Part A											
ID	Used Edges	Scar Type[*]	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
RBC 677	2: one margin and distal end	b, f, rare s, some fresh	Continuous	Pronounced, some spots	Dense, deep, parallel	Both faces	Light to moderate	Few spots	Developed	Patchy	None
RBC-678	2: one margin and distal end	Margin: b, f, some fresh; distal end: s, b, f, some fresh	Both edges: continuous	Some spots	Relatively numerous, isolated; sawing edge: parallel, slightly diagonal; scraping edge: perpendicular and slightly diagonal	Both faces	Light to intensive	Patchy	Light	Patchy	None
RBC-680	2: one margin and distal end	Margin: b, f; distal end: mixed s, b, f	Continuous	Some spots, margin: light; distal end: pronounced	Margin: relatively numerous, isolated, slightly diagonal; distal end: perpendicular and slightly diagonal	Margin: dorsal face; distal end: both faces	Margins: light; distal end: light to moderate	Patchy	Margin: light to developed; distal end: developed	Patchy	Distal end: resinous material, plant fiber, starch

Appendix 1 (*Continued*)

Part A

ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
RBC-683	2: one margin and distal end	Margin: b, f; distal end: s, f	Continuous	Pronounced, few spots	Dense, long, parallel on the margin and perpendicular on the distal end	Both faces	Both edges: moderate to intensive	Patchy	Both edges: well developed	Patchy	None
RBC-684	2: one margin and distal end	Margin: b, f, some fresh; distal end: s, b, some fresh	Continuous	Pronounced, some spots	Margin: dense, long, parallel, some crossed; distal end: dense on dorsal, less numerous on ventral, perpendicular and slightly diagonal	Margin: both faces, distal end	Both edges: moderate to intensive	Patchy	Both edges: developed	Patchy	None
RBC-691	1	s, b, f, some fresh	Continuous	Some spots	Dense, deep, perpendicular and slightly diagonal	Both faces	Moderate to intensive	Patchy	Well developed	Patchy	Plant tissue, starch

Appendix 1 (*Continued*)

Part A											
ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
RBC-693	3: (1) left margin, (2) right margin, and (3) distal end	Edge 1: f, b; edge 2: mixed s, b, f; edge 3: s, some b, f	Continuous	Light to pronounced; some spots on all edges	All edges: dense; edge 1: parallel, some crossed; edge 2: diagonal, some crossed; edge 3: perpendicular, slightly diagonal, some crossed	Both faces	All edges: intensive	Patchy	All edges: well developed	Patchy	None
Softer parts of plants, grasses, and tubers											
RBC-670	2 margins	f, b, some fresh	Continuous	Light, rarely pronounced, few spots	Relatively numerous, well isolated, long, thin, slightly diagonal, some crossed	Both faces	Light to moderate	Patchy	Light to developed	Patchy	Plant tissue
RBC-692	1, distal end	Mixed s, f, b	Continuous	Pronounced, few spots	Isolated, relatively numerous, fine, perpendicular, slightly diagonal, few parallel and crossed	Both faces	Moderate to intensive	Patchy	Light to developed	Patchy	Plant tissue, starch

Appendix 1 (*Continued*)

Part A											
ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
RBC-696	3: distal end and both margins	b, f all edges	Continuous, mostly microscars, all edges	Light to pronounced, few spots	Few, isolated, fine, short, parallel, some slightly diagonal, all edges	Both faces	Very light to light	Patchy	Light to developed, pitted	Patchy	Plant tissue, starch
RBC-685	1 margin	f, b, some fresh	Continuous	Light to pronounced, few spots	Numerous, parallel and slightly diagonal	Both faces	Light to moderate	Patchy	Light to developed	Patchy	Plant tissue
Shell or bone											
RBC-682	2, both margins	f, b, some fresh	Continuous	Severe, continuous on some spots	Numerous, shallow, parallel, some crossed and few perpendicular on right margin	Both faces	Intensive	Continuous in some spots	Well developed	Patchy	Multicolored, granular, opaque
RBC-686	1, distal end	Mixed s, b, f, some fresh	Continuous	Severe, some spots	Isolated, perpendicular and slightly diagonal	Both faces	Light	Patchy	Very light	Patchy	White, multicolored, granular,
RB- 690	2, both margins	f, b, both edges	Continuous	Severe, continuous, both edges	Fine parallel both edges, rough diagonal on the tip	Both edges	Intensive	Continuous	Rough, well developed	Patchy	White, flaky, some vivianite inclusions

