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A personal perspective on microblade and microblade core variability in northeast Asia and northwest North America

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ABSTRACT

For more than five decades, researchers have attempted to classify different microblade traditions from Late Pleistocene and Holocene assemblages of northeast Asia and northwest North America. Many have interpreted various attributes observed on archaeological examples of microblade cores and microblades by relying upon conjecture or the experimental results of others. Contrary to the prevailing belief that microblade production was a complicated process that involved indirect percussion or assisted pressure and holding devices, a simple free-hand pressure technique can easily replicate examples comparable to those recovered from pre-contact sites. It is argued here that such a technique prevailed in the past, and that many of the variations in formal and metric attributes of archaeological microblade cores and microblades are the result of a wide range of environmental, behavioural, and functional variables rather than of completely different methods of manufacture.

KEYWORDS

Experimental archaeology, microblades, microblade cores, Late Pleistocene, Holocene

1. Introduction

Microblades represent a distinctive lithic technology in northeast Asia and northwest North America from at least the Early Upper Pleistocene and through much of the Holocene. When and where microblade technology originated are debated, although the Altai region has been proposed as a possible place where it first appeared in northeast Asia (Goebel 2002:121). Goebel concluded that no convincing microblade technology in northeast Asia can be shown to predate the Late Glacial Maximum (ca. 18,000 BP). During the Late Pleistocene, microblade technology became widespread throughout northeast Asia and the Japanese Archipelago. The evidence from Swan Point, Alaska, indicates that some of the first people to enter North America by way of Beringia brought microblade technology with them. In northwest North America, it constituted a primary element of the general lithic technology until the Late Holocene.

Heat treatment and pressure flaking had already been introduced to the north and northeast of the Black Sea by 32,000-25,000 BP, as much as 14,000 years prior to the appearance of microblade technology in the Altai region. Both heat treatment and pressure flaking are reflected in the fine workmanship displayed on thin bifacially flaked projectile points of the Kostenki-Streletskaya Culture (Bradley et al. 1995:996; Anikovitch 2000), and can be assumed to have been necessary prerequisites for microblade production, regardless of the specific methods used.

Flintknappers and archaeologists have attempted to replicate microblade production in order to understand specific methods of manufacture and to account for what is found in the archaeological record. Speculation about how microblades were manufactured continues to this day. One aim of this paper is to assert that microblade manufacture can be easily achieved through a direct free-hand pressure method that employs short pressure flakers comparable to items reported from archaeological sites. This method differs from other proposed manufacturing techniques ascribed to the production of microblades and microblade cores. A secondary objective is to characterize variability in morphological and metric attributes observed on microblade cores and microblades in archaeological assemblages and to suggest that this can all be replicated with the proposed free-hand pressure method. Finally, I will discuss topics to consider when interpreting microblade assemblages. I hope these insights will help researchers fine-tune interpretations of microblade traditions and the possible different uses of pre-contact microblades.

2. History of experimental microblade manufacture

Experimentation with microblade manufacture, in general, dates back to at least Sollberger and Patterson's (1976, 1983) attempts to replicate microblades from small, bullet-shaped cores; Callahan's (1985) trials to replicate Danish Mesolithic microblades; Flenniken's (1987) experiments to replicate microblades from Late Pleistocene Yubetsu-type microblade cores recovered from Dyuktai Cave, Siberia. These and other researchers were heavily influenced by Don Crabtree who had earlier reported his results on replicating both Folsom fluting (Crabtree 1966) and Mesoamerican prismatic macroblades (Crabtree 1968). They were also likely aware of the earlier trials of H. Holmes Ellis (1940:48-49) on general flint working, which cites ethnohistoric accounts of Aztec macroblade production by means of a long T-shaped crutch. In an attempt to replicate Folsom fluting, Crabtree (1966:15-16) was able to remove only "a rudimentary fluting flake" through free-hand pressure using a variety of hand-held bone or antler tools while holding a preform on a leather padding in the palm of his hand. Using a similar preform holding position, but applying pressure by means of a short shoulder crutch, Crabtree had the misfortune of a preform collapse and, consequently, drove the antler-tipped pressure tool through the palm of his left hand. To prevent similar injuries from occurring, he developed "a series of clamps and holding devices" to secure preforms (Crabtree 1966:16).

In their experiments to replicate microblades, both Flenniken (1987) and Callahan (1985) used a vice to secure the core and a wood, stone, or bone anvil to backstop it, plus long or extended pressure flakers to press off microblades. Others adopted a hand-held wood, bone, or antler contraption to immobilize the core and protect the palm, or they used long or composite pressure flakers similar to examples illustrated by Crabtree (1967:Figures 2 and 3): e.g., Ohnuma (1993), Pelegrin (2012), Tabarev (1997:Figures 2 and 4 and 2012:Figure 13.9), and Wilke (2007). One of the pressure techniques Sollberger and Patterson (1976:524) experimented with involved holding the core by hand (protected by a leather pad) and applying pressure via an approximately 40 cm long elk antler tine. They also produced microblades by employing a lever/fulcrum technique, which included using an iron rod fork, holding the core in place by hand, and applying pressure with an approximately 20 cm long pointed antler tool. They later published results of a lever method to replicate small bullet-shaped cores (Sollberger and Patterson 1983:25-31). They selected for their model a 37 mm long and 6 mm wide core that Hole et al. (1969:Figure 24) had recovered from a 9500 to 7600 BP site in Iran. Wilke (2007:222) also experimented in replicating Near Eastern Neolithic bullet-shaped microcores. He concluded that in order to obtain straight blades, the core had to be immobilized in some sort of grooved device that included a built-in anvil. However, Flenniken and Hirth (2003:100 and Figure 6.5) were able to replicate 5.0-7.2 cm long Mesoamerican prismatic blades using a long hand-held pressure flaker and a leather pad.

The experimental results, plus earlier speculation regarding microblade detachment - especially by West (1967:368) - led many archaeologists to interpret attributes sometimes observed on the keel, the side, or other areas on microblade cores, as "damage" or "crushing" that resulted from use of a clamp or anvil during microblade removal. In describing the microblade cores discovered at Donnelly Ridge, Alaska, West (1967:368) wrote that:

> A pattern of minute fractures or crushing may be discerned along some portion of the base of most cores and another along one edge of the top just behind the striking platform. I interpret both to result from rebound as blades were punched off. If this is correct then the basal crushing would suggest a hard surface, a flat rock or, perhaps, more likely, a section of compact bone or antler used as an anvil.

Many archaeologists have accepted West's conjectures, or Flenniken's (1987) experimental results, regarding microblade detachment: Chen and Wang (1989:131), Cook (1969:87 & 266), Del Bene (1980:34-35, 1992:66), Doleman (2008:354), Elston and Brantingham (2002:105), Esdale et al. (2015:46), Fladmark (1986a:34 and 1986b:45), Ham (1990:213), Lee (2007:153), Lee et al. (2016:141), Potter (2005:423, 424), Powers (2017a:52), and Takakura (2010:343). Magne (1996:153) considered basal battering, sometimes evident on microblade cores, as damage from anvil use during microblade detachment or from artifacts being used for the purposes of a wedge.

In contrast, I wrote (Gryba 2006:59) that:

> In his analysis of microblade cores from the Campus site, Mobley (1991:27-28) noted that Mauger (1971:7-8), had concluded that the crushing was due to either purposeful or inadvertent strengthening of the keel during core shaping… Because it sometimes occurs only on the bottom of the keel, both on the bottom and on the side, only on the side of the core, or is not represented at all on many microblade cores (e.g., Mobley 1991:Figures 11 to 19; Clark and Gotthardt 1999:84 & Figures 3.2 to 3.7), it is apparent that this "crushing" is, as Mauger had earlier concluded, due most likely to preform preparation rather than from use of a hard anvil during blade removal. A similar interpretation could easily account for the "damage" also reported on the core platform.

