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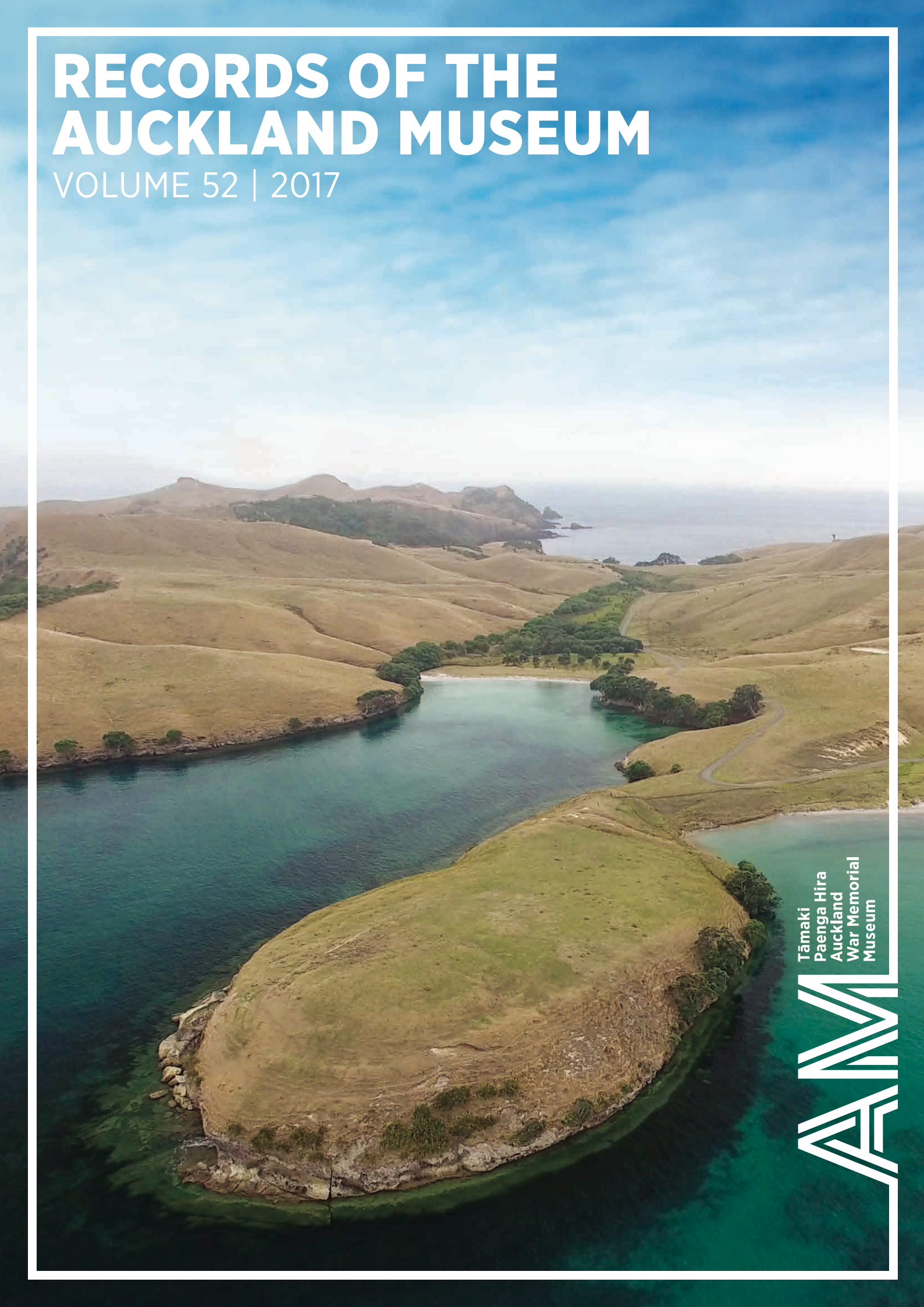

Tāmaki Paenga Hira Auckland War Memorial Museum

Archaeological excavations at Pig Bay (N38/21, R10/22), Motutapu Island, Auckland, New Zealand, in 1958 and 1959

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Abstract
A large collection of artefacts and faunal material recovered 60 years ago from an excavation on the island of Motutapu, Hauraki Gulf, New Zealand is described for the first time. The occupation site primarily functioned as an adze manufactory using a nearby source of indurated greywacke. Large numbers of adzes at various stages of manufacture through to fully polished form are present. Other artefacts are bone and shell fish hooks, lure shanks, bone needles, a bird spear point, a probable bull roarer, and a seal-tooth pendant. Faunal remains consist of shellfish, marine fish, sea mammals, and birds. The site has a complex stratigraphical history, but radiocarbon dates suggest a relatively brief period of occupation ranging from AD 1400 to 1500.

Keywords
New Zealand archaeology, Motutapu Island, Pig Bay, adze manufactory, material culture, archaeofauna.

INTRODUCTION

Motutapu is a relatively low-lying island in the inner Hauraki Gulf. It is situated immediately to the east of Rangitoto Island, the most recent of the Auckland volcanoes. The northern and eastern parts of the island are formed by ancient greywacke of the Waipapa Series (Mayer 1968, 1969), while the southern and western parts are composed of Tertiary Waitemata sandstone. The entire island was blanketed by fine volcanic ash from Rangitoto. After initial devastation of forest by the eruption, fertile soils developed on the ash, making the island attractive for Māori cultivation.

Pig Bay is a north-facing beach on the northwestern part of the island (Fig. 1). It is adjacent to outcrops of greywacke, which were an important source of raw material for adze manufacture (Turner 2000: 43–46). The excavations at Pig Bay were carried out in conjunction with a geological investigation aimed primarily at dating the eruption of Rangitoto (Brothers and Golson 1959; Golson and Brothers 1959). The island has seen considerable archaeological survey and excavation over the six decades since the excavations described in this paper, but when Jack Golson first went there it was archaeological *terra incognita*.

Golson's attention was drawn to Pig Bay by Jack Diamond, a member of the newly formed Auckland University Archaeological Society, who had collected some stone adzes from the site while serving in the Home Guard, based at nearby Administration Bay, during the Second World War.

Golson and Brothers first visited the site in 1957, when Brothers examined a deep profile in the eroding beach front and took samples for radiocarbon dating. The site's archaeological potential, convenient location close to Auckland, and nearby accommodation facilities made it eminently suitable for further investigation. Archaeological excavations were carried out at Easter and Anzac weekends in 1958, and during the same period in 1959 (Fig. 2).

The Pig Bay material, along with other archaeological collections, was taken to Canberra when Golson took up an appointment at the Australian National University in 1961. It was carefully catalogued and some analysis undertaken. It was returned to New Zealand in 1976. At some point before that time, a considerable amount of material, mostly faunal remains, went missing. The material described here is accessioned into the collection of Auckland Museum as 2014.85.1−.

This paper draws on original field notes and drawings made available by Jack Golson, colour photographs provided by Wal Ambrose and black and white photographs in the archive of the Anthropology Department, University of Auckland. Roger Green organised and made available the site map and final versions of section drawings. Marianne Turner provided

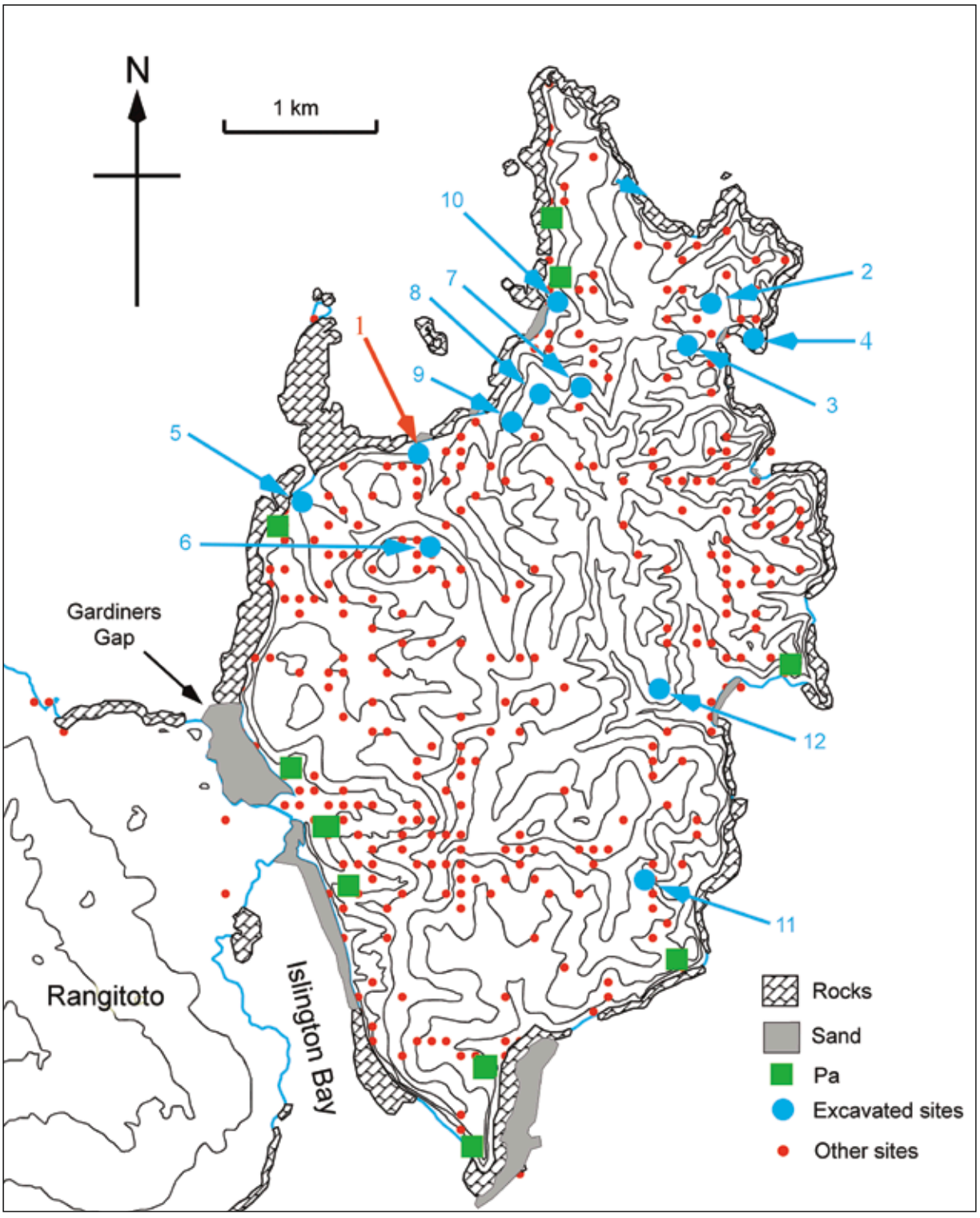

Figure 1. Motutapu Island, showing the location of Pig Bay and other excavated archaeological sites. 1: Pig Bay (R10/22); 2 and 3: Station Bay undefended sites (R10/31 and R10/38); 4: Station Bay Pā (R10/26); 5: Sunde Site (R10/25); 6: R10/524; 7: R10/494; 8: R10/497; 9: R10/496; 10: R10/47; 11: R11/1277; 12: R10/557.