Appendix 1 (*Continued*)

Part A											
ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
Soft elastic material (meat, skin)											
RBC-674	1	f, b, some fresh	Discontinuous	Light, few spots	Isolated and some spots with closely packed, dense, parallel, some diagonal and crossed	Both faces	Light	Patchy	Very light	Patchy	None
RBC-679	1	f, b, some fresh	Continuous and discontinuous	Light, rare spots	Relatively numerous, isolated, parallel, some diagonal and crossed	Both faces	Light to moderate	Patchy	Light	Patchy	None
RBC-694	1	f, b, some fresh	Discontinuous	Light, few spots	Isolated, diagonal, some parallel and crossed	Both faces	Light	Patchy	Very light	Patchy	None
Soft elastic material (fish)											
RBC-681	1	f, b, some fresh	Continuous	Light to pronounced, numerous spots	Numerous, isolated, diagonal, some parallel and crossed	Both faces	Light to moderate	Patchy	Light	Patchy	Rainbow colored tissue

Appendix 1 (*Continued*)

Part A

ID	Used Edges	Scar Type*	Scar Distribution	Attrition	Striation Type and Orientation	Striation Distribution	Edge Rounding	Edge Rounding Distribution	Polish Develop-ment	Polish Distribution	Residue on Edge
RBC-687	1	f, b, some fresh	Continuous	Light, few spots	Numerous, isolated, parallel and slightly diagonal	Both faces	Moderate	Patchy	Light to developed	Patchy	None
Not used or Unknown											
RBC-672	None	None	None	None	None	None	None	None	None	None	None
RBC-676	None	None	None	None	None	None	None	None	None	None	None
RBC-688	None	None	None	None	None	None	None	None	None	None	None
RBC-689	None	None	None	None	None	None	None	None	None	None	None
RBC-695	None	None	None	Some spots on the ridges of the surfaces	Dense, relatively rough, sub-parallel in relation to each other; random on the surface		None	None	None	None	None

* Scar type: f, feather; b, bending; s, step.

Appendix 1.

Part B									
ID	Proposed Mode of Use	Mode of Use Confidence	Proposed Contact Material	Contact Material Confidence	Intensity of Use	Hafting Wear	Residue on Stem	Proposed Hafting Method	Figure
Woody plants									
RBC-669	Scraping	Definite	Siliceous, woody plant	Definite	Probably intensive, but re-worked	Unknown	None	Unknown	Fig. 5f
RBC-671	Whittling	Definite	Siliceous, woody plant	Definite	Intensive	Attrition, striations	None	Probable wooden handle	Fig. 1e
RBC-673	Margin: sawing, occasional whittling; distal end: scraping	Definite	Resinous, woody plant	Definite	Moderate to intensive	Attrition, striations	None	Probable wooden handle	Fig. 6a–d
RBC-675	Whittling	Definite	Siliceous, woody plant	Definite	Intensive	None	None	Possible wrapped	Fig. 5e
RBC 677	Sawing	Definite	Siliceous, woody plant	Definite	Intensive	None	None	Unknown	Fig. 8e and f
RBC-678	Left: sawing; distal end: scraping with occasional whittling	Definite	Siliceous, woody plant	Definite	Intensive	None	None	Unknown	Fig. 9d–f
RBC-680	Margin: whittling; distal end: scraping	Definite	Siliceous, resinous, woody plant	Definite	Intensive	Attrition, striations	Mixed resin and probable ochre	Probable wooden handle	Fig. 7a–d
RBC-683	Margin: sawing; distal end: scraping	Definite	Highly siliceous, woody plant	Definite	Intensive	Attrition, striations	None	Probable wooden handle	Fig. 9a–c

Appendix 1 (*Continued*)