Following a series of experiments with various direct and assisted pressure flaking techniques, Pelegrin (2012:465-500) proposed six different "modes" of pressure blade production. Using the first three modes, he produced blades that fit within the width range of archaeological microblades. In his simplest method, mode 1, the core was held in the left hand (he is right handed) with a piece of leather to protect the palm and fingers. Mode 1b was similar but here the core was immobilized in a small hand-held grooved piece of wood, bone, or antler. He then used an approximately 17 cm long antler pressure flaker to press off about 5 mm wide microblades with mode 1, and up to 8 mm wide microblades with mode 1b. Mode 2 was considered an improvement over modes 1 and 1b. In this case, he secured the core in a hand-held grooved device and employed an approximately 30-40 cm long shoulder crutch to press off microblades up to 10 mm wide. Most of the microblades produced by modes 1 and 2 were "twisted or skewed". Mode 3 was similar to mode 2, but differed because the core was placed in a grooved device resting on the ground where it was backstopped by a rock or root. Pelegrin then applied pressure with a short crutch positioned at the belt and, because the force was more direct, was able to press off straighter "flint bladelets up to 12 mm wide and about 8 cm long" (Peligrin 2012:473).

Pelegrin's experimental results, using direct and assisted pressure techniques, were adopted by Gómez Coutouly (2011a, 2011b, 2015, 2017) to interpret variations in height of microblade cores, and in width and thickness of microblades, recovered from Late Pleistocene and Early Holocene archaeological sites throughout northeast Asia and northwest North America.

3. A simple direct, free-hand pressure method of microblade detachment

In 1988 (Gryba 1988:57), and later in greater detail (Gryba 2006:59-62), I described a simple, free-hand pressure flaking technique of microblade manufacture based on the use of short pressure flakers plus two pieces of soft leather within which to secure the pressure flaker and the preform or core. This method differs considerably from the one entailing long pressure tools and fixed holding devices used by Crabtree (1967) and others.

The tools I employ to fashion a microblade core preform may include a small stone that can serve as a hard hammer and platform abrader, an antler billet, several pressure flakers of different dimensions, plus two pieces of soft leather to cushion the core and pressure flaker. The moose, deer, or caribou antler pressure flakers I use for detaching microblades measure from 4.5 to 7.5 cm long (Figures 1 and 2) are comparable to artifacts recovered from archaeological sites throughout North America (Gryba 2006). In this simple technique, no wood, bone or antler devices for securing cores or preforms are required; such items have yet to be reported from archaeological sites. Instead, I wrap the microblade core in soft leather to prevent it from cutting my hand and hold the object in my left hand. The antler pressure flaker, is also wrapped in soft leather and held in my right hand, as I am right-handed. I then stabilize the hand holding the core or preform on the inside of the left leg just above the knee, and, with the hand holding the flaker resting on top of the right leg, apply steady pressure to detach microblades from the side of the core facing the palm of the left hand (Figure 3).

Human hands are readily adjustable clamps that can accommodate a vast range of sizes and configurations of microblade cores, from initial preforms to depleted cores. I use no hard anvil; the distal end of the core can be backstopped against the leather padding in which it is wrapped. Or, I simply secure the core between the palm and fingers without any sort of backstopping allowing microblades to "pop off" with a sufficient amount of pressure.

With a curved pressure flaker, I can direct force along both the length of the fluted face and into the core, which usually detaches microblades flat in longitudinal cross section. Depending on lithic material quality, height of the fluted element, and configuration of negative scars from primary and secondary ridge blades, I find it easy to remove long microblades that are flat or slightly curved in longitudinal cross section by using straight or curved pressure flakers. Free-hand pressure application and core holding adds variability to the process, further affecting the microblades produced.

With this method of pressure flaking, I found it easy to press off microblades and channel flakes more than 8 cm long (Gryba 1988:54; see also Figure 4). I stated (Gryba 2006:62) that by using this technique, I "detached microblades greater than 9.0 cm long, and a channel flake 2.2 cm wide, 2.3 mm thick, and 12.0 cm long with an outrepassé termination," the latter suggesting that given high quality lithic material, I had not yet reached the maximum length or width of microblades that could be removed by direct free-hand pressure. Figures 5-9 display more examples of the microblades and microblade cores I have produced by this direct, free-hand pressure method.

Figure 1. Large bidirectional obsidian microblade core (lower left) and microblades, plus robust deer antler pressure flaker (upper left) used to detach the microblades.

Figure 2. Second series of microblades and largely depleted core (lower right) from Anahim Peak obsidian. The longer deer antler pressure flaker (upper right) was used to detach many of the larger microblades and the smaller one was used to prepare platforms and to press off some of the smaller microblades. Microblades are arranged, from upper left to lower right, in order of detachments.

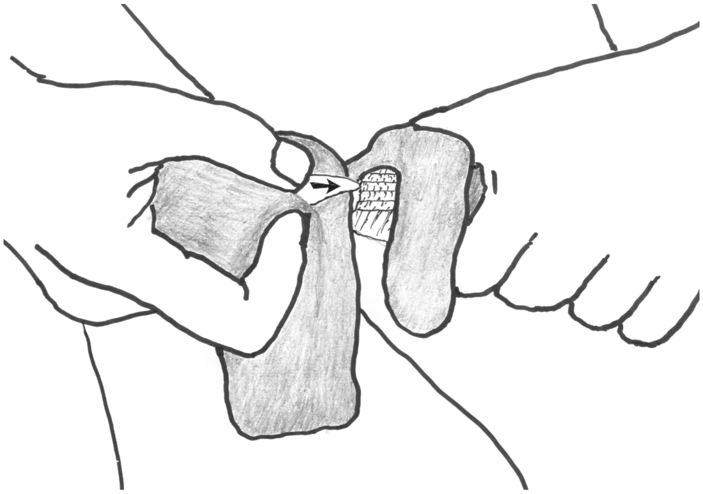

Figure 3. Method of grasping a core and a short antler pressure flaker during microblade manufacture. Arrow shows direction of pressure application.

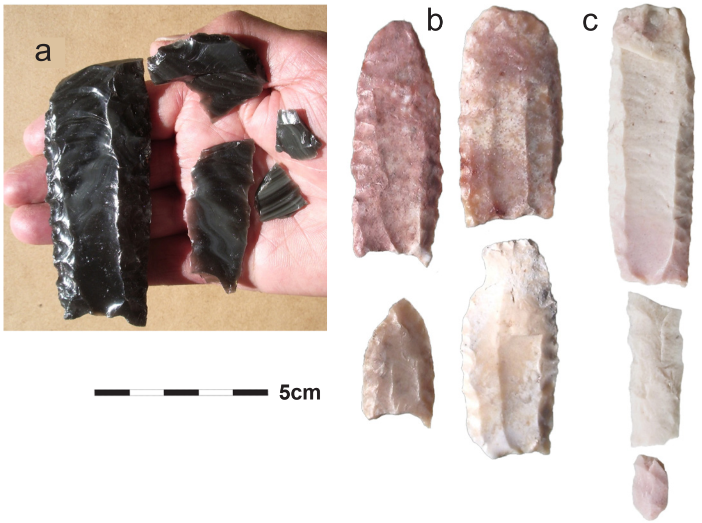

Figure 4. A large obsidian preform and 2.3 cm wide, 2.3 mm thick and 12.0 cm long channel flake detached from it (a), four basally thinned Swan River Chert preforms (b), and one long fluted example (c). Channel and base thinning flakes were detached by direct free-hand pressure.

Figure 5. Heat-treated orange Swan River Chert microblade core (right), plus microblades detached by free-hand pressure.