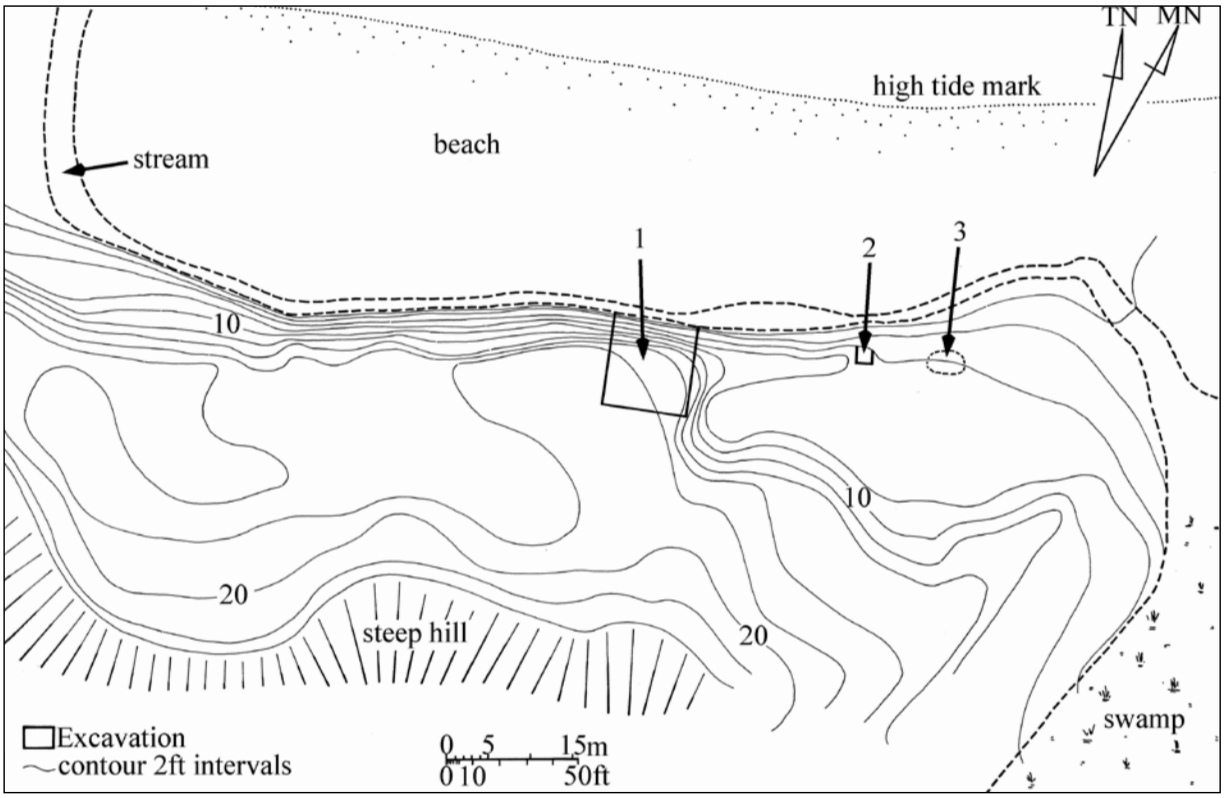

Figure 2. Roger Green's 1959 map of Pig Bay. 1: the main area of excavation in 1958 and 1959; 2: the east trench investigation by Brothers and Golson; 3: the approximate location of the mound investigated by Turner in 1995.

information about a small investigation she carried out at the site in 1995, in conjunction with a survey of stone resources useful to Māori (greywacke and chert) on the island.

THE EXCAVATIONS

During the first excavation season, over Easter and Anzac weekends in 1958, an area just behind the eroding beach section was cleared of wind-blown sand and a grid of twelve foot (3.6 m) squares laid out, within which six ten-foot (3 m) squares were excavated, leaving four-foot (1.2 m) baulks between (Fig. 3).The following year, the site was surveyed by Green and the baulks between the still open squares were removed, after clearing away "a tremendous amount of blown stuff" (Golson ms). New squares were excavated to the east and south (Fig. 4). An additional east trench was opened well to the east of the main excavation (2 on Fig. 2).

Stratigraphy

Brothers provided an initial outline of the site's stratigraphy (Fig. 5) and summarised the recent geological history of Pig Bay, as revealed in section, as follows:

> The section given above represents the sedimentational history of the Pig Bay foreshore over the last 700 to 800 years. The shore profile formed by the non-volcanic sand of Layer 1, which was in evidence about the year 1200 A.D.,

Figure 3. Excavations in progress in 1958. Top, left to right Andrew Pawley, Lawrie Birks; standing centre and right Ron White and Pat Sunde; seated centre front Helen Birks. Photograph by Wal Ambrose.

was greatly altered by a voluminous ash shower which blanketed the area and formed a compact tuff deposit (Layer 2) at the back of the beach. This sudden influx of volcanic debris caused progradation of the shoreline, and a sandy foreland, consisting of ash mixed with original beach sand, was built out. Migratory dunes (Layer 3) composed of these mixed sediments moved inland across the line of the buried pre-volcanic beach and covered the undisturbed ash bed.

Sand dune accumulation was probably rapid and within a short period of time after the eruption Pig Bay stream was blocked and ponded at the mouth. A temporary freshwater lake formed and was gradually infilled to a level 6 ft above high tide mark by ash fragments (Layer 4) washed down from the inland hill slopes. Wind-blown sand (Layers 5, 7, 9) continued to fill the lake hollow during dry seasons and raised the level of deposition of subsequent subaqueous beds of ash (Layers 6, 8) brought in from the adjacent hills. Shortly afterwards the Pig Bay stream must have regained its original lower profile by cutting down through the sand dune barrier, for lake beds are absent above Layer 8 and dunes form the modern topography. Tidal scour along the foreshore at present is continuing to erode the seaward face of the dune belt (Brothers and Golson 1959: 572–3).

Golson's comments on Layers 4 to 8 of the geological section summarised the complexity of the archaeological deposits.

> The most remarkable feature of the archaeology is the stratification throughout the lake beds and intervening wind-blown ash series of numerous culture layers. The beds contain evidence of cooking

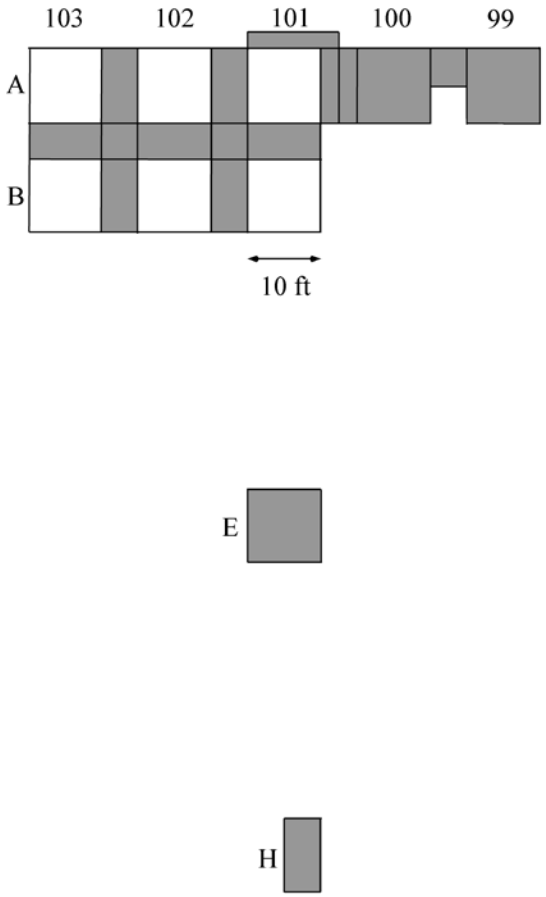

Figure 4. The layout of the excavations. The six unshaded squares were excavated in 1958; the shaded baulks and additional squares in 1959. The square numbers are a combination of the letters on the left and the numbers on the top, e.g., A103, E101. The long axis of the grid is aligned approximately north-south; the top line of squares is along the eroding beach front, as it was at the time.

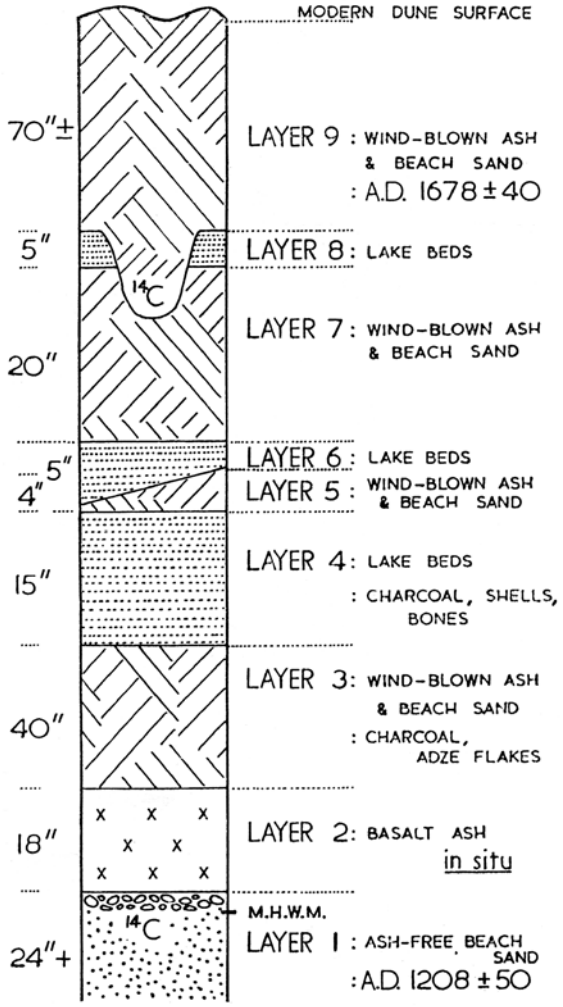

Figure 5. The section illustrated by Brothers and Golson (1959, p. 570). The radiocarbon dates are as originally reported by the laboratory. NZ220 is below the Rangitoto ash; NZ221 is the upper cultural layer. The scale on the left is in inches; from bottom to top these translate as 61, 46, 102, 38, 10, 13, 51, 23, 13 and 177 cm.

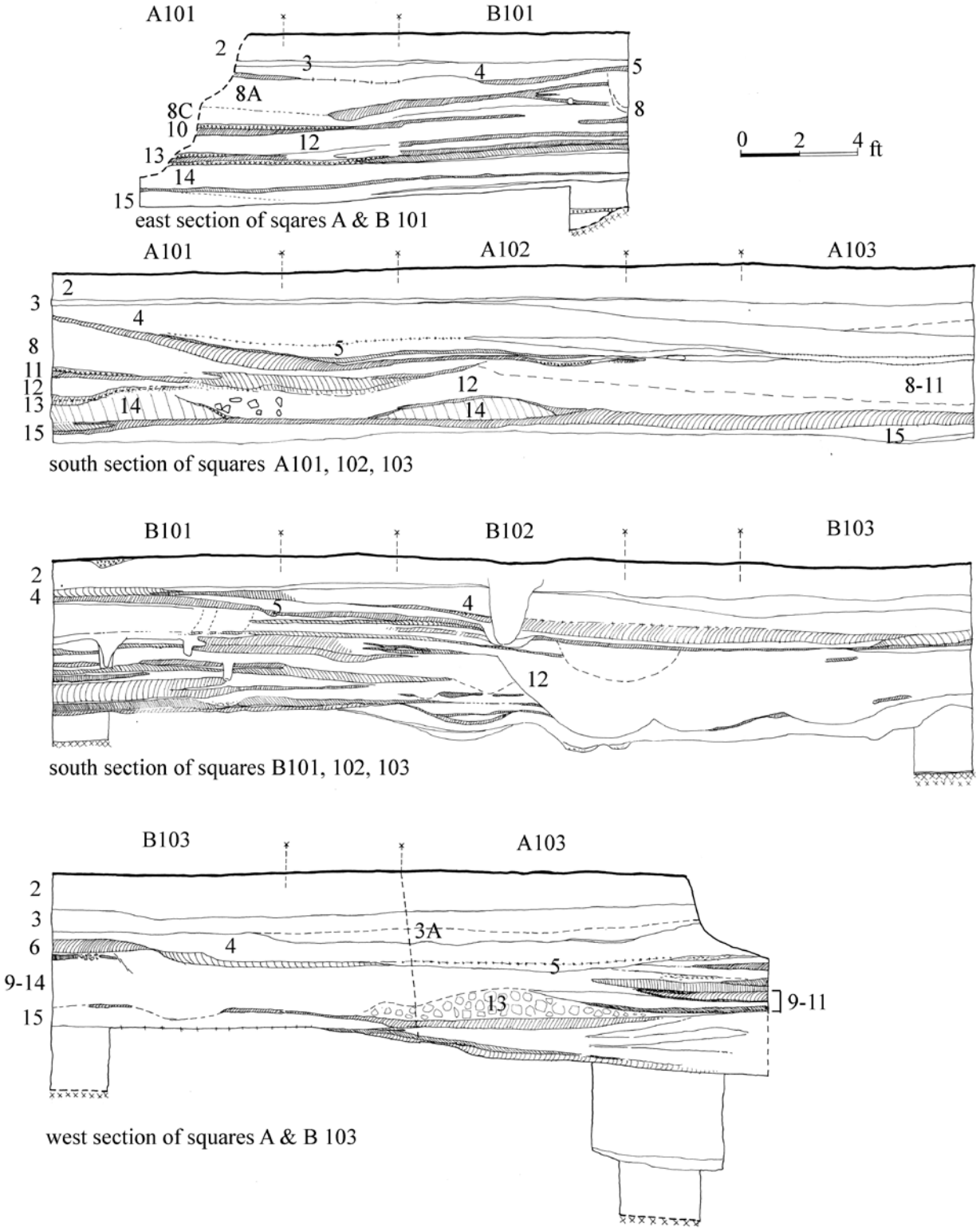

Figure 6. Cross-sections through the main excavated area, showing the complexity of the stratigraphy, particularly in square B101.