Part B									
ID	Proposed Mode of Use	Mode of Use Confidence	Proposed Contact Material	Contact Material Confidence	Intensity of Use	Hafting Wear	Residue on Stem	Proposed Hafting Method	Figure
RBC-684	Margin: sawing; distal end: scraping, occasional whittling	Definite	Siliceous, woody plant	Definite	Intensive	Attrition, striations	Grey resinous, plant tissue, starch	Probable wooden handle	Fig. 8a–d
RBC-691	Scraping	Definite	Siliceous, woody plant	Definite	Intensive	Attrition, striations	Soil contamination with plant material on unused dorsal surface	Probable wooden handle	Fig. 6e and f
RBC-693	Edge 1: sawing; edge 2: whittling; edge 3: scraping	Definite	Siliceous, woody plant	Definite	Intensive	None	None	Unknown	Fig. 5b
Softer parts of plants, grasses, and tubers									
RBC-670	Cutting/slicing	Definite	Softer parts of woody plants (e.g., leaves, green stems) and grasses	Probably	Moderate	Unknown	Unknown	Unknown	Fig. 5j
RBC-692	Cutting/slicing	Definite	Probably tubers	Probably	Intensive	Attrition, striations	Grey resinous residues with plant tissue, starch grains	Probably wooden handle	Fig. 12a–f

Appendix 1 (*Continued*)

Part B									
ID	Proposed Mode of Use	Mode of Use Confidence	Proposed Contact Material	Contact Material Confidence	Intensity of Use	Hafting Wear	Residue on Stem	Proposed Hafting Method	Figure
RBC-696	Cutting/slicing	Definite	Softer parts of woody plants (e.g., leaves, green stems) and grasses	Probably	Moderate	Attrition, striations	None	Probable wooden handle	Fig. 13d–f
RBC-685	Cutting/slicing	Definite	Softer parts of woody plants (e.g., leaves, green stems) and grasses	Definite	Moderate	Isolated striations	None	Possible wrapped in plant material	Fig. 13a and b
Shell or bone									
RBC-682	Sawing	Definite	Shell	Definite	Intensive	None	None	Unknown	Fig. 14a–d
RBC-686	Scraping, some whittling	Definite	Shell	Definite	Intensive	None	None	Unknown	Fig. 5d
RBC-690	Sawing and scraping with some whittling	Definite	Bone	Definite	Intensive	None	None	Unknown	Fig. 14e and f
Soft elastic material (meat, skin)									
RBC-674	Cutting/slicing	Definite	Meat, skin	Probably	Moderate	Attrition, striations, both faces	None	Wooden handle	Fig. 5a
RBC-679	Cutting/slicing	Definite	Meat, skin	Probably	Intensive	Attrition, striations, both faces	None	Wooden handle	Fig. 10a–c

Appendix 1 (*Continued*)

Part B

ID	Proposed Mode of Use	Mode of Use Confidence	Proposed Contact Material	Contact Material Confidence	Intensity of Use	Hafting Wear	Residue on Stem	Proposed Hafting Method	Figure
RBC-694	Cutting/slicing	Definite	Meat, skin	Probably	Moderate	Attrition, striations, both faces	Resinous material	Wooden handle	Fig. 10d–f
Soft elastic material (fish)									
RBC-681	Gutting/cutting	Definite	Fish	Definite	Intensive	None	None	Possible wrapped and inserted into handle or used in hands	Fig. 11a–f
RBC-687	Gutting/cutting	Definite	Fish	Probably	Moderate	Attrition, striations, ventral face	None	Probable wooden handle	Fig.5c
Not used or Unknown									
RBC-672	None		None		Unknown	None	None	None	Fig. 5g
RBC-676	Unknown		Unknown		Unknown	None	None	Unknown	Fig. 5h
RBC-688	None		None		Unknown	None	None	None	
RBC-689	None		None		Unknown	None	None	None	
RBC-695	Unknown		Unknown		Unknown	Attrition, striations on surface both faces	Resin-like substance, starch, raphides	Wrapped and inserted into a wooden handle	Fig. 5i