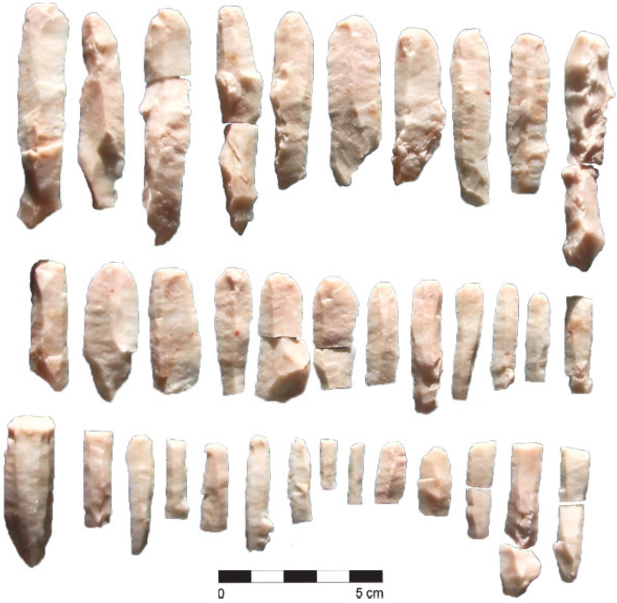

Figure 6. Heat-treated cream Swan River Chert microblade core (lower left), plus primary and secondary ridge blades and microblades detached by free-hand pressure.

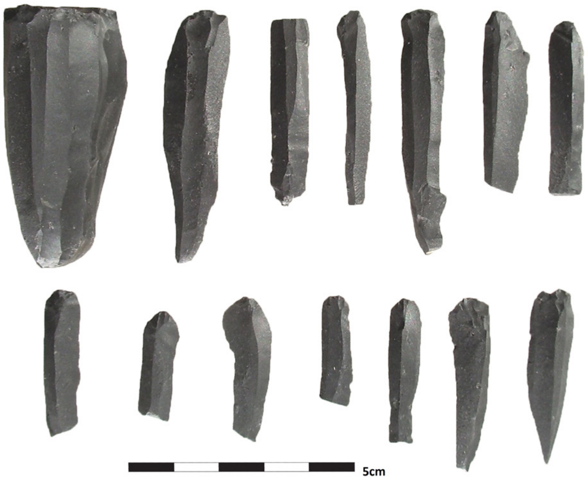

Figure 7. Heat-treated dacite microblade core (upper left), plus microblades detached by free-hand pressure.

Figure 8. First series of microblades and partially depleted microblade core (lower right) made from Anahim Peak Obsidian. Microblades are arranged, from upper left to lower right, in order of detachment.

Figure 9. Heat-treated Cat Head Chert microblade cores (upper right and lower left), plus microblades removed by direct free-hand pressure.

3.1 Merits of the free-hand manufacturing technique

The free-hand pressure method I use, based on short pressure flakers and hand-held cores and preforms, offers a simpler and more efficient model of microblade production in northeast Asia and northwest North America than experimental approaches described above. Foremost, it is supported by empirical archaeological evidence. The short pressure flakers I use are similar to items that have been reported from archaeological sites (Gryba 2006). Technically, microblades may have been made with long or composite pressure tools in the course of manufacturing parallel-sided, prismatic macroblades at historic contact in Mesoamerica or during the Neolithic in the Old World. However, archaeological evidence in northeast Asia indicates that microblades had been produced for at least 10,000 years prior to the appearance of prismatic macroblade technology. In addition, there is no evidence that assisted pressure macroblade technology ever spread across Bering Strait into northwest North America. It is evident that macroblades recovered from Late Pleistocene or Early Holocene sites on both sides of Bering Strait were not produced by some type of assisted pressure technique because of their usually non-parallel lateral edges, uneven, sinuous arrises, and an often curved longitudinal profile. Rather, they were made by hard hammer, or more likely soft hammer (antler billet), percussion. This is exemplified by macroblades recovered from: 1) Northeast Asia, including Ust-Kan Cave, Afanasyeva Gora, and Tolbaga and Kunaley – Layer 3 (Michael 1984:Figures 18, 21, 25, and 28, respectively citing Konstantinov 1980, Lisitsyn 1980, and Rudenko 1960), Risovoye-1, Molodezhnaya-1 and Dyuktai Cave (Gómez Coutouly 2011a:Figures 5.31, 5.44, and 6.14, respectively); 2) Northwest North America, including Anangula (Aigner 1970:Figures 11 to 13, Del Bene 1992:Figure 7, and Gómez Coutouly 2015:17 and 18), Campus site (Mobley 1991:Figure 28), Donnelly Ridge (West 1967:Figure 5), Dry Creek (Powers 2017a:Figure 4.45), Moose Creek (Pearson 1999:Figure 7h and Figure 8g), Walker Road (Ackerman 2007:Figure 10.4 x and y), as well as examples from various Clovis sites (Collins 1999:Figures 3.14 to 3.18, 6.1 to 6.3, and 6.7 to 6.15).

My technique also differs from most others because both the core and the pressure flaker are immobilized in only soft leather. I use no wood, bone, or antler clamps or grooved devices to secure the core or preform; such contraptions have yet to be reported from archaeological sites. Another benefit of my free-hand pressure flaking technique is its versatility and portability - qualities that are important to mobile hunter-foragers with whom microblade technology is usually associated. Moreover, this simple technique can account for the observed variability in microblade cores, microblades, and other pressure-flaked items seen in the archaeological record.

4. Metric dimensions of artifacts from archaeological contexts

4.1 Microblade core metrics

Microblade cores recovered from Late Pleistocene and Holocene sites generally range in height along the fluted element (i.e., the length of the longest flake scar left by the detached microblade) from slightly over a centimetre to more than 7 cm (Table 1). Small cores around 1.75 cm in height are illustrated from Risovoye (Gómez Coutouly 2011a:Figures 5.22 and 5.23), Broken Mammoth and Ground Hog Bay 2 (Ackerman 2007:Figures 10.9f and 10.10b), and Banjo Lake (Esdale et al. 2015:Figure 10 a, d & h). By contrast, some of the microblade cores found at Dyuktai Cave are between 3.0 and 6.5 cm in height (Table 1; Gómez Coutouly 2011a:81, Figures 5.8 and 5.9). One of the microblade cores from Mount Edziza is close to 9.5 cm high, but the fluted element on it extends only around 6.5 cm (Table 1; Fladmark 1985:Figure 77a).

The measurements in Table 1 are for cores at the time of loss or abandonment and are not necessarily indicative of maximum height at the start of microblade detachment. This is particularly true for examples where the angle of the striking platform is significantly less than 90 degrees and an unknown portion of the core had already been depleted through microblade removal (it is absent) or by detachment of platform rejuvenation tablets. The maximum length of primary ridge flakes, or complete microblades, is likely a better indicator of maximum core height at the start of microblade production. For example, a primary microblade ridge flake from High River, Alberta, is a good indicator that at least one of the obsidian blanks carried there was over 7.3 cm long (Sanger 1968:Plate 1; Wilson et al. 2011:Figure 2).

Many prehistoric microblade cores, especially those where the fluted surface extends only part way around the core circumference, have a striking platform angle that measures slightly less than 90 degrees. The striking platform angle may be considerably less than 90 degrees depending upon the initial shape or size of the preform, the success of platform formation or rejuvenation, or the history of blade removal. For instance, the striking platform angle on some of the cores from Dyuktai Cave (Gómez Coutouly 2011a:Figures 6.4-6.6), Verkhne-Troitskaya (Gómez Coutouly 2011a:Figures 6.21b and 6.22b), and Drachak-Vetrenny (Gómez Coutouly 2011a:Figure 6.35) approaches 45 degrees. In extreme cases, platform angles on cores from Mount Edziza range from 30 to 60 degrees. Microblades from these cores were removed from both faces of the acute platform (Fladmark 1985:176 and Figures 75 and 77).

Table 1. Metric data (mm) for archaeological and replicated microblade cores.