> and tool making activities. Over a large part of the site, however, they have been so cut about that the correlation of beds is difficult. In the eastern third of the excavated area up to six levels of occupation are present, sealed in for the most part between layers of water-laid re-worked basaltic ash, and representing occupations of the lake margins between periods of flooding (Brothers and Golson 1959: 575).

Initially, the complex layers of wind-blown ash and water-laid silt or clay and interspersed cultural deposits in the archaeological excavation were numbered separately in each square. Golson subsequently went to great efforts to correlate the layers and ensure that the catalogue entries were amended. The result is summarised here, and the final numbers are shown in Figure 6. Golson's numbering was, according to archaeological practice, from the top down, whereas Brothers had followed the geological system of numbering from the bottom up. Not listed below are the many subdivisions of some of the layers. Golson was at pains to point out that the drawn sections do not show the extent to which the deposits had been disturbed by the digging of numerous hāngi (earth ovens).

Layer 1. Loose wind-blown overburden of clean sand
Layer 2. Evenly banded layer of volcanic ash
Layer 3. Dark loose sand with scattered shell
Layer 4. Lighter clean sand
Layer 5. Composite lenses of ash, sand and midden
Layer 6. Midden on and in silt layer
Layer 7. Interspersed layers of greasy black soil and shell
Layer 8. Dark with shell and stone
Layer 9. Silt with patch of greasy black at base
Layer 10. Midden and working floor in A101, A102
Layer 11. Silt
Layer 12. Sandy, greasy in places with artifacts and scattered midden
Layer 13. Greasy, working floors interspersed with silt
Layer 14. Blackened silt with stone flakes
Layer 14A . Ash (only in A101)
Layer 15. Shell and clay in most squares, ash in B102 and B103

The two most productive squares in the 1958 excavation were A101 and B101, with material petering out to the west. However, the 1959 squares A100 and A99, immediately to the east of the 1958 excavations, revealed layers of banded ash and silt with only slight traces of cultural activity.

No evidence of cultural activity was found in the inland test squares. After a thick sterile upper layer, square E101 revealed a series of layers of sand and clay interspersed with four thin black layers until the primary layer of volcanic ash was reached, nearly 8 feet (2.4 m) below the surface. The narrower test trench, variously described as G101 or H101 (shown as H101 on Fig. 4), was much shallower and revealed very little.

Subsequent excavation

In 1995, Marianne Turner conducted an excavation on a "mound" to the east of the earlier investigations (Fig. 2). Stratigraphy here was simpler, as follows:

Layer 1.Wind-blown brown sand
Cultural layer B. A thin cultural deposit pressed into the surface of Layer 2
Layer 2. Water-laid ash
Cultural layer A. A thin cultural deposit on the surface of Layer 3
Layer 3. Brown black sand/ash
Layer 4. Water laid ash

The surface of Layer 4 was only 100 cm below the surface. Time did not permit testing to see whether there was any deeper cultural material.

The material from Turner's excavation has not been included in the present study.

CHRONOLOGY

Golson and Brothers (1959: 571, 572) obtained two radiocarbon dates for their section, on shells from immediately below the primary deposit of volcanic ash (NZ220) and burned twigs from a hāngi higher up the section (NZ221). These results have been emended by the laboratory, following ongoing research into radiocarbon dating, and the most recent versions differ slightly from the original publication. The date from immediately below the ash was supported by a similar result (NZ222) for burned twigs[1] immediately under the ash in a road cutting elsewhere on the island. There was no definite evidence of human activity before the eruption at either location. However, "a fist-sized lump of chipped greywacke, much rolled but apparently flaked by human agency" was found immediately beneath the primary deposit of Rangitoto ash in the East Trench of the excavation (Golson and Brothers 1959: 574). Subsequent investigations at the Sunde site, on the west coast of the island, just south of Pig Bay, revealed definite evidence of occupation both immediately below the ash and immediately after the eruption (Scott 1970; Nichol 1981: 248–250, plates 1 and 2, 1988).

More recently, an additional radiocarbon date (NZ8126) was obtained for twig[2] charcoal from a cultural deposit part way through the sequence at Pig Bay. Unfortunately, this sample was from "square B102, Layers 6 and 8", which Golson in his final correlation of layers, bundled together as 8 and 9 to 14. Details of the Pig Bay dates are presented in Table 1 and illustrated in Fig. 7.

1 The person identifying samples NZ221 and NZ222 as twigs is unknown.

2 Anatomy and species of this charcoal were identified by Rod Wallace.

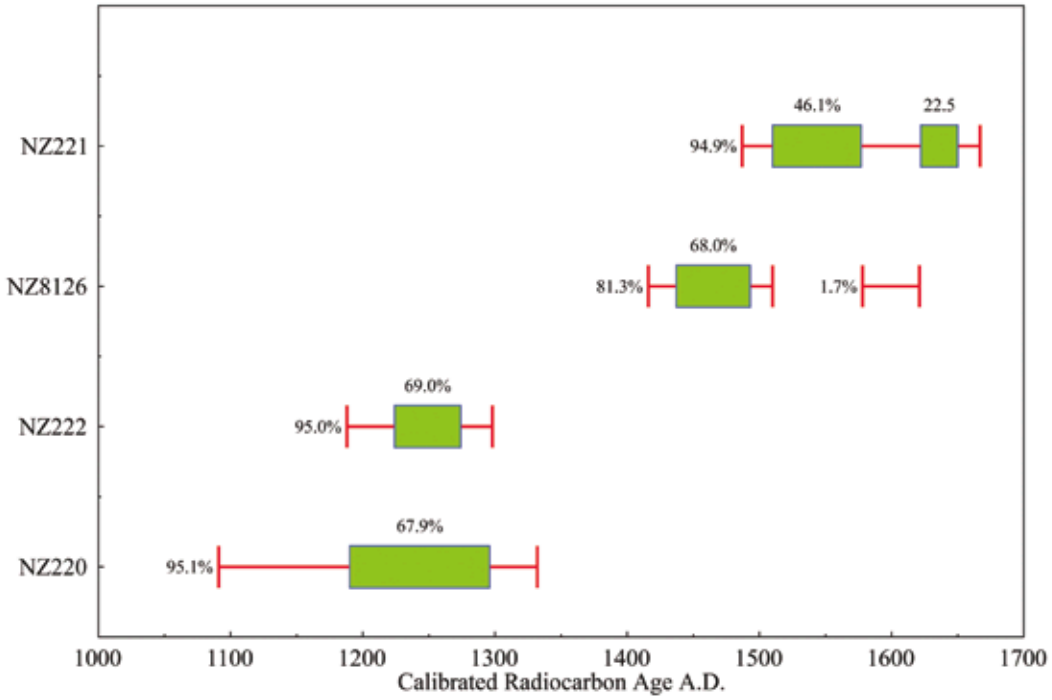

Figure 7. Radiocarbon dates from Pig Bay and a road cutting elsewhere on Motutapu Island (NZ222). See Table 1 for details.

Table 1. Radiocarbon dates from Pig Bay (R10/22) and associated with Rangitoto ash elsewhere on Motutapu Island.

Lab no.	Context	Material	δ13C	Δ-R	CRA	Years AD 1 sigma	Years AD 2 sigma
NZ221	Uppermost cultural layer	Charcoal			322 ± 39	1510–1577 (46.1%) 1622–1650 (22.5%)	1487–1667 (94.9%)
NZ8126	Layers 13 and 15	Charcoal	-25.9		462 ± 39	1437–1493 (68.0%)	1416–1510 (81.3%) 1578–1621 (1.7%)
NZ220	Under ash	Shell		-7 ± 45	1153 ± 40	1190–1296 (67.9%)	1091–1332 (95.1%)
NZ222	Under ash in road cutting	Charcoal			823 ± 40	1224–1274 (69%)	1188–1298 (95%)

CHARCOAL AND VEGETATION

The relatively few surviving charcoal samples were examined by Wallace, whose findings are discussed in Appendix 1. Wallace provides a plausible explanation for the prevalence of beech-dominated forest trees in the samples, which is quite untypical of post-eruption charcoal samples from other archaeological sites on Motutapu. It is generally assumed that the forest on the island was destroyed by the eruption and that Māori cultivations on the fertile, ash-enriched soils prevented forest regeneration.

MATERIAL CULTURE

Although adze manufacture was the most important activity at Pig Bay, the people who visited the bay also engaged in the making and use of items of fishing gear and undertook some hunting of birds. They may have been growing crops on the fertile soils developed on the Rangitoto ash, although they left no material items relating to this activity. They brought with them to Pig Bay some personal things such as ornaments and perhaps even toys.

Hunting and fishing implements

Items of fishing gear include trolling lure shanks and broken pieces of bait hooks; no definite trolling points were recovered. There are a few drilled out tabs, showing that some hook manufacture was taking place at the site. The majority of these items are illustrated in Fig. 8.

Apart from a small number of shell hooks and a trolling lure shank of silicified wood, the fishing gear is made of bone. Smith (1981: 104) identified most of it as an unidentified species of sea mammal, one very large hook piece as cetacean, an unfinished trolling lure as probably dog tibia, and one tab as possibly moa. Wallace (pers.

comm. 3/10/2016) identified the silicified wood specimen (Fig. 8.23) as a *Nothofagus* species. He commented:

> This is quite typical of the abundant silicified wood found in the Miocene volcanic geology of the Coromandel peninsula. Artefacts of this form and material are quite common on Coromandel and Great Mercury Isl. sites.

Worked pieces of silicified wood from Sarah's Gully on the Coromandel Peninsula were probably blanks for trolling lure shanks (Davidson n.d.).

Trolling lures and bone bait hooks were in use from the earliest cultural layers through to Layer 7; the shell hooks were mostly from layers 7 and 8, except for a single example from Layer 12 in the eastern extension to square A101.

In addition to the illustrated examples, broken pieces of drilled out bone tabs came from Layer 15 in A/B 101 and A102 and Layer 12 in B101. There was a broken shank leg from A/B102/103. Two small fragments, each with a perforation suggesting an attempt to lash parts of a broken one-piece hook or possibly a trolling point, came from Layer 15 in A/B101 and A/B101-102. Three broken limb fragments and a small one-piece hook, now in three pieces, are uncatalogued and may be surface finds. There are several small fragments of shell hooks from B101 Layer 8C and one from A/B101 Layer 15.