Appendix 2. Results (ppm) from pXRF analysis of obsidian sources and artifacts

ID	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
4-1	Orito	788	23,480	216	24	13	83	33	142	876	123
4-10	Orito	738	23,036	231	24	12	83	33	140	754	119
4-11	Orito	774	22,082	221	24	12	79	34	137	966	121
4-12	Orito	796	22,432	221	24	13	82	32	139	816	119
4-13	Orito	823	23,437	234	24	10	88	34	143	837	120
4-14	Orito	702	21,874	213	24	8	77	31	131	786	116
4-15	Orito	774	22,410	219	24	12	84	30	139	910	120
4-16	Orito	709	22,458	208	24	9	84	31	132	796	120
4-2	Orito	875	22,498	220	23	10	87	33	139	833	122
4-3	Orito	836	22,600	224	23	13	84	32	142	996	117
4-4	Orito	824	23,512	235	23	11	82	32	139	826	122
4-5	Orito	780	22,027	201	24	12	83	31	141	772	121
4-6	Orito	796	22,582	232	24	11	83	31	144	892	125
4-7	Orito	777	22,735	227	24	10	86	32	138	874	123
4-8	Orito	768	23,007	210	24	11	84	33	140	813	123
4-9	Orito	843	22,314	214	23	14	84	30	139	885	124
OR3-1	Orito	849	22,198	193	23	12	81	32	140	753	122
OR3-10	Orito	663	23,012	230	23	10	84	32	142	924	118
OR3-11	Orito	687	22,633	224	24	12	81	31	141	805	121
OR3-12	Orito	647	21,630	208	23	10	79	28	133	773	118
OR3-13	Orito	738	22,546	212	24	12	82	32	139	775	119
OR3-14	Orito	710	22,327	221	24	11	84	31	140	971	118
OR3-15	Orito	681	22,786	192	23	9	83	30	132	818	117
OR3-2	Orito	794	22,269	218	24	13	82	33	138	757	120
OR3-3	Orito	817	21,770	225	24	12	82	31	137	759	122
OR3-4	Orito	793	22,762	229	24	12	84	30	144	782	119
OR3-5	Orito	771	23,116	215	23	11	81	34	148	1078	122
OR3-6	Orito	848	21,189	199	23	10	80	30	137	758	122
OR3-7	Orito	728	22,725	226	23	11	85	31	142	774	129
OR3-8	Orito	727	21,989	221	24	10	81	31	140	777	122
OR3-9	Orito	754	22,165	234	24	10	79	34	139	777	117
EI-RKI-A2	RKI	808	24,172	237	23	10	91	35	153	1303	129
EI-RKI-A4	RKI	778	24,823	240	24	9	93	33	148	779	123
EI-RKI-A5	RKI	695	23,310	225	24	11	86	29	142	844	121
EI-RKI-B3	RKI	707	23,031	225	24	10	82	30	142	805	123
EI-RKI-B5	RKI	659	23,521	235	24	8	85	32	145	768	125
EI-RKI-C6	RKI	863	22,961	228	24	12	87	33	146	924	126
EI-RKI-C7	RKI	779	24,499	245	25	14	93	32	154	1020	125
EI-RKI-D2	RKI	693	22,875	229	24	11	91	31	143	860	125
EI-RKI-D6	RKI	832	23,162	239	24	12	90	31	148	785	123

Appendix 2 (*Continued*)