Core height	Height range	Height average	Maximum length flute element	Average length flute element	Site	Sample size	Lithic type	Reference
	14.0-37.0				Xiachuan	17	chert	Chun & Xiang-Qian 1989:Figures 5 & 6
	13.0-30.0				Xueguan	17	chert	Cchun & Xiang-Qian 1989:Figures 12 & 13
	4.0-70.0				Dyuktai Cave	6	chert	Gomez Coutouly 2011a:81, Figures 6.4-6.6
	13.0-35.0				Risovoye-1	17	obsidian, volcanic tuff	Gomez Coutouly 2011a:Figures5.22-5.24
	50.0-60.0				Ushki-1		cryptocrystalline silicates, obsidian	Gomez Coutouly & Ponkratova 2016:13
	25.0-30.0				Ushki-1		cryptocrystalline silicates, obsidian	Gomez Coutouly & Ponkratova 2016:13
	26.0-57.0				Amakomanak	14	chert	Gomez Coutouly 2017:Table 1
			78.0		Point Lay	1	chert	Gomez Coutouly 2017:Figure 15c
			76.0		Nogahabara	1	obsidian	Gomez Coutouly 2017:Figure16
			57.0	42.7	Anangula	7		Morlan 1970:Table 2
			85.0	53.8	Akmak	9		Morlan 1970:Table 2
			35.0	26.4	RaEc-1	14		Morlan 1970:Table 2
	14.0-29.0	21.6	28.1		Campus	41	chert	Mobley 1991:Table 8
	18.0-31.0	25.0			Dry Creek	21	chert, chalcedony, rhyolite	Powers 2017a:Table 4.1
	15.0-39.0				Kelly Creek	28	chert	Clark & Gotthardt 1999:Table 3:11
	41.1-95.2		49.4	35.4	Mt. Edziza	5	obsidian	Fladmark 1985:Table 5 (flute element face 1)
	41.1-95.2		71.9	48.0	Mt. Edziza	4	obsidian	Fladmark 1985:Table 5 (flute element face 2)
			43.7		HhOv-449	1	Swan River chert	Wickham & Graham 2009:360 & Figure 144
	20.9-32.4				Bezya	5	chert	Le Blanc & Ives 1986:Table 1
	19.7-29.2				Little Pond		siltstone	Younie et al. 2010:Table 4, Figures 5-8
				37.4-56.6	High River	5.0	chert	Wilson et al 2011:Table 1
56.8			56.8		replication	1	orange Swan River Chert	Gryba Figure 5 this paper
69.5			69.5		replication	1	obsidian	Gryba Figure 1 this paper
35.4			35.4		replication	1	Anahim Obsidian	Gryba Figures 2 and 8 this paper
34.8			34.8		replication	1	Cat Head Chert	Gryba Figure 9 top row this paper
45.0			45.0		replication	1	cream Swan River Chert	Gryba Figure 6 this paper

4.2 Microblade metrics

Microblade width and length is partly controlled by: width and height of the core, diameter of the flute chord, configuration of the striking platform, dimensions and weight of the pressure flaker as well as the shape of its tip, spacing of arrises formed by the removal of prior microblades, quality of the lithic material, and the amount and direction of pressure applied. The width of microblades cannot exceed that of the flute chord. Most microblades recovered from archaeological sites are between 0.6 and 4.5 mm thick and seldom exceed 10 mm wide or 60 mm long (Table 2).

After removal of the majority of cortex, primary ridge blades are the initial detachments when preparing a fluted face of a core and they often display transverse flaking on their dorsal aspect if preform preparation was required. Secondary blades, or “edge flakes” (Pitulko 2013:55), may display on the dorsal aspect the natural cortext or transverse flaking from core preparation, plus a scar of a prior blade detachment. In comparison to secondary blades or microblades, ridge blades tend to be thick and long, depending on how acutely the ridge was shaped and whether detachment was by pressure or percussion. For instance, primary and secondary ridge blades from the High River site in Alberta (EdPk-3) range from 2.2 to 4.2 mm thick, 6.2 to 11.0 mm wide, and as much as 70 mm long, which is indicative of the minimum core height.

Table 2. Metric data (mm) for archaeological and replicated microblades. Widths and thicknesses taken on complete and proximal portions, lengths for complete examples.

Width range	Width average	Thickness range	Thickness average	Length range	Length average	Sample size	Lithic type	Site	Reference
2.5-14.0	5.8	0.8-7.4	1.9	7.8-42.8		39	various	Campus	Mobley 1991:Table 7
	2.7					3	green chert	Dry Creek, Com. II	Powers 2017:Table 4
	4.9					188	rhyolite	Dry Creek, Com. II	Powers 2017:Table 4
2.7-4.9	4.1					980	8 types	Dry Creek, Com. II	Powers 2017:Tables 4.3 & 4.4
1.9-12.2	6.1	0.6-4.5	1.5	5.0-32.0		57	jasper, chert, andesite	Village Site, Level 1	Cook 1969:143
2.9-12.8	6.4	0.6-3.4	1.6	8.0-33.0		53	jasper, chert, obsidian,	Village Site Level 2	Cook 1969:146
3.8-11.0		0.9-2.9	1.6	6.0-31.0		28	jasper, chert, obsidian, rhyolite	Village Site Level 3	Cook 1969:148
	6.4		1.4			583	9 lithic types	Gerstle Lake, C. 3	Potter 2005:449-450
2.0-8.0						186		Lawn Point	Fladmark 1986b:Table 4
3.3-8.8	5.8	0.90-3.10	1.8	7.5-29.3	17.3	42	various	Lawn Point, complete	Magne 2019 pers. comm.
2.7-8.8	5.8	3.10-8.90	1.7	5.4-30.0		97	various	Lawn Point	Magne 2019 pers. comm.
2.6-8.7	5.7	0.20-4.60	2.2	11.8-37.7	22.1	38	basalt, chert	Kaska, complete	Magne 2019 pers. comm.
	6.0		2.4		18.7	80	basalt, chert	Kaska, comp & prox.	Magne 2019 pers. comm.
4.6-6.3		1.04-1.56				448	16 types	On-Your-Knees Cave	Lee 2007:Table 4.2
2.9-5.2		0.75-1.57				73	various types	Ed's Delimma	Lee 2007:Table 4.3
4.3-7.9		1.72-2.52		33.5-52.7		103	obsidian	8 Mt. Edziza sites	Fladmark 1985:Table 6
3.5-12.2	6.2	0.8-3.1	1.7	7.9-34.8		444	basalt	Lehman	Sanger 1968:Table 4
2.6-6.9		0.6-2.4		8.1-30.2		11	chert	Bezya	Le Blanc & Ives 1986:Table 5
	4.6		1.5			10	mudstone/siltstone	Little Pond	Younie et. al. 2010:84
4.0-10.4	7.2	1.0-4.0	2.0	7.2-45.9		54	obsidian	High River	Sanger 1968:Table 1
5.0-7.4	6.4	1.4-2.8	1.8	8.0-22.4		8	chalcedony	High River	Sanger 1968:Table 1
5.4-9.2	7.7	1.7-3.4	2.4	46.3-56.3		10	orange Swan River Chert	replication	Figure 5 this paper
6.1-15.5	11.5	1.6-6.4	3.7	30.7-69.7		16	cream Swan River Chert	replication	Figure 6 this paper
5.0-10.3	7.6	1.1-2.9	2.0	34.8-57.1		23	Anahim Obsidian	replication	Figure 2 this paper
3.7-8.8	5.7	1.4-2.9	1.8	31.3-46.7		18	Anahim Obsidian	replication	Figure 8 this paper
4.7-7.7	6.4	0.9-2.4	1.3	21.6-44.0		11	Cat Head Chert	replication	Figure 9 bottom row this paper
3.7-7.0	5.3	1.0-2.5	1.6	23.3-39.9		27	Cat Head Chert	replication	Figure 9 top row this paper
7.5-11.3	9.5	1.9-3.8	2.9	41.3-76.0		32	obsidian, bidirectional	replication	Figure 1 this paper

5. Sources of microblade core and microblade variability using direct free-hand pressure

I find it easy to intentionally replicate or exceed the variability in length, width, or thickness seen in archaeological assemblages of microblades by making adjustments within the direct free-hand pressure technique, or by using cores of different sizes, morphology, or lithic quality. Variability is also inherent to the process and stages of manufacture of cores and microblades using this technique.