A single rather poorly made example of a probable bird spear tip, listed in the catalogue as "barbed bone point" and identified by Smith (1981: 104) as made from a dog tibia, came from Layer 8C in square B101 (Fig. 9.2). Another "barbed bone point" listed in the catalogue is now missing.

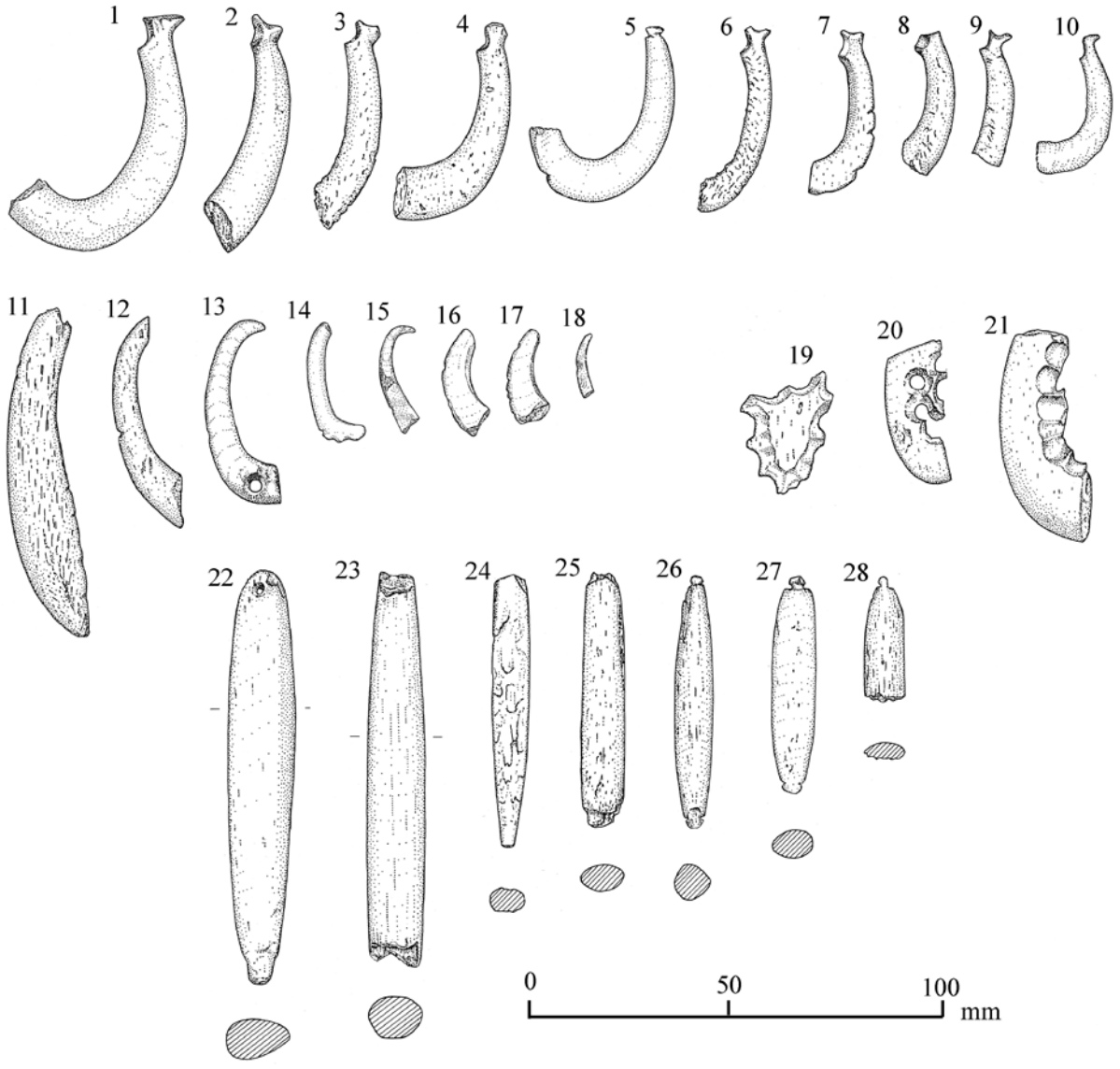

Figure 8. Items of fishing equipment from Pig Bay. 1–13, bone bait hooks: Layer 15 (1, 5, 10, 13); Layer 16 (2); Layer 13 (6, 7); Layer 12 (4, 11); Layer 8 (3, 8, 9, 12); 14–18, shell bait hooks: Layer 12 (14), Layer 8 (16–18), Layer 7 (15); 19-21, bone bait hook manufacturing debris: Layer 12 (19), Layer 15 (20, 21); 22–28, trolling lure shanks: 23 is silicified wood, the remaining shanks from bone; Layer 15 (22), Layer 12 (23), Layer 8 (25), Layer 7 (24, 26), Layer 5 (27), Layer 4 (28).

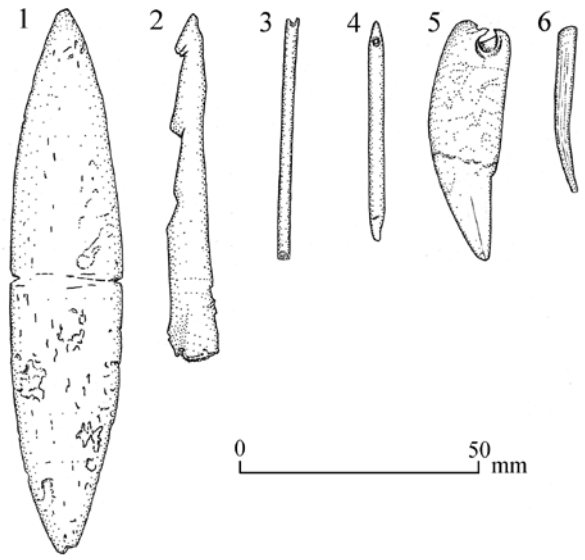

Figure 9. Other bone and shell items from Pig Bay. 1, flat bone item, possibly a *kōrorohū* (child's bull roarer), Layer 8; 2, bone point, Layer 8; 3, broken bone needle, Layer 10=?; 4, bone needle, Layer 14; 5, perforated fur seal tooth, Layer 8; 6, two joining *Antalis* units, squares B101/102, Layer 6 and A/B101, Layer 8.

Personal ornaments

Personal ornaments include a canine tooth of a fur seal (*Arctocephalus forsteri*), perforated for use as a pendant (Fig. 9.5), and some small fine units of *Antalis nana* (previously called *Dentalium nanum*). The former was from Layer 8 in baulk AB101. Thirty-six *Antalis* units came from Layer 8 in baulk A/B101 and vicinity. Three additional pieces were found in a small shell sample from the same context. They are probably all from a single ornament. Two joining pieces, from B101/102 and A/B101 Layer 8 are illustrated (Fig. 9.6).

Other bone items

A carefully made bone item from "a disturbance in Layer 8 in square B101" (Fig. 9.1) is difficult to interpret. In size and shape it resembles a kōrorohū, or child's bullroarer (Hamilton 1900: 373–374). However, instead of perforations for the cords, it has shallow notches, which might not be sufficient to support even a toy bullroarer.

Two broken examples of very small fine bone needles, from A103 Layer 10? and A100/101 Layer 14 (Figs 9.3, 9.4) show that some fine thread work was being undertaken at the site.

Pieces of worked bone (bird and sea mammal) were recovered from various contexts. Scarlett noted his identifications in the catalogue and Smith's were published (1981: 104). Some have recently been re-examined by Smith, along with two previously unstudied pieces, with some changes in probable identifications. A rectangular tab of cetacean bone, 147 mm long, came from Layer 15 and two others, 108 and 110 mm long, from Layer 13. Two pieces previously identified by Smith as ?dog from Layers 8 and 15 are unchanged, while two previously listed as ?dog, and bird or dog, from Layers 14 and 15 are now confirmed as large bird. These pieces were identified by Scarlett as albatross bone. In addition to two pieces previously identified by Smith as ?moa, from Layers 8 and 12, a worked piece from Layer 5 and a weathered and probably unworked piece from a collapsed baulk are also identified as ?moa.

Adzes and preforms

A total of 270 preforms and adzes are available for study. Of these, 194 were characterised as *earlier* (below Layer 8) and 74 as somewhat *later* (Layer 8 and above) (the other two are uncatalogued specimens, thought to be Jack Diamond's original surface finds). This distinction between earlier and later made it possible to look for any changes through time in the character of the adzes being manufactured. The preforms were laid out on a work table in seven separate layouts according to their stratigraphic provenance. The layouts were photographed (Figs 10 to 16) and the objects numbered; cross-section, nature of flaking, and other features of each item were described. The same approach was taken with the finished adzes (Figs 17, 18).

Type of stone used

The stone used for making most of these adzes is greywacke, deriving from a local source on the island. In hand specimen, there appear to be more than one type of rock present. Some specimens show dark crystals in flake surfaces, suggesting something other than greywacke. One small finished adze from Layer 15 is quite distinctive and is presumably an import (Fig. 17.18), as is a preform from Layer 12 (Fig. 14.20). One other small, fully polished adze is light grey stone, probably from D'Urville Island (Fig. 18.4). Greywacke from most parts of New Zealand is not considered a very useful material for making adzes using controlled flaking methods. Indeed, the best known greywacke adzes are probably those made primarily using stone pecking techniques, such as those from Hawkes Bay, east coast North Island (Skinner 1974: 24–25). In spite of the general unsuitability of most forms of greywacke for adze making, the outcrops on Motutapu Island appear to be somewhat more indurated, or at least sufficiently isotropic that conchoidal flaking is possible.

State of completion

Many of the preforms show evidence of secondary trimming, pecking, and polishing, and in some cases there is clear evidence of haft polish.[3] They qualify as preforms rather than finished adzes because they have finally been rendered unusable, either by end shock or some other form of fracture during secondary working. This suggests that the preforms would begin life as adzes quite early in their process of manufacture, and continue to be trimmed, pecked, and polished during

3 Haft polish is easily distinguished from cosmetic surface polishing because the polishing is present in the minute irregularities of the rear face of the adze, not just the high points of the surface.