ID	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
EI-RKI-E2	RKI	702	23,358	229	24	12	89	30	145	848	127
EI-RKI-E8	RKI	764	25,708	240	24	14	90	34	148	798	126
EI-RKI-F2	RKI	774	22,990	221	25	11	83	30	144	779	124
EI-RKI-F5	RKI	728	23,674	204	24	12	87	29	148	795	120
EI-RKI-G5	RKI	688	23,534	211	24	10	88	31	144	814	122
EI-RKI-G7	RKI	706	23,673	216	24	12	85	30	145	1077	124
EI-RKI-H4	RKI	701	23,351	228	25	10	88	29	142	886	121
EI-RKI-H5	RKI	765	23,677	235	24	10	89	28	145	816	126
EI-RKI-H6	RKI	790	23,914	214	25	9	89	34	150	1053	129
EI-RKI-I1	RKI	818	25,161	237	24	11	94	33	150	838	125
EI-RKI-I2	RKI	818	23,238	237	24	11	83	31	146	764	123
EI-RKI-I3	RKI	813	23,488	222	24	11	90	31	142	798	122
EI-RKI-J3	RKI	806	25,918	241	25	12	92	33	156	863	127
EI-RKI-J4	RKI	756	22,901	222	24	11	87	30	142	801	126
EI-Rki-J5	RKI	819	23,805	236	24	10	93	32	149	838	125
EI-RKI-K2	RKI	840	24,540	229	24	13	95	34	158	1098	125
EI-RKI-K7	RKI	690	23,289	220	24	11	89	30	143	767	124
EI-RKI-K9	RKI	816	24,038	234	24	13	87	29	148	835	125
EI-RKI-L2	RKI	601	22,590	219	24	8	85	29	140	813	118
EI-RKI-L7	RKI	787	23,550	237	24	9	89	32	150	878	127
EI-RKII-A4	RKII	591	19,882	230	24	10	87	14	146	834	125
EI-RKII-A9	RKII	517	19,635	215	24	11	91	11	145	793	122
EI-RKII-B3	RKII	733	20,900	215	24	12	95	14	154	828	125
EI-RKII-B4	RKII	638	21,196	230	24	11	94	12	154	835	125
EI-RKII-C7	RKII	630	20,326	227	24	12	96	10	161	852	130
EI-RKII-C8	RKII	593	21,135	255	24	11	95	16	153	831	124
EI-RKII-D1	RKII	558	20,813	245	24	12	96	12	156	855	128
EI-RKII-D7	RKII	455	18,203	209	24	13	99	7	157	750	132
EI-RKII-E2	RKII	468	20,545	231	24	13	92	13	152	831	128
EI-RKII-E8	RKII	640	20,618	238	23	12	92	12	151	834	127
EI-RKII-F4	RKII	652	21,089	232	24	11	92	11	151	833	128
EI-RKII-F5	RKII	606	19,417	224	24	9	90	15	145	792	122
EI-RKII-G5	RKII	637	20,809	231	24	12	92	12	153	829	127
EI-RKII-G7	RKII	684	19,646	208	24	12	92	16	143	788	125
EI-RKII-H5	RKII	589	20,714	226	24	13	94	13	151	830	125
EI-RKII-H6	RKII	670	20,142	229	24	11	90	10	156	830	121
EI-RKII-I11	RKII	485	18,907	224	24	10	101	10	149	794	129
EI-RKII-I3	RKII	595	21,693	252	24	13	104	12	160	876	135
EI-RKII-J2	RKII	662	20,610	250	24	11	97	12	155	835	126
EI-RKII-J7	RKII	486	18,464	224	24	9	99	8	152	753	124
EI-RKII-J9	RKII	659	20,773	238	25	10	100	14	150	825	120

Appendix 2 (*Continued*)