When removing primary or secondary ridge blades to prepare an even fluted surface, I frequently use a more robust pressure flaker as this allows me to press off wider, thicker, or longer microblades. Once I have succeeded in shaping a smooth and even fluted surface that is free of hinge terminations, I may switch to a lighter pressure flaker and configure platforms slightly narrower. When pressing off microblades that have a trapezoidal cross section, I frequently prepare a striking platform where two arrises are spaced less than 4.0 mm apart. Many times I have purposefully detached a microblade with a single arris and triangular cross section in my quest to produce microblades with a trapezoidal cross section. Therefore, I can produce microblades of different widths or thicknesses with one to three arrises during the reduction of a single core. This depends upon initial dimensions, shape, lithic quality, width of the potential flute chord (or perimeter in the case of cylindrical or conical cores), spacing of arrises formed by previous microblade removals, and the use of pressure flakers of different thicknesses and weights (Figures 1, 2, 5, 6, 7, 8 and 9; Table 2).

Depending upon the shape of the core and angle of the striking platform, the length of microblades may get progressively shorter during the production process. However, it is important to detach microblades that run the full length of the fluted surface; if a microblade hinges short there is a great probability that a subsequent microblade struck off down a ridge (i.e., arris) adjacent to the hinge fracture will also break short. Because of this, the production process often entails detaching a mix of narrow and wide microblades during the reduction of a single core. The width measurements of an entire sample of microblades I produce from a single core may show a central tendency, but more frequently an irregular distribution.

6. Potential sources of microblade core and microblade variability in archaeological contexts

As discussed, a wide variety of metric and formal results can be achieved without fundamentally changing the simple toolkit or methods I have described for the production of microblades. While the general manufacturing process is within the knapper's control and intent, external circumstances as well as the modes of using microblades will also affect what we find expressed in the archaeological record including the debitage associated with the preparation of core preforms.

A number of variables should be kept in mind when interpreting metric and formal variations of microblade cores and microblades recovered from archaeological sites. Some of these variables are discussed below.

6.1 The knapper

We should not assume the ability to manufacture microblade cores and microblades was limited to specialist individuals. It was more likely a standard part of the repertoire of knapping skills in societies where microblades were used. Knappers undoubtedly differed in skill, strength, physical wellbeing, or temperament, which would contribute to the variability we see in archaeological assemblages. Knowledge and expertise were likely gained differently by each artisan, often learned from members of the same family or larger social group.

The ease of learning microblade manufacture was exhibited at a lithic workshop I directed in 2015 during the Alaska Anthropological Association 42nd Annual Meeting in Anchorage. Several female and male participants with no prior experience with this technique used free-hand pressure and short pressure flakers to manufacture reasonably good quality microblades after only a half day of tutoring.

As indicated previously, the knapper can control the width of microblades to a considerable degree. It does not require great force to regularly press off microblades with simple free pressure that are 1.2 to 3.0 mm thick, 4.0 to 10.0 mm wide, and 2.5 to 6.0 cm long (Figures 1-5, 9, Table 2) if the lithic quality is good; something that should have been easily achieved by an average-sized adult male or female artisan. I am only 1.68 m in height and averaged 71 kg in my adult years. Why pre-contact knappers did not routinely test the maximum width limits of microblades may well have been because they were more set on producing practical examples to serve a domestic function rather than flaunting their strength and skills. Conservation of lithic raw material would be another incentive; a 6.0 mm wide and 5.0 cm long microblade has as much potential length of cutting edge as a 12.0 mm wide and a 5.0 cm long one, but the latter consumes almost twice as much lithic material.

6.2 Lithic material

Lithic material suitable for the manufacture of flaked stone tools varies tremendously in size, shape, knapping quality, availability, and abundance. These factors have been acknowledged by numerous researchers (*e.g.*, Chen 2007:28; Gómez Coutouly 2012:367, 2017:111), and are supported by my own experience that extends from southwestern Manitoba to southwestern Yukon. Variability in lithic material undoubtedly influenced strategies for the procurement and thermal alteration of raw stone, the manufacture of core preforms, preparation or rejuvenation of striking platforms, correcting failures along the fluted aspect, intended length or width of microblades, the size of pressure flakers, and the amount of pressure required to press off microblades.

6.2.1 Nature of the raw material

Excluding bedrock quarries, it was likely a matter of luck as to what size, shape, quality, or quantity of stone the knapper had on hand, when the need arose to fashion microblade cores and microblades. Such factors would influence manufacturing options available and the nature of microblades produced. Lithic material selected for a microblade core preform requires sufficient mass to yield enough suitable microblades for the intended task, whether that be only a few, or few dozen of, microblades from which the more desirable ones could be selected.

Glacial outwash gravel deposits and other exposures of coarse sediments that once were excellent sources of tool stone for Late Pleistocene artisans may have become covered by fine sediments or overgrown, while new sources were exposed by floods or during droughts, or picked over by earlier knappers. Flat chert nodules, ranging from approximately 1.5 to 3.5 cm in thickness, were brought to Dyuktai Cave (Flenniken 1987:Figure 6, Gómez Coutouly 2011a:-Figures 6.6, 6.7, 6.13 and 6.14). In contrast, microcores from the Bezya site in Alberta, range between a relatively diminutive 20.9 and 32.4 mm in height and were made from small rounded pebbles (Le Blanc and Ives 1986:Table 1). At the Little Pond site in Alberta, large siltstone percussion flakes were unifacially shaped into microblade cores which, at the time of their abandonment, measured 7.5 to 12.2 mm in thickness and 19.7 to 29.5 mm in height (Younie et al. 2010:Table 4 and Figures 5 to 8).

Round cobbles or angular pieces may exhibit a thick, porous, silica-deficient cortex, or a highly weathered one that is difficult to pressure flake and has to be removed by percussion flaking. Lithic material deposited in a high energy environment usually has a highly fractured exterior marked by numerous percussion cones created during transport, many of which extend a centimetre or more into the rock. Such a highly fractured surface would have to be removed by percussion flaking in order to access the solid fracture-free interior. Concave areas on a core are potential places where microblades might terminate short in a hinge fracture whereas a pronounced convex surface could result in microblades excessively curved in longitudinal cross section. Many archaeological microblade cores may have acquired a bifacially flaked wedge shape because of the need to even out the surface along which microblades were to be removed, or to shape a core so that it became either parallel sided or tapered toward the base, thereby creating a striking platform angle less than 90 degrees.

At sites with a large number of microblade cores, platform tablets, "gull-wing" flakes, and microblades – e.g., the Campus site (Mobley 1991:Figures 11 to 20 and 22), Ilnuk (Ackerman 1996), and the Kelly Creek site (Clark and Gotthardt 1999:Figures 3.2 to 3.9) – flexibility is evident in the size and shape of stone selected for core preforms and the method of preparing, rejuvenating, and maintaining striking platforms. The large number of microblade cores from these sites suggests several occupation events, likely with participants of different levels of knapping skill. From the broad variation in preform or core sizes and shapes, it appears as if lithic material for microblade cores was scrounged from whatever pieces, broken tools, or debitage that lay about. At Anangula, microblade cores were fashioned from thick flake fragments, angular chunks, and depleted macroblade cores. Individual microblade cores at this site display varying degrees of reduction at the time of abandonment, including tabular, wedge-shaped, cylindrical, and conical types (Gómez Coutouly 2015:Figures 2 to 9). Summarizing Early Holocene microblade components from sites in the Alexander Archipelago, Lee (2007:44) noted that the "two oldest components, Ground Hog Bay 2 and Hidden Falls, have both wedge-shaped cores and expediently split pebble cores. The slightly younger sites, Chuck Lake and Thorne River, have boat-shaped or blocky cores and conical cores". This variability may reflect technological adaptations to the nature of the available lithic material, as well as the degree of core depletion.