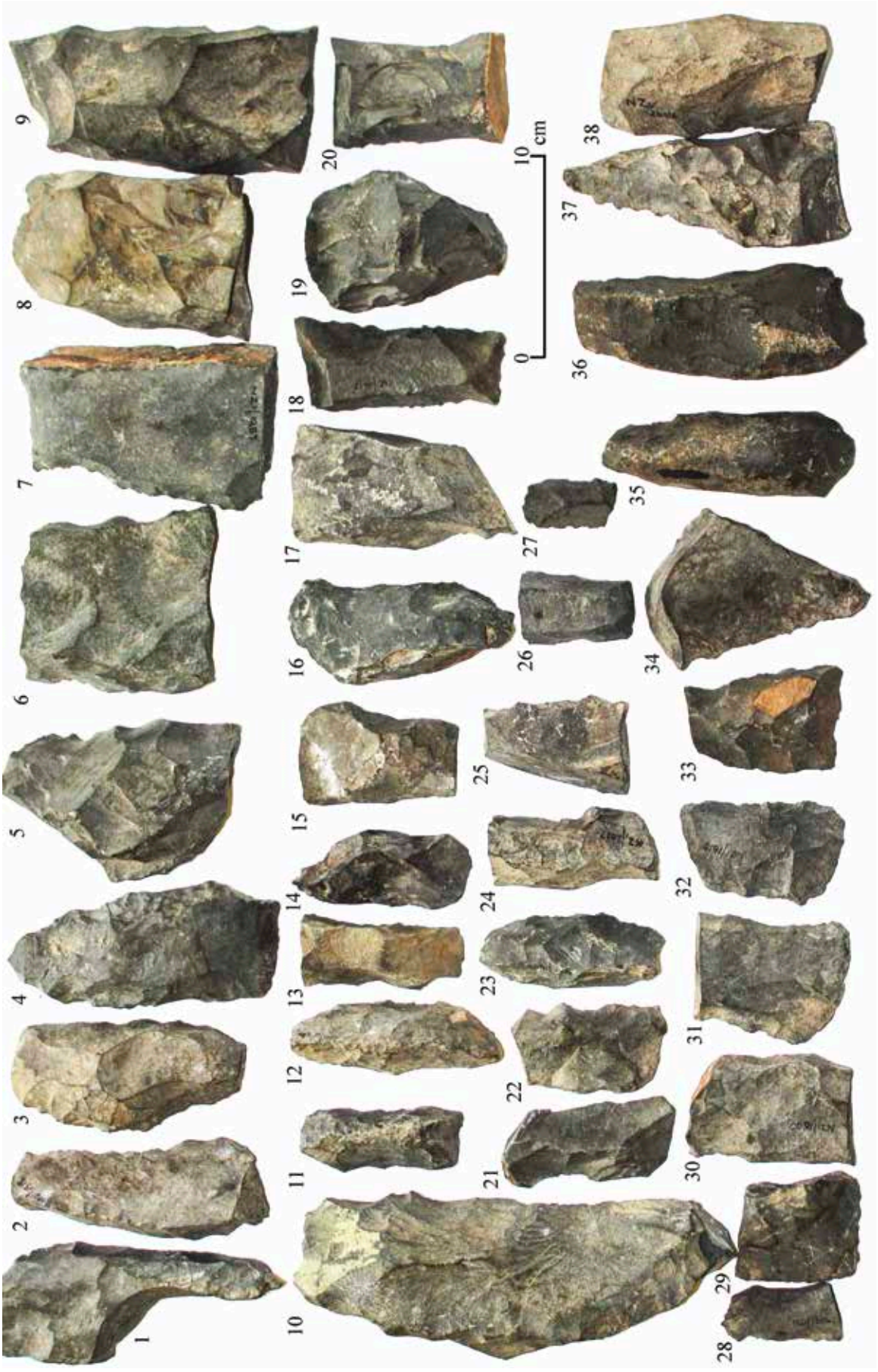

Figure 10. Preforms from Layer 15 at Pig Bay.

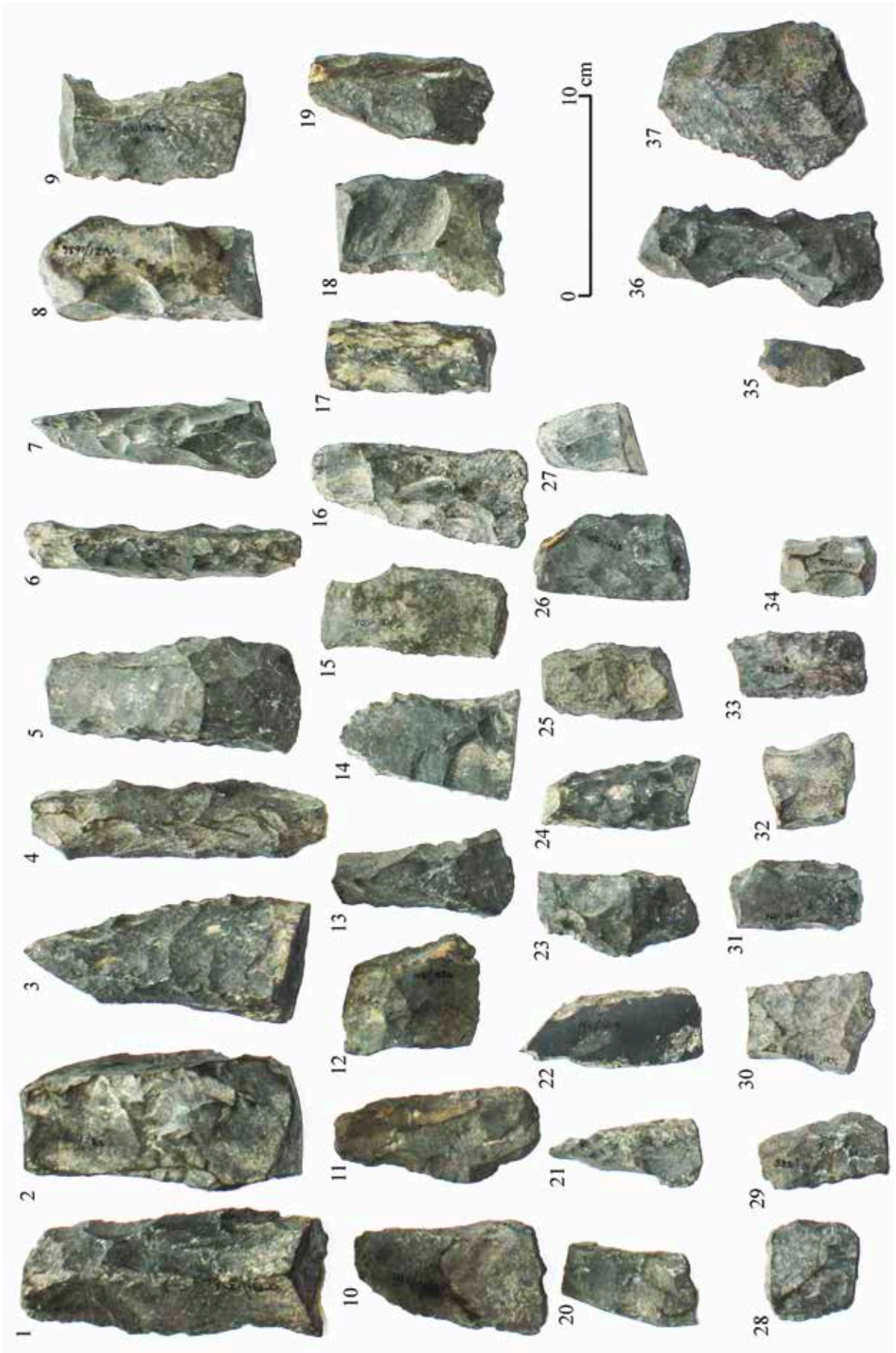

Figure 11. Preforms from Pig Bay: Layer 15 (1–34); Layer 16 (35–37).

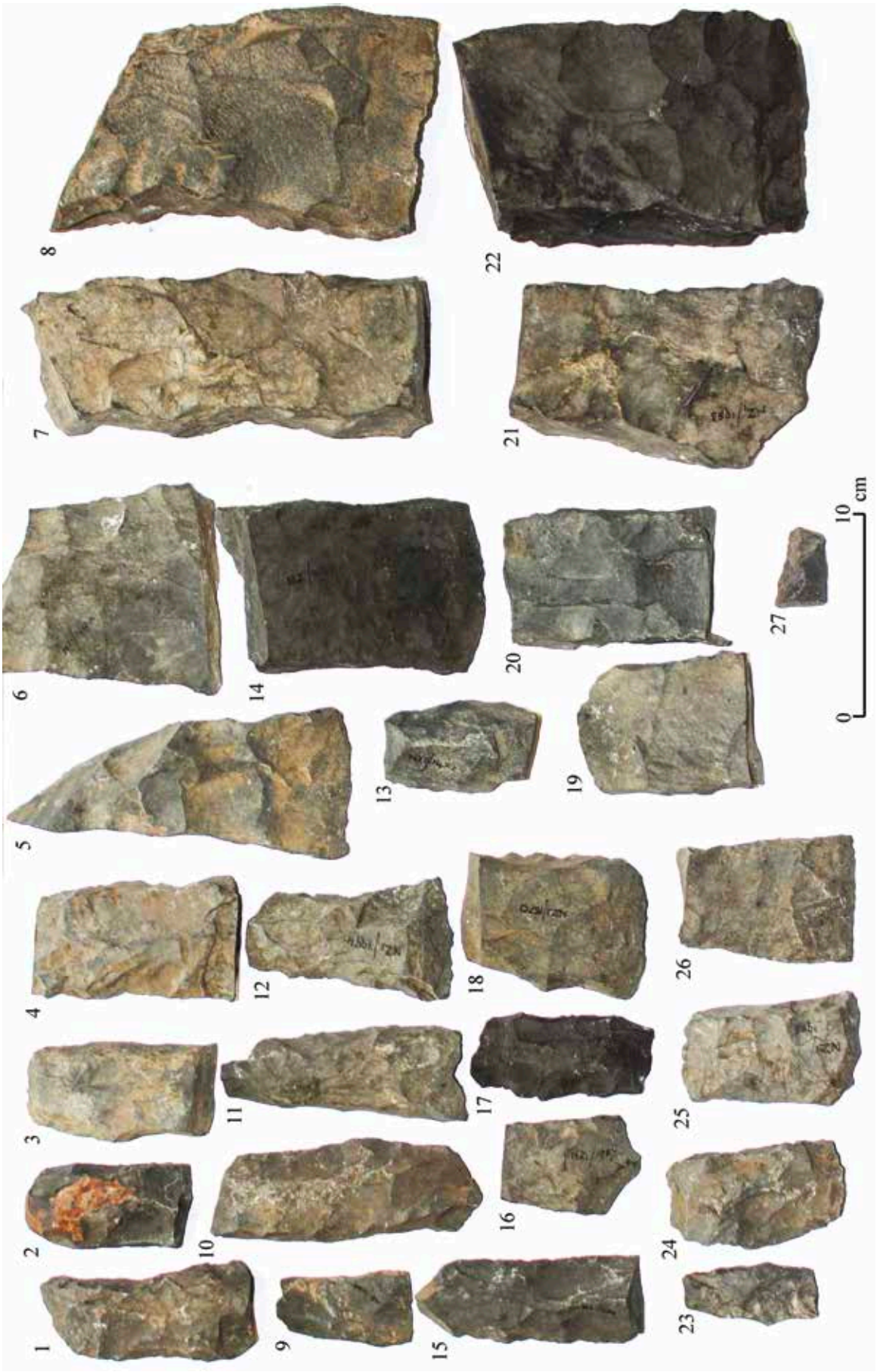

Figure 12. Preforms from Pig Bay: Layer 13 or 15 (first two columns); remainder Layer 13.