ID	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
EI-RKII-K2	RKII	588	20,772	216	24	11	95	13	153	839	128
EI-RKII-K3	RKII	566	20,657	231	24	11	89	12	150	858	123
EI-RKII-L1	RKII	640	20,524	234	24	13	96	13	161	848	133
EI-RKII-L2	RKII	671	21,362	257	24	12	91	11	158	853	127
EI-RKII-M2	RKII	657	21,494	258	24	14	98	15	159	857	128
EI-RKII-M6	RKII	667	21,578	235	24	12	89	16	153	814	125
EI-RKII-N4	RKII	683	20,823	221	24	10	95	14	153	839	126
EI-RKII-N6	RKII	532	18,754	226	24	14	108	7	162	767	132
MI-1	Motu Iti	918	25,135	225	24	10	86	58	142	768	124
MI-10	Motu Iti	901	22,187	214	24	9	76	49	127	688	112
MI-2	Motu Iti	919	25,606	231	24	11	83	60	143	758	121
MI-4	Motu Iti	912	25,044	226	24	10	80	55	139	811	119
MI-5	Motu Iti	921	24,685	231	25	11	84	56	143	766	122
MI-6	Motu Iti	792	24,688	220	24	8	83	55	137	722	118
MI-7	Motu Iti	884	25,465	239	24	9	83	55	139	760	123
MI-8	Motu Iti	913	23,097	217	24	11	80	51	132	690	117
Motu 1	Motu Iti	960	23,921	206	24	12	85	52	134	705	122
Motu 2	Motu Iti	939	24,337	219	24	10	78	53	138	717	125
Motu 3	Motu Iti	889	23,887	210	24	11	80	55	134	704	118
Motu Nui 1a	Motu Iti	776	24,571	228	24	9	87	53	136	719	118
Motu Nui 1b	Motu Iti	754	24,321	206	24	12	82	50	136	721	120
Motu Nui 2a	Motu Iti	794	24,840	215	25	10	88	54	136	723	122
Motu Nui 2b	Motu Iti	734	23,721	216	24	9	79	53	133	782	119
Motu Nui 3a	Motu Iti	737	23,705	200	24	9	76	49	127	678	117
Motu Nui 3b	Motu Iti	747	24,215	217	25	10	80	53	129	707	116
RBC-88a	Motu Iti	874	23,714	223	24	10	80	55	134	714	121
RBC-88b	Motu Iti	901	24,124	209	24	9	81	56	134	711	122
RBC-89a	Motu Iti	895	23,654	205	24	10	83	55	133	752	118
RBC-89b	Motu Iti	881	23,689	214	24	11	81	54	137	714	119
RBC-90a	Motu Iti	975	23,564	224	24	10	82	53	133	704	122
RBC-90b	Motu Iti	851	23,136	196	24	9	80	48	131	701	118
RBC-91a	Motu Iti	947	23,554	210	24	9	83	52	130	736	117
RBC-91b	Motu Iti	939	23,676	210	24	10	83	51	136	689	115
RBC 669	Orito	838	22,417	226	24	11	83	30	138	791	119
RBC 670	Orito	841	22,612	226	24	11	87	33	139	793	118
RBC 671	Orito	839	22,686	220	24	13	86	33	144	921	122
RBC 672	Orito	753	22,518	223	24	10	86	31	140	827	121
RBC 673	RKI	772	23,729	236	24	11	86	31	145	802	125
RBC 674	Orito	863	23,151	237	23	12	86	35	142	827	126
RBC 675	RKI	830	22,934	222	24	11	83	30	143	791	123
RBC 676	RKI	766	22,992	218	23	11	84	29	143	899	120

Appendix 2 (*Continued*)

ID	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
RBC 677	Orito	840	21,862	216	24	11	80	30	138	819	119
RBC 678	Orito	801	22,137	220	24	10	85	34	141	766	122
RBC 679	Orito	854	23,833	227	23	13	85	35	145	870	128
RBC 680	Orito	809	22,106	218	24	11	82	32	139	784	124
RBC 681	Orito	804	23,405	234	24	14	83	38	144	896	127
RBC 682	Orito	811	22,294	216	24	14	86	33	147	834	127
RBC 683	Orito	807	21,960	234	23	12	80	35	134	805	117
RBC 684	Orito	881	21,699	219	24	10	81	31	138	948	123
RBC 685	Orito	881	22,981	221	24	13	90	33	145	814	127
RBC 686	Orito	880	22,043	222	24	12	81	32	137	811	121
RBC 687	Orito	761	22,348	197	24	10	85	32	136	763	120
RBC 688	Orito	879	21,904	214	24	13	85	31	138	845	119
RBC 689	RKI	813	22,797	234	24	10	90	32	146	803	125
RBC 690	Orito	837	22,637	217	24	11	88	30	138	781	122
RBC 691	Orito	839	22,462	216	24	11	84	30	139	840	123
RBC 692	Orito	809	22,857	217	23	10	81	29	144	872	119
RBC 693	Orito	785	19,737	197	23	10	73	29	130	911	112
RBC 694	Orito	769	21,676	210	24	11	82	32	135	787	121
RBC 695	Orito	733	21,903	231	24	12	85	32	137	754	122
RBC 696	Orito	784	21,500	206	24	9	80	29	137	751	117