From my experiments, I have learned that whether microblades remain intact or shatter into a number of fragments during detachment is highly dependent on the quality of the lithic material and the amount of pressure required to detach them, and not on the free-hand pressure technique employed. For instance, depending upon the texture of Swan River Chert, a lithic material that is highly variable in texture and workability after it has been heat treated, microblades remained either largely intact or else broke into several pieces. By comparison, microblades from heat-treated Cat Head Chert (Figure 9; an Ordovician chert from central Manitoba), heat-treated mudshale, which occurs as concretions in the Mount Head formation in southwestern Alberta, usually stayed intact during detachment

6.2.2 Heat treatment

It has now been firmly established, based on ethnographic accounts and verified by numerous experiments, that heat treatment greatly improves the workability of many lithic types, including some varieties of obsidian (Hester 1972:63; Gryba and Kumai 2009:70-72) and siliceous volcanic tuff (Kononenko et al. 1998:22) that are suitable for microblade manufacture. Personal trials showed that heat treatment greatly improved the workability of dacite obtained from the Quesnel area of central British Columbia. Heat treatment was recognized on artifacts from Dyuktai Cave (Flennekin 1987:121), amongst 7.3% of the microblades from the Campus site (Mobley 1991:38), and possibly on microblades found at On Your Knees Cave (Lee 2007:147). A microblade core, made from heat-treated Swan River Chert, was discovered at site HhOv-449 in northeast Alberta (Wickham and Graham 2009:360-361 and Figure 144). The red colour and smooth fracture surface of the core are traits absent in raw samples of Swan River Chert, but observable after heating a tan variety of this lithic material to around 390 degrees Celsius.

In 2005 (Gryba and Kumai 2009), before I was aware that different widths of microblades would be interpreted in terms of different detachment modes (Gómez Coutouly 2011a; Pelegrin 2012), I produced 24 microblades by free-hand pressure from a semi-translucent black variety of Glass Buttes obsidian. Twelve microblades pressed from raw obsidian were between 6.0 and 10.0 mm wide. By comparison, 12 other microblades made from heat-treated obsidian were between 9.0 and 12.5 mm wide; the upper width limit on these falls just above that of microblades Pelegrin produced with his more elaborate mode 3 (Gryba and Kumai 2009:Figures 5.6 and 5.7). I also found that the microblades made from untreated material tended to break into several pieces upon detachment as the stone was brittle and also because of "pressure follow-through" due to the significantly greater force needed to press off microblades. By comparison, heat treatment made the obsidian much easier to pressure flake and less prone to breaking. Consequently, I found it relatively easy to press off microblades up to 6.0 cm long by simple free-hand pressure, with many of them remaining intact (Gryba and Kumai 2009:Figures 5.6 and 5.7)

6.2.3 Raw material availability

Conserving suitable stone may have been a very practical decision made by pre-contact knappers, particularly in instances where high quality lithic material was locally or seasonally scarce or because it had been carried a long distance from its source. In northern latitudes, potential sources of lithic material are normally snow-covered for six months of the year. This would have necessitated strategic planning for the transport, caching and curation of suitable preforms and cores when future availability of suitable material was expected to be limited or unknown.

Cores of high quality lithic material such as obsidian were undoubtedly highly coveted and prudently exploited almost to their maximum potential until they were lost or exhausted and abandoned, which influenced the variability of ensuing microblades and core morphology. Throughout northwest North America only 19 obsidian platform tablets have been reported from sites located hundreds of kilometers from bedrock sources (*e.g.*, five examples from Dry Creek, two each from Hayfield and Little John, and one each from BEL-00053, BET-00022, FAL-00035, Ringlin, Birches, Mead, and Linda's Point (Jeffrey Rasic, personal communication 2018), which suggests that knappers often adopted a less wasteful means of platform preparation or rejuvenation on cores made from this choice lithic material. Obsidian has been reported from numerous sites on both sides of the Bering Strait, including High River near Calgary and Fullerton near Edmonton, Alberta, (Sanger 1968); Teklanika West (Coffman 2011:Figure 7); Healy Lake Village site (Cook 1969:228); Campus (Mobley 1991:38); Gerstle River Components 3 and 5 (Potter 2005:395); Dry Creek (Slobodina et al. 2009:115-117 and Powers 2017a:Tables 4.2 and 4.3) and Matcharak Lake (Tremayne 2015:21) in central Alaska. Obsidian microblades are also reported from Anangula in the eastern Aleutians (Gómez Coutouly 2015:28); from sites in the Alexander Archipelago in southern Alaska (Lee 2007:121 and 123); the Primorye region of eastern Siberia (Doelman 2008:356); on Russia's Sakhalin Island north of Japan (Tabarev 2012:Figure 13-11, referring to Vasilivsky 2006), and on Zhokhov Island in the East Siberia Sea (Pitulko et al. 2019).

In contrast to most sites with obsidian, artisans at Mount Edziza had access to an abundance of local obsidian and there appears to have been no attempt to standardize the size or shape of microblade cores; preform shaping was accomplished in an assortment of ways with very little to quite extensive bifacial flaking (Fladmark 1985:174 and 176 and Figures 76 to 78)

6.3 Functions of microblade cores and microblades

6.3.1 Microblade cores

Microblade cores may have been fashioned for immediate use, in anticipation of future raw material scarcity (*e.g.*, where availability of quality lithic material was lacking, or unknown, or to gear up for the winter season), for practice, teaching/learning, or for exchange purposes. Microblade cores would also provide a ready source of sharp cutting edge in a very portable package for mobile hunters and foragers. Preforms or cores may also have served purposes beyond yielding microblades. For example, Gómez Coutouly and Ponkratova (2016:313), referring to use-wear studies undertaken by Dikov and Kononenko (1990) on preforms and exhausted microblade cores from Ushki I, Kamchatka, note that preforms may have been used for scraping while exhausted cores displayed wear from cutting hard material,-similar to that seen on end scrapers. It is worth recognizing that the various intended use lives of microblade cores may partially explain some of their variable morphologies.

6.3.2 Microblades

In archaeological contexts, microblades occur either complete, or fragmented during detachment, or deliberately broken into segments suitable for insertion into slotted antler handles or weapon tips, or for transport for future use. Breaking a microblade can be easily accomplished by placing it it on or within soft leather and applying pressure or a light blow with a hard object at a selected spot, or by just snapping it between both hands. If needed, further shaping of segments to a desired length or width, or trimming a thinly feathered distal end, can be quickly accomplished with a small pressure flaker. Because of their generally delicate nature, we should not rule out possible natural causes for microblade fragmentation such as that which might have resulted from animal or human trampling or by pressure exerted during cryoturbation.

Segmented microblades have been recovered in Late Pleistocene or Early Holocene sites on both sides of the Bering Strait as insets in unilaterally and bilaterally slotted antler or bone handles used as weapon tips or knives (see, for instance, the summaries presented by Gómez Coutouly [2011a:29-88] and Lee [2007:154-185]). Long portions, relatively flat in longitudinal profile were, no doubt, preferred for inset purposes. Fifty-eight microblade midsections, some measuring between approximately 2.3 and 8.0 mm wide and 1.3 to 2.3 cm long, were recovered from Lime Hills Cave 1 Stratum 3 and were interpreted to be replacements for slotted antler arrow points (Ackerman 2011:263 and Figure 15.18). An antler "arrowhead" with 3.22 mm deep U-shaped bilaterally located incisions was also discovered at the site (Ackerman 2011:264 and Figure 15.16). Antler points with 2.0 mm wide and 2.0 to 4.0 mm deep slots found at Trail Creek were radiocarbon dated to between 9914 ± 30 BP and 9185 ± 30 BP (Lee and Goebel 2016:Table 2). A 24.6 cm long and 1.0 cm wide bilaterally grooved antler point, suitable for insertion of snapped microblades, was recovered from site JhVl-1 on an alpine ice patch east of Kluane Lake in southwestern Yukon and radiocarbon dated to 7310 ± 40 BP (Hare et al. 2004:264 and Figure 8). In the Trans-Ural region, bone arrowheads slotted for microblade inserts were used from the Early Mesolithic until the Early Neolithic (Savchenko 2010, and 2011:Figures 4 to 8).