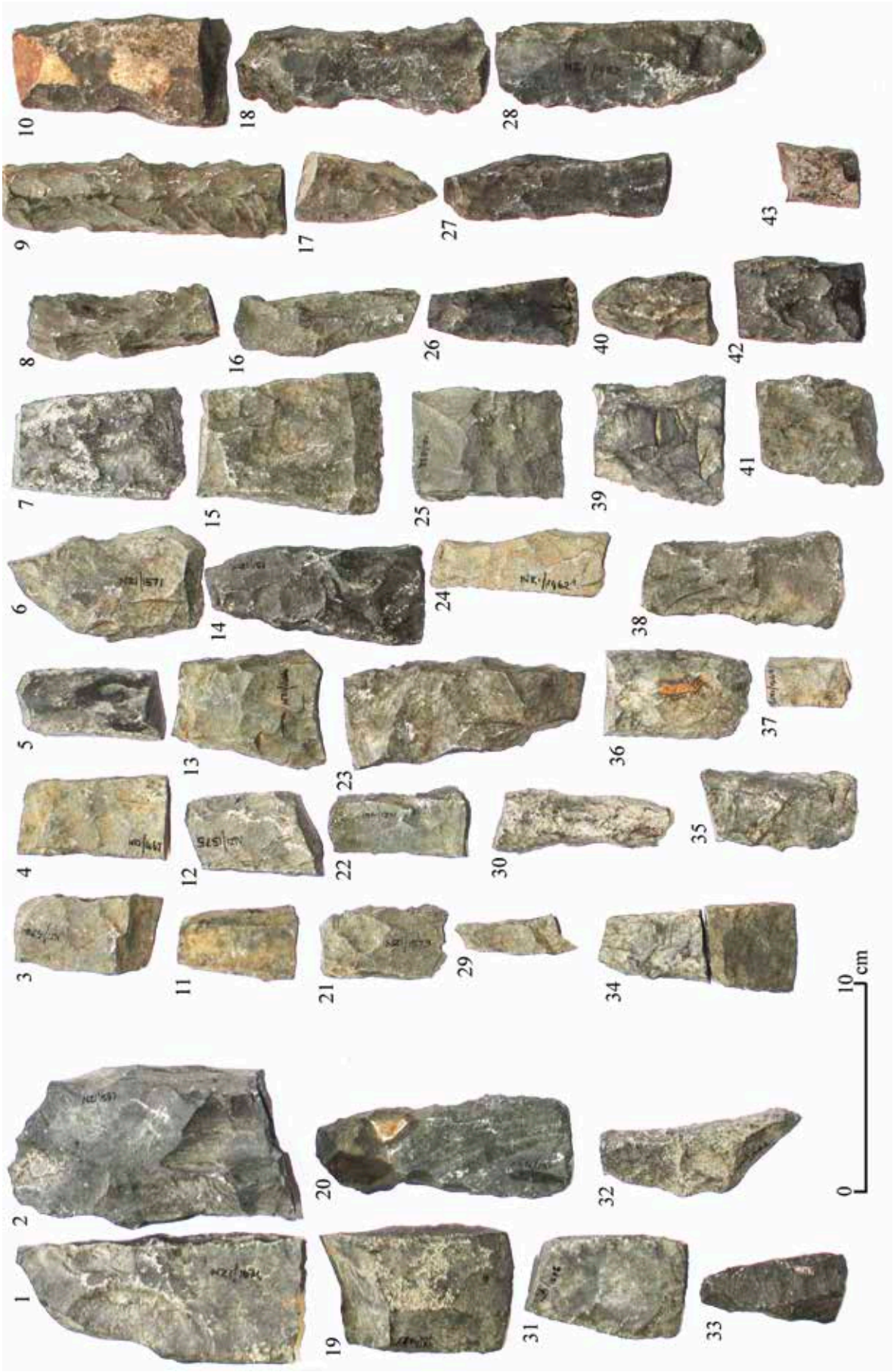

Figure 13. Preforms from Pig Bay: Layer 13 or 15 (first two columns); remainder Layer 13.

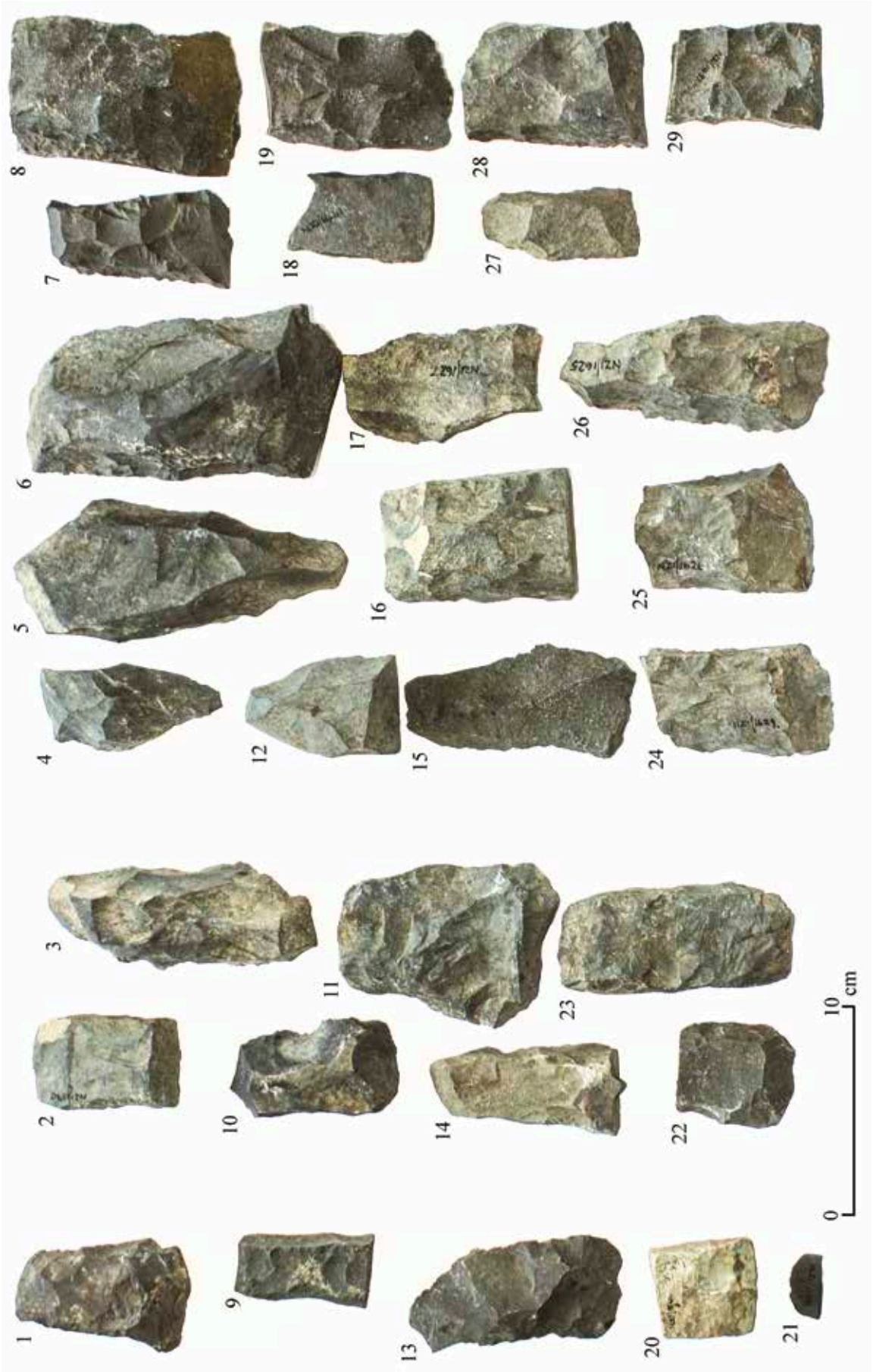

Figure 14. Preforms from Pig Bay: Layer 12 (1, 9, 13, 20, 21); Layers 9 to 14 (2, 3, 10, 11, 14 22, 23); Layer 11 (4–6, 12, 15–17, 24–26), Layer 14 (7, 8, 18, 19, 27–29).

Figure 15. Preforms from Layer 8 at Pig Bay.

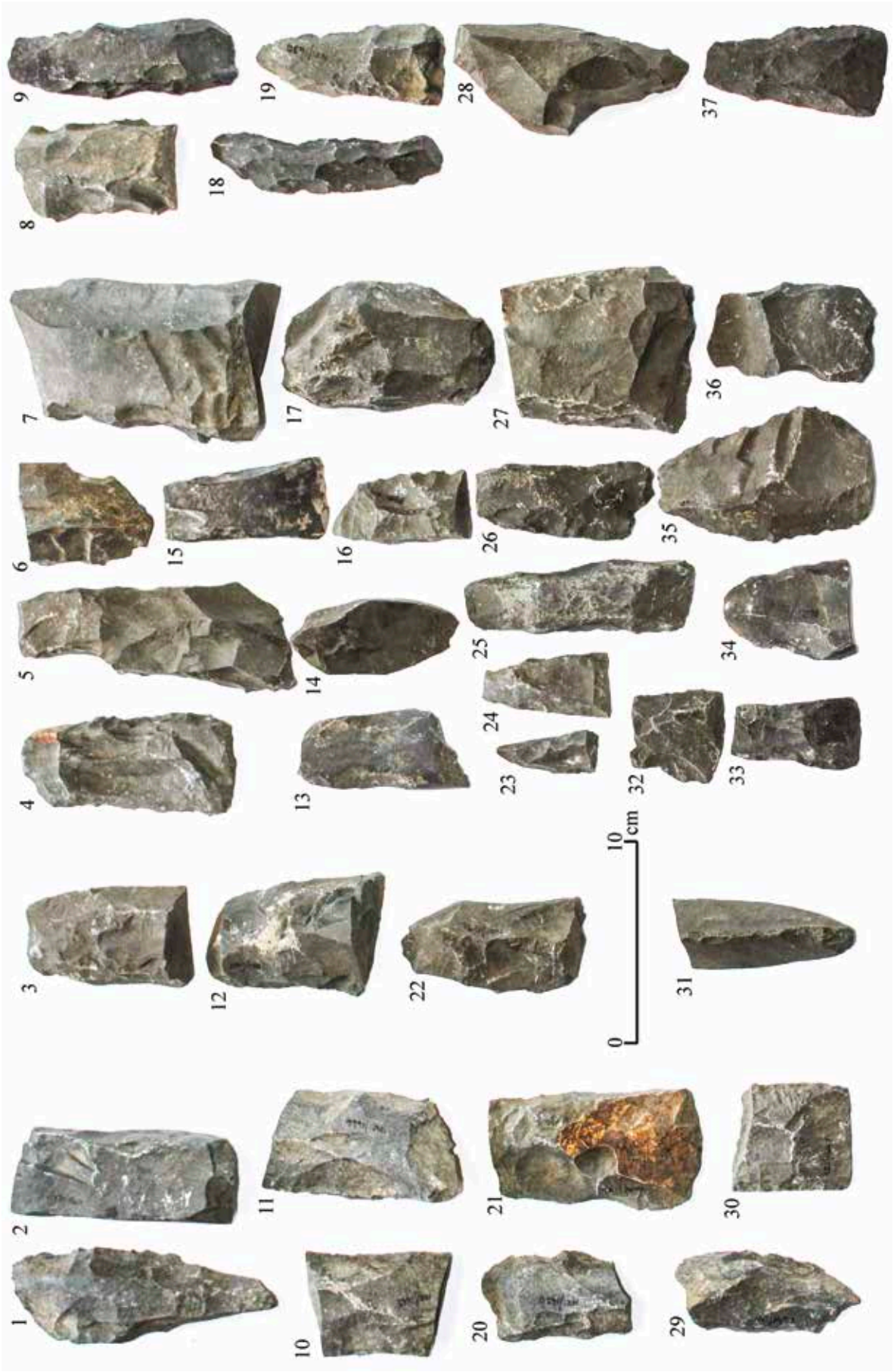

Figure 16. Preforms from the upper layers at Pig Bay: Layer 2 (1, 2, 10, 11, 20, 21, 29, 30); Layer 3 (31); Layer 4 (3, 12, 22); Layer 5 (4–7, 13–17, 23–27, 32–36); Layer 5A (28); Layer 6 (8, 9, 18, 19, 37).

Figure 17. Adzes from Pig Bay: Layer 8 (1 [found in two pieces], 2); Layers 9–14 (10); Layer 10/top 11 (13); Layer 12 or 15 (7); Layer 12 (11); Layer 13 (15); Layer 14 (14); Layer 15 (3–6, 8, 9, 12, 16–18).

Figure 18. "Archaic" adzes from Pig Bay. 1, 3, uncatalogued examples of Duff's (1956) Type 1A; probably the examples originally found by Jack Diamond, which led to the investigation of the site. 2, small Duff Type 1A, showing haft polish and use wear. 4, Duff Type 1C, made from the dark-veined metamorphosed argillite typical of the northern South Island.

their functional life. Of the 270 specimens, 37 are certainly usable, and range from almost fully polished to barely polished at all. End-shock is prevalent in the collection, including some of the most finished adzes, accounting for 127 specimens (47.4%). Some of these have end-shock at both ends of the preform or final form. This is a fair indication of the problems encountered when trying to make adzes from greywacke. Turner, who also studied the Pig Bay adzes and carried out replication experiments, also noted this problem (Turner 2000: 117).

It was not possible to be sure in all 270 cases what the stone worker's precise intention was when flaking the piece of stone at hand. One or two pieces may even fortuitously have ended up as large awls rather than adzes. However, clear intention was possible to determine for 191 specimens (72%), and each of these was subjected to close scrutiny.