Microblades may also have been mounted in a bone, wood, or antler handle (Lee 2007:175-184 and Figure 5.7a; Lee et al. 2016:142-144 and Figures 4 and 5), or perhaps even wrapped in soft leather and just hand-held for tasks such as cutting hide for rope, containers, dog harnesses, lodge covers, snowshoes, and various tailored clothing, as well as in skinning and cutting up small mammal carcasses, processing fish, or in light wood working. Lee (2007:Figures 5.3 and 5. 7a) and Lee et al. (2016:Figure 4), acknowledging Barclay et al. (2005) and Croes (1995), illustrate a microblade hafted at the end of a wooden handle recovered from the Hoko River site. Use-wear studies on microblades recovered from the Upper Paleolithic sites of Xiachuan and Chaisi in northern China suggested that the artifacts had been used mainly for processing animal substances such as flesh, plus fresh and dried hide, and less on vegetal substances (Chen et al. 2016:501). Based on the evidence from Grestle River Components 1 to 4, Potter (2005:598) concluded that "microblades, as a class of artifacts, may be strongly associated with faunal remains", although he did not specifically mention the connection to hide and the need for cutting this material with some degree of precision.

The context of microblades and associated artifacts may be indicators of tool function, site function, and season of occupation. Burins and burin spalls are often recovered at sites that have a microblade component: for instance throughout eastern Siberia (Ineshin and Teten'kin 2011:Figures 4.4, 4.6, and 4.9); at Dry Creek Component II (Hoffecker 2017:119), Ilnuk (Ackerman 1996:Figure 10-5); the Campus site (Mobley 1991:Figures 35 and 36); Kelly Creek (Clark and Gotthardt 1999:Figures 3.7 and 3.9), Gerstle River (Potter 2005:415), at Matcharak Lake (Tremayne 2010:77-89), and at Little Pond (Younie et al. 2010:Figure 10). Such artifacts are frequently interpreted as having been used for incising slots in bone or antler, presumably into which microblade segments would have been inserted. Other functions of burins or burin spalls may have been to obtain lengths of antler through the "groove and splinter technique" which could then be fashioned into various items (Clarke and Thompson 1953), as engravers (Park et al. 2017), or as scrapers (Ackerman 1996:467). Yi et al. (2013:216-217) report on the co-occurrence of microblades and needles at the Late Pleistocene site BP SDG12 in north-central China. This association supports the likelihood that a common activity at many microblade sites may have been the production or maintenance of fur clothing.

Holmes (2011:188-189) notes a major technological switch at Swan Point, from the Yubetsu/Dyuktai technique and composite microblade inset technology in Layer CZ 4 to the Chindadn phase in Layer CZ 3, which is characterized by small bifacial points and Campus-type microblade cores. He attributes this switch to major climate changes during the Younger Dryas cooling period at the end of the Pleistocene. Could not this change in microblade technology have been caused by the introduction and acceptance of the atlatl and darts tipped with small bifacially flaked stone points, which involved a transition in the function of microblades away from inset weaponry towards a stronger focus on everyday utilitarian campsite purposes? At Swan Point and Healy Lake, this change is marked by the appearance of the small Chindadn projectile points.

Long, crested ridge flakes and ski spalls with a relatively thin and an even longitudinal profile are associated with the Yubetsu technique employed at Dyuktai Cave, Druchak-Vetrenay , Ushki Lake-1, and at Swan Point CZ 4 (Gómez Coutouly 2011a:Figures 6.10, 6.37, and 6.42, 6.55, 7.3, and 7.5, and Holmes 2011:Figure 10.6). These microblades are suitable for inset weaponry. By comparison, shorter and proportionately thicker platform tablets, such as those recovered from later Denali Complex sites, for example, the Campus site (Mobley 1991:Figure 22), from Dry Creek Component II (Gómez Coutouly 2011a:Figures 7.8b and c, 7.9c, 7.11b; Powers 2017a:Figures 4.17 and 4.18), and from Kelly Creek (Clark and Gotthardt 1999:Figures 3.3-3.8), would suggest that Denali Complex microblades may have been intended more for campsite utilitarian functions rather than for additions to composite weaponry. Atlatl darts recovered from ice patches in southwestern Yukon suggest that, with the exception of a bilaterally slotted antler point radiocarbon dated to 7310 ± 40 BP, atlatl darts tipped with stone points were the preferred hunting weaponry in open environments from at least 8300 BP until 1200 BP, when it was replaced by bow and arrow technology (Hare et al. 2004:265, Figure 4). It is worth additional research to investigate how microblade variability relates to temporal changes in weaponry.

6.4 Environments in which microblades were produced and used

We should not assume that microblade production was always carried out under ideal natural or cultural conditions; factors that can influence microblade dimensions and morphology. Knapping may have occurred amidst swarms of insects, during windy and dusty days, or on frigid days when hands were numb and/or arm movement was hampered by bulky clothing. If microblades were produced in a dwelling or rock shelter, lighting may have been poor. In damp environments, pressure flakers could have become slippery and difficult to grasp. Furthermore, since antler usually becomes somewhat softer when damp, the tip of a pressure flaker would have become more prone to crushing and wear, perhaps to the point where the area of surface contact between the tool and the core became too great to allow for easy microblade detachment. The archaeological implications are that methods and tool kits for the production of microblades would have to accommodate prevailing conditions.

6.5 Core reduction history

Archaeologists set general rules of manufacture through reconstructed sequences of preform and platform preparation and blade removal (chaine opératoire), in order to trace cultural traditions or patterns of technology usage through time and space. As numerous archaeological examples demonstrate, pre-contact artisans did not always abide by those rules. At sites like Campus (Mobley 1991:Figures 11-19), Ilnuk (Ackerman 1996:Figure 10-5 and Table 10-5), and Kelly Creek (Clark and Gotthardt 1999:Figures 3.2-3.7), where large samples of microblade cores, platform tablets, and gull-wing flakes have been reported, there is considerable evidence that knappers were quite flexible about the size of lithic material selected for the core, how they shaped the preform, and how the striking platform was prepared or rejuvenated.

Given the already small size of many cores, the further loss of a substantial portion of potentially useable material through detachment of platform tablets, may seem rather wasteful and does not fit the notion that microblade technology minimized risk and conserved lithic material (Elston and Brantingham 2002). For instance, of the 90 platform tablets recovered from the Kelly Creek site, some examples measure close to 10 mm thick (Clark and Gotthardt 1999:73 and Figures 3.5-3.8). Perhaps, as well as being a quick and effective means of preparing or rejuvenating a platform, or correcting step fractures on the fluted element (an action that can often be achieved through a well-directed swift blow with a flat, rounded pebble), another intent of the artisans in striking off platform tablets was to shorten the height of the core to make it easier to press off microblades that were still of sufficient size for the intended task. One task where short microblades (flat or curved in longitudinal cross section) may have sufficed is in hide working and the production of fur garments.

Microblade manufacture was likely not carried out in an assembly line-like environment where the emphasis was on efficiency of technique or compliance with rules of form and size, or conservation of lithic material, but rather in situations where the producers were also the users. Depending upon the intended use, different forms of microblades may have been deemed equally acceptable and desirable.

When interpreting metric or morphological variations of either cores or microblades we should keep in mind the history of microblade detachment and resulting alteration in core size and shape. Cores in various degrees of reduction have been recovered from archaeological sites, some of which may have been discarded at the start of blade manufacture because of unforeseen flaws in the lithic material. Or perhaps the core could not be effectively grasped or was too small or narrow to yield the desired length, width, or thickness of microblades (see also discussion by Mobley [1991:40-41] referring to Mauger [1971:22] and West [1967:368]).

Microblade dimensions can change as a core is depleted. Microblades detached from a wedge-shaped core with an acute striking platform will get progressively shorter through the production process. Those removed from conical cores may become shorter and narrower as both the length and diameter of the core are reduced. It is, however, possible for a skilled artisan to detach microblades from a cylindrical core that fall within fairly narrow width and length ranges (*e.g.*, Figures 2, 8).

It is possible to reconstruct what the original size and length of a core was at the start of blade removal by refitting a platform tablet. For instance, one of the exhausted Yubetsu type cores from the Kurla site is only 1.5 cm high and has a 0.6 cm long platform remaining from what was possibly a 2.25 cm long preform at the start of blade production (Flenniken 1987:Figures 20-21). Other examples of refitted platform tablets showing the degree of blade detachment include: Dry Creek (Powers 2017a:Figure 4.13); Kelly Creek (Clark and Gotthardt 1999:Figures 3.5-3.6); Swan Point (Gómez Coutouly 2011a:Figure 7.3 and Holmes 2011:Figure 10.6); Ustinovka 6 (Gómez Coutouly 2011a:Figure 5.6) and Druchak-Vetrenny (Gómez Coutouly 2011a:Figures 6.40 and 6.42).

Bi-frontal wedge-shaped cores – cores where microblades had been removed from both ends of the platform – have been found in the Baikal region, Primorye, the Amur River basin, Kamchatka, and Alaska in complexes dated to the Late Paleolithic/Early Holocene (Slobodin 2009:25). Such cores occur rather infrequently and likely represent opportunistic acts of blade removal. If enough microblades are detached from both ends of Yubetsu-type cores, which have a fairly flat striking platform, wedge-shaped cores can assume a cylindrical shape (*e.g.*, Kobayashi 1970:Figures 6 and 10). Cylindrical cores, through further reduction, may or may not taper at the distal end and take on a conical appearance. Conical or cylindrical cores are sometimes recovered in sites along with wedge-shaped or tabular cores. At Healy Lake Garden Site a conical core was recovered from Level 1, above levels in which cores made on thin tabular slabs were found (Cook 1969:263-265). Conical cores occur together with wedge-shaped cores at the Upper Paleolithic site of Xiachuan (Chen and Wang 1989:Table 1 and Figure 5), at Molodezhhnaya 1 (Gómez Coutouly 2011a:-Figure 5.35), at Ilnuk (Ackerman 1996:Figure 10-5a-d and 2011:15.8) and at Anangula (Gómez Coutouly 2015:Figures 2-9). Cores of different morphologies, including frontally faceted ones, boat shaped examples, plus ones made on split pebbles and tabular pieces, occur at sites in the Alexander Archipelago (Lee 2007:43). Wedge-shaped, conical, and tabular examples are reported from Middle Prehistoric Period context at Pointed Mountain in the Mackenzie Valley (Morrison 1987:57-58 and Figure 4).

There may be other reasons why cores with useable material were discarded at archaeological sites. They could have been set aside or abandoned after the desired quantity of blades for the task at hand had been realized, particularly in situations where there was easy access to an abundance of high-quality lithic material. Personal experience shows that it takes just a few minutes for a skilled artisan to fashion a new core and initiate microblade production. Maybe the knapper was interrupted and did not resume microblade manufacture, or the core was lost in forest litter or snow, or was cached for future use. Perhaps the core was abandoned when the knapper encountered inclusions, or realized it was too tough to detach blades, or so brittle that blades shattered into small segments or terminated short in hinge fractures

6.6 Time

One of the key variables pre-contact artisans had to constantly adapt to was the amount of time available to become familiar with lithic procurement, effective heat treatment (if needed), and core and microblade manufacture. This may have affected the quality and quantity of cores and microblades. Time devoted to microblade production was undoubtedly highly variable relative to a multiplicity of other tasks such as setting up camp, hunting or foraging, butchering animals and processing hides, preparing or preserving food, plus amount of daylight.

The above listed variables are by no means exhaustive but illustrate some of the potential sources of microblade and core variability that appear in archaeological records. They provide logical and practical explanations of lithic variability to augment our interpretation of specific technological traditions or reduction strategies

7. Sample bias and data presentation issues

The following are some questions to bear in mind when assessing published findings. Does the archaeological sample represent only microblades or does it also contain primary and secondary ridge flakes? Does the sample comprise products of a single occupation event by a few individuals or multiple occupation events by people from the same or different cultural traditions? Answering the latter question can be challenging with thin, shallow stratigraphy, which is a major problem at many northern archaeological sites. Does the sample include only rejected microblades or an entire range of microblades produced at one knapping event? Or does the sample contain only utilized microblades? Given the broad expanse of terrain available at many sites for various activities, were microblades manufactured, then utilized, and discarded within a limited area?

Potter (2005:80) noted that in the Tanana Basin of interior Alaska only ten sites had excavations greater than 10 square metres. At Little Pond (Younie et al. 2010:Figure 3) and at Bezya (Green and Blower 2006:Figure 10) excavation units were confined largely to areas of highest artifact occurrences; in both cases locations of preform shaping and microblade production. The size and configuration of excavation units can greatly influence the sample size and variability of recovered microblades and cores.

At the time of archaeological discovery, some sites had already been partially destroyed by stream erosion, for instance, Dry Creek (Powers 2017b:13 and Figures 2.2, 2.3, 2.11, and 2.12), or by industrial activities, for example, Kelly Creek (Clark and Gotthardt 1999:Figure 2.6), and Gerstle River (Potter 2005:91-101 and Figures 3.16 and 3.17). The implication is that excavated activity areas and microblade recoveries may not be representative of the entire site.

Excavation techniques and artifact recovery methods were not always consistent from site to site or by different parties excavating the same site, which can influence the type of microblades recovered and their interpretation. Healy Lake Village Site was excavated in two inch (5 cm) levels and not based on natural stratification (Cook 1969:119-120). In 1983, Kelly Creek was excavated by trowel using 3/8 inch (9.5 mm) mesh screens but in 1990 and 1992 it was excavated by trowel with 1/9 inch (2.8 mm) mesh screens (Clark and Gotthatdt 1999:29). And, from the time it was discovered in 1938 to the final excavations in 1974, Anangula had been excavated by several different parties with different recovery techniques (Gómez Coutouly 2015:25). Gómez Coutouly identified 30 microblade cores and one microblade core preform but only 18 microblades in the Anangula collections (Gómez Coutouly 2015:28), which may be explained by early excavation techniques that did not recover smaller specimens.

In addition to sources of microblade variation, interpretations and comparisons can be muddled by inconsistent presentations of data; for example, length-to-width or width-to-thickness ratios (*e.g.*, Table 2). In some cases, it is not clear where specimen measurements were taken, whether the presented width, thickness, or length measurements are for complete or fragmentary microblades, or if the samples also include primary and secondary ridge blades. Cook (1969:86-87) suggested that width and thickness measurements of complete microblades be taken 7-10 mm below the striking platform, and at the proximal end of fragmented specimens. Width and thickness measurements on complete and fragmented microblades are still important, but researchers should clearly indicate what the data represent.

8. Summary and conclusions

Microblades comparable to those reported from Late Pleistocene and Holocene sites in northeast Asia and northwest North America can be easily replicated by a simple free-hand pressure technique that requires no additional knapping tools aside from those necessary for regular pressure flaking. Formal and metric differences observed on archaeological microblade cores and microblades may be accounted for by different variables noted above, rather than changes to the "mode of detachment" as has been posited by Gómez Coutouly (2011a) and Pelegrin (2012).

Replication of microblade manufacture has been largely dominated by people influenced by Don Crabtree's experiments with Mesoamerican prismatic macroblade manufacture and Folsom point replication, as well as with his general method of pressure flaking using long pressure flakers. Prismatic macroblade technology achieved through some means of assisted pressure was introduced to northeast Asia relatively late, during the early Holocene, perhaps 10,000 or more years after microblade technology first appeared in that region and some 20,000 years after general pressure flaking and heat treatment technologies had already been practiced in Eurasia. The origin of microblade technology, thus, does not lie in an assisted pressure prismatic macroblade industry but rather in the Early Upper Paleolithic hard and soft hammer percussion flake and blade industries and in the early pressure flaking traditions of northeast Eurasia.

I suggest that the transition from the use of microblades as insets for weaponry and for domestic utilitarian tasks to essentially the latter function was brought about by the adoption of the atlatl and stone-tipped darts. This switch is reflected in a change from soft hammer percussion method of the Yubetsu style to a mainly hard hammer percussion Denali type of platform tablet detachment.

Lastly, rather than seeing microblade production as a very constrained and specialized technology, we should recognize that it is rooted in basic pressure flaking technology, which was wide-spread and very adaptable to circumstances. Accordingly, interpretations of microblade assemblages should recognize that a wide variety of factors have affected the samples of artifacts we recover. Many are undetectable in the archaeological record but we must temper our interpretations with these considerations in mind.

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