Types of preform and flaking method

Wherever possible, the final cross-section being sought by the artisan was tabulated, along with information on the number of edges being flaked (that is, the edges which appear in cross-sectional profile). This follows the descriptive technique used in the study of adze manufacturing at Riverton in Southland (Leach and Leach 1980). Four cross-sections were identified:

Rectangular
Sub-rectangular
Triangular
Elliptical/lensoid

It was possible in some cases to distinguish between sub-rectangular, front wider than back, and back wider than front; however, in most cases it was not, because the high degree of end-shock made it difficult to determine

which end was which, and therefore distinguish front from back surface.

In addition, in most cases it was possible to ascertain the number of edges the stone worker was flaking to form the desired cross-section. It might be thought that rectangular adzes would always require four edges to be worked, but this is not the case. One of the interesting features of the Pig Bay collection is the high proportion of preforms that started life as a very large thick flake. In other words, one surface was already almost fully formed before the process of fashioning it into an adze shape began. It is most likely that this process of producing large flakes was carried out at the stone source with very heavy hammer stones.

It appeared that a considerable proportion of both rectangular and sub-rectangular preforms were being fashioned using bilateral flaking techniques, in additional to quadrilateral flaking, and it was thought useful to document this. Thus, four edge-flaking methods were identified as:

Unilateral
Bilateral
Trilateral
Quadrilateral

Wherever possible, each preform was categorised and tabulated in this 4 x 4 matrix, one for the earlier series and one for the later series (Table 2).

This information was inspected to see if there were any signs of change in adze making behaviour from the earlier to later period of the site. For example, rectangular cross-sectioned adzes are the most common form in both time periods (37.2 and 37.0% respectively). A statistical test is not needed to conclude that there was little change over time in this respect. However, it is not always so clear with each pair of comparisons, so the confidence limits of each pair of percentages was calculated using the formula: $C= K*(P*(1-P)/N)^{0\,5} + 1/2N$, following the method suggested by Leach and de Souza (1979: 32, see also Snedecor and Cochran 1967: 210 ff). C is the confidence limit, P the sample proportion, N the sample size, and K a constant related to the chosen probability level (=1.96 for 95% confidence). It was found that for every pair of percentages that was tested there was no significant difference.

Thus, there is no observable difference between the earlier and later series of adzes and preforms in the site, at least with respect to method of flaking and abundance of different cross-sections.

The overall numbers of each adze type and flaking type are given in Table 3, from which it will be seen that rectangular cross-sectioned adzes are the most common (37.2%), followed by roughly equal numbers of sub-rectangular and triangular forms (29.8% and 26.7%). About 6% of all adzes and preforms are elliptical in cross-section.

Bilateral flaking of edges is the most common method (40.3%). This is in keeping with the common choice of large flakes for shaping a preform, where one surface requires little preparation. Quadrilateral flaking is the next most common method (36.5%), followed by trilateral (22.5%).

Comparable information on flaking choices when making adzes is available only for the site of Riverton in Southland. Here it was found that 86% of the preforms were manufactured using bilateral methods. This is much higher than at Pig Bay. Trilateral and quadrilateral flaking at Riverton accounted for only 7% each (Leach and Leach 1980: 131). Like the stone workers at Pig Bay, those at Riverton preferred to fashion adze preforms from flakes in almost every case where this could be determined (*ibid.*).

The biggest observable difference between these two adze making people at opposite ends of New Zealand is the fact that at Riverton "there are no large triangular preforms in the site" (*ibid.*: 116), which would be recognisable as hog-back adzes, although smaller triangular adze preforms are present.

The flake assemblage

During the excavation, flake debitage was not collected systematically, so the sample available for study is unfortunately selective. In spite of this, there are some features that are worth noting. There are quite a few very large flakes, which could well have been produced at the quarry site rather than at the Pig Bay site itself. The largest weighs 1594 g and would have required a very heavy hammer stone to remove it. Only a small number of hammer stones were recovered in the excavation. Some of the larger hammer-dressed preforms could well have functioned as hammer stones after they had been discarded as adze blanks.

Quadrilateral flaking is likely to result in an abundance of flakes with striking platform angles approaching 90º; whereas bilateral and trilateral flaking is more likely to produce flakes with acute angled striking platforms. No attempt was made to quantify this angle in the collection because of the selective nature of the sample, but from casual observation it was clear that there is a large number of high-angle flakes. Flakes that are elongated are particularly well represented. A sample of these is illustrated in Fig. 19.

One interesting feature of some of these blade-like flakes is the presence of small negative flake scars in front of the striking platform (Fig. 19: 1, 2, 3, 4, 5, 9, 15, 17). In some, but not all, blade industries, removal of the overhanging platform before the blade was struck is a common feature. This leaves the negative scar just described. This procedure was followed in the case of the *Leilira* blade industry in Australia (Akerman 2007: 30–31), but not in the case of the Oturehua blade industry in Central Otago, New Zealand (Leach and Leach, n.d.: 42). Its existence at Pig Bay is therefore unusual. Whether its presence is fortuitous or part of the intentional flaking behaviour of the stone workers could only be decided after analysis of a systematic sample of flakes from the site.

All of these elongated flakes have a clear median ridge, which is the reason a blade-like flake was formed when the stone worker struck the core. However, several

Table 2. Classifications of adze preforms from Pig Bay in two time periods.

Earlier	Rectangular	Sub-rectangular	Triangular	Elliptical	Total	%
Unilateral	-	-	1		1	0.7
Bilateral	17	21	6	8	52	38.0
Trilateral	-	-	32	-	32	23.4
Quadrilateral	34	18	-	-	52	38.0
Total	51	39	39	8	137	100.1
Percent	37.2	28.5	28.5	5.8	100.0	
Later	Rectangular	Sub-rectangular	Triangular	Elliptical	Total	%
Unilateral	-	-	-	-	0	0.0
Bilateral	7	13	1	4	25	46.3
Trilateral	-	-	11	-	11	20.4
Quadrilateral	13	5	-	-	18	33.3
Total	20	18	12	4	54	100.0
Percent	37.0	33.3	22.2	7.4	99.9	

Table 3. Classifications of adze performs from Pig Bay, two time periods combined.

	Rectangular	Sub-rectangular	Triangular	Elliptical	Total	%
Unilateral	-	-	1	-	1	0.5
Bilateral	24	34	7	12	77	40.3
Trilateral	-	-	43	-	43	22.5
Quadrilateral	47	23	-	-	70	36.5
Total	71	57	51	12	191	99.9
Percent	37.2	29.8	26.7	6.3	100.0	

show lateral trimming along the length of this medial ridge (Fig. 19: 8, 9, 10, 11, 12, 16, 17, 18, 19, 20), before the flake removal. This is the type of trimming that took place on many of the trilateral preforms described above (for example, Figs 11.6, 13.9, 15.13, 24, 16.18, 31, 17.6). Some of the sub-rectangular adzes with back wider than front may have been fashioned by removal of a large blade-like flake from the front surface. An example is featured in Fig. 17.5.

The Pig Bay adze kit

One of the interesting things about the adzes and preforms at Pig Bay is the considerable range of forms being manufactured, in terms of both size and shape. This is most clearly illustrated in Fig. 17, which is a selection of the most complete adzes. All of these adzes are from the "earlier" layers (below Layer 8, except the first two, which are from Layer 8). Present are classic Duff (1956, 1959) type 1A (Fig. 17.1), hogback forms (Fig. 17.4 and 7), sub-rectangular back wider than front (Fig. 17.5), sub-rectangular front wider than back (Fig. 17.16), pear-shaped (Fig. 17.15), so-called Duff type 2B (Fig. 17.18), side-hafted (Fig. 17.11), chisel forms (Fig. 17.14), and very tiny adzes (Fig. 17.10). Some very large adzes were being manufactured at the site too; an example is illustrated as Fig. 12.22. This suffered end-shock on each end, leaving only the central portion, and was scheduled to be a large thick rectangular adze.

Of some interest in this adze kit is the presence of pear-shaped adzes, which are classified as having an elliptical or lensoid cross-section. These are produced by very efficient bilateral flaking. The bevel is manufactured

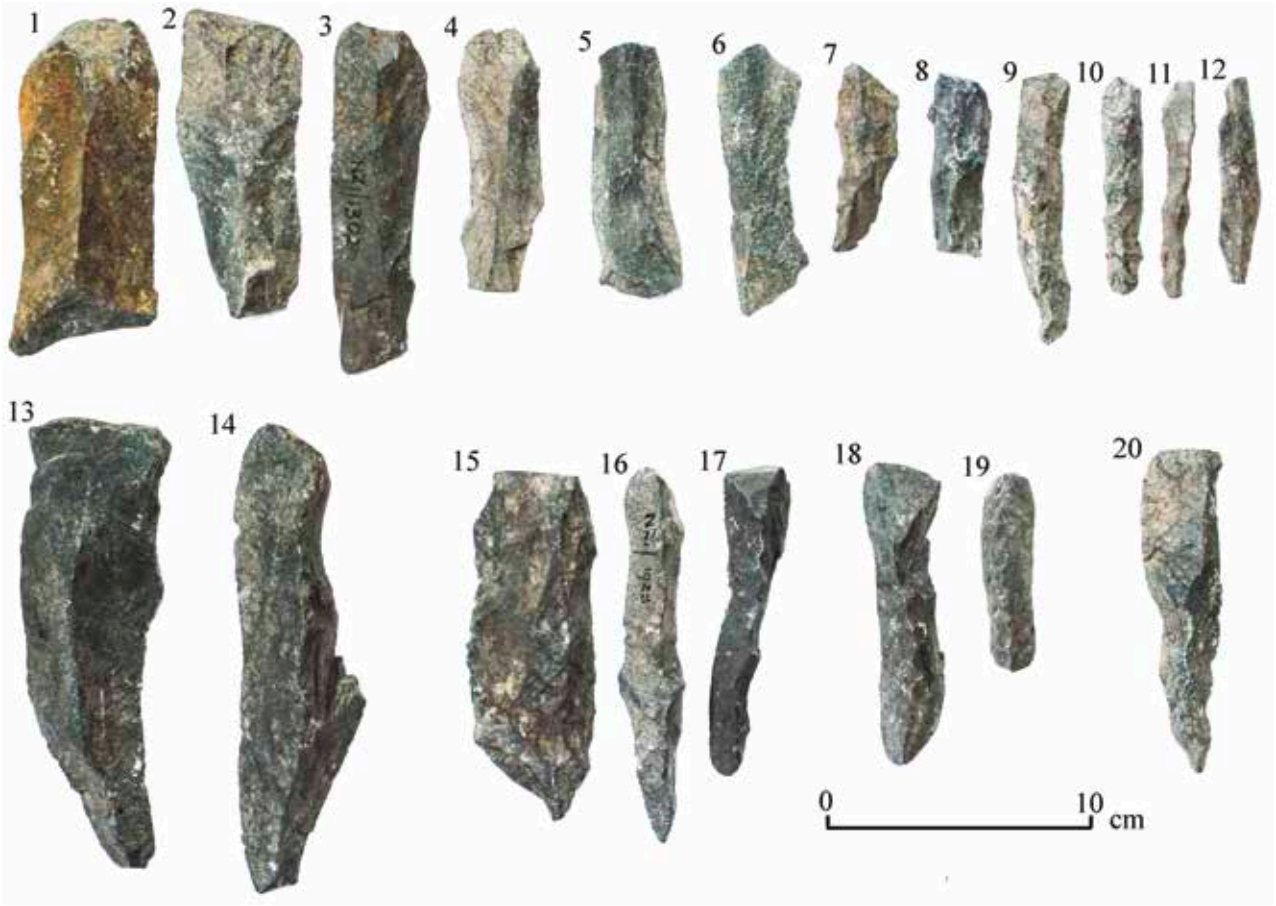

Figure 19. Elongated flakes from Pig Bay: Layer 13 (1–14); Layer 8 (15–17); Layer 10 (18, 19); Layer 15 (20).

by the removal of a single flake at one end, and sides are trimmed bilaterally, sometimes by alternate flaking along one side. This is how the lensoid cross-section is achieved. It also results in an apex along the length of the back, terminating in two ridges that run to the width of the cutting edge. When fully polished, these lines are clear outlines along the back of the adze. Item 4 in Fig. 18 is a perfect example of this. The same pear-shaped adze was probably the intention in a number of preforms (Fig. 11.13, 19; Fig. 13.26, 33; Fig. 15.18; Fig. 16.37; Fig. 17.15).

The adze manufacturing industry at Pig Bay has previously been described by Turner (2000: 43–8) who, with Dante Bonica, carried out replication experiments. She compared the Motutapu industry with other major industries at Tahanga (Coromandel Peninsula) and the Nelson mineral belt in the top of the South Island. She also considered the chronology of use on Motutapu, and the extent to which the products were distributed in the region (*ibid.*: 352–362).

Obsidian

Only a relatively small collection of obsidian was recovered in the excavation (N=173), of which 72 were from earlier contexts (Layer 9 downwards), and 101 from later contexts (Layer 8 and above). The largest numbers were from Layers 5 (16), 8 (45), 13 (34) and 15 (35).The collection is best described as a grab sample. Eight pieces from various contexts were taken by Martin Jones for specialist examination and are not included in the present study. The sources of the obsidian have not been identified, but hand specimen reveals various shades of grey and olive green in transmitted light. Most specimens have a smooth texture and are good quality for flaking, some are vesicular, and some have a matt finish.

Each specimen was examined with a low power binocular microscope (Kyowa SDZ, x 0.7 to 4.5) to detect signs of secondary flaking due to use as tools. A surprisingly large number (more than 50%). showed use wear. Most signs are along only one edge, but some have multiple worked edges. The most common form of use wear is as a bi-directional scraper, showing micro-flaking along both sides of an edge. Edge wear is almost exclusively along acute-angled edges, but one specimen is a steep edged scraper (circa 90). Fig. 20 illustrates five examples of typical use wear found in the obsidian collection (photographed under tungsten filament light with Canon EOS 60D, Macro lens and barrel).

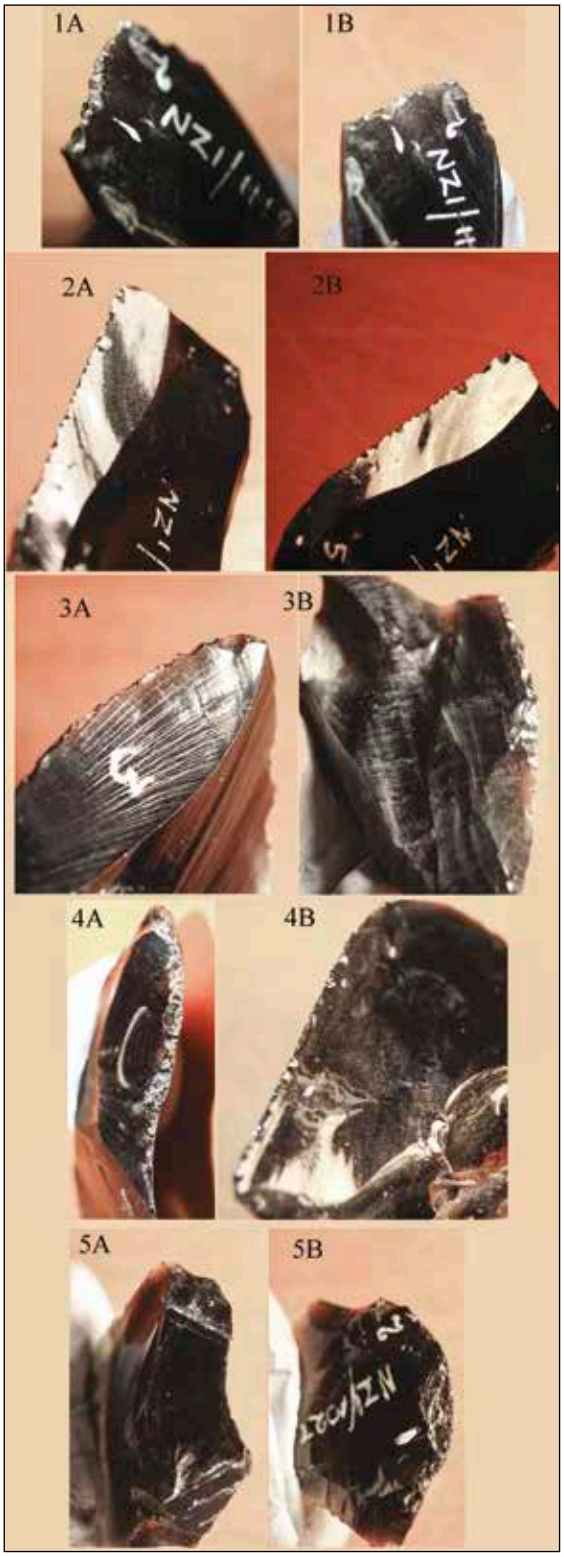

Figure 20. Obsidian tools. 1, bidirectional scraper, Layer 6; 2, bidirectional scraper, Layer 13; 3, arrow-shaped flake, bidirectional scraper, Layer 8; 4, unidirectional scraper with minor micro-flaking on the other side, Layer 13; 5, concave spoke-shave with unidirectional use-wear, Layer 15.

Other stone tools

Three large discoidal flakes of greywacke show secondary flaking around the perimeter (Fig. 21). This type of flaked implement is found in many archaeological sites in the South Island, and was first described in detail by Haast in 1875 from examples found at the Shag River site in Otago (Haast 1875: 96). He compared them to oval spalls called *teshoa*, which were well known among the Sheshone Indians, and were used for scraping buffalo hides. Haast stated that these implements were also numerous at the Rakaia moa hunter site in Canterbury. Griffiths later reported them from a site near Normanby, Timaru (Griffiths 1941), and Trotter recorded many such discoidal flakes made from greywacke at the Rakaia moa hunter site (Trotter 1972: 140–41). Skinner and Simmons (1974: 120–22) called these implements *ulu*, referring to similar implements among Arctic communities, and provided five illustrations of specimens from several New Zealand archaeological sites. Anderson (1989: 158–59) reviewed evidence for these *ulu* and/or *teshoa*, and documented their occurrence at more than 70 archaeological sites in the South island.

To our knowledge, these finds at Pig Bay represent the first time they have been recorded in a North Island archaeological site, although there may well be examples that have not been reported. In the South Island, they are most commonly made from large, water worn greywacke boulders, so it is not surprising, perhaps, that these three specimens at Pig Bay are made from greywacke. Their function is quite unclear. All three are retouched around the perimeter, and none shows any signs of pecking or polishing, which might be expected if they were destined to become, say, a pectoral amulet, the only other possible interpretation.

Duff (1956: 127–29) described pectoral amulets as an extremely rare form, confined, as far as he was aware, to the South Island. He made the plausible suggestion that they were based on the pearl shell ornaments of tropical Polynesia. Prickett (1999: 22–4) provided more details on these very rare ornaments. The examples he described are all from the South Island, apart possibly from one with no known location. Most are made from serpentine, one from slate, and one from black argillite.

Manufacturing tools included hammer stones, drills, and files and other abraders. Their distribution is shown in Table 4.

The hammer stones range from large heavy items in coarse volcanic stone, presumably used for initial removal of large flakes, to smaller smooth oval pebbles, with evidence of percussion on the ends. The quantity of hammer stones is disproportionate to the amount of adze making that was clearly going on at the site. Good hammer stones were presumably taken away when people left the site.

The "other" category in Table 4 includes fragments of broken grindstones from Layers 4 (1) and 13 (2), pebbles apparently used for smoothing or burnishing from Layers 15 and 8, and two pieces of pumice from Layer 15 with evidence of use as abraders. There was a similar piece from the "east trench". Small pieces of

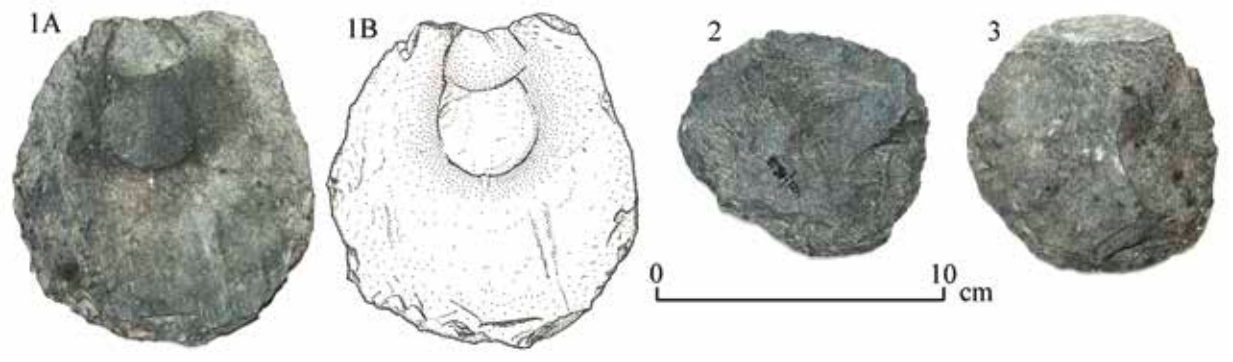

Figure 21. Large discoid flakes from Pig Bay: Layer 13 (1, 3); Layer 5 (2).

Table 4. The distribution of manufacturing tools at Pig Bay.

Layer	Hammers	Abraders			Drills	Total
		Files	File material	Other		
2	1					1
3						
4				1		1
5	1	1				2
6	1					1
7	2?					2
8		3	2	1	2	8
13	1?	3	1	2	1	8
15	4	4	4	3	4	19
16			1			1
Total	10	11	8	7	7	43

pumice with no evidence of use were collected from Layers 12, 14, 15 and 16, and from the mid-sequence deposit in B102.

Turner located several outcrops of good quality chert on Motutapu during the 1995 Auckland University field school on the island, including one just to the east of Pig Bay. However, there is very little evidence of chert use in the Pig Bay site. Apart from the drill tips, there are only four flakes, five cores or pieces, and two pebbles of siliceous material scattered through the excavation, from Layers 1, 2, 8, 13 and 14.

Two small pieces of *kōkōwai* (red ochre) from Layer 13 in square B101 suggest that some artistic activity may have been carried out.

FAUNA

Retention strategy during the two seasons at Pig Bay was not described. Several small "bulk samples" were taken from squares A103 and B103. These were examined in Auckland before Golson moved to Australia in 1961. They were passed through a nest of screens and there are notes on weights of shell, stone, bone, and charcoal retained by half, quarter, eighth and sixteenth inch meshes (12.7, 6.4, 3.2 and 1.6 mm). Only one of these samples is now in the collection; it is described below under shellfish.

Twelve hundred and nine faunal items were catalogued, of which only a small proportion is now in the collection. The majority of missing items are fish and mammal bones (the latter usually described as dog/seal). The following discussion must therefore be treated with caution.

Mammals

Unfortunately, a large number of "seal/dog" bones have long been missing and were not able to be examined by Smith.[4] In his report, he does mention the existence of pilot whale and cetacean fragments (Smith 1981).

4 Before the collection was sent to Otago University, each item was checked against the main catalogue. A large number of items could not be found. A list was made of these missing items. Among this list of missing items are 565 entries that are seal/dog, and a few whale.

The mammalian remains were initially examined by Ron Scarlett and were later studied in detail by Smith (1981). His summary of identifications is given in Table 5. Smith concluded as follows:

> The mammalian fauna from Pig Bay is remarkably limited in range of species when compared to contemporary coastal sites in New Zealand. The reliance on sea mammal hunting as well as moa hunting observed in so many coastal Archaic sites is absent here, suggesting a somewhat different economic adaptation in this region. Although the non-mammalian fauna has not yet been analysed, it would appear that the food quest centred around fishing and shellfishing. Horticulture may well have played an important role in the economy. Throughout the occupation of the site dogs were an important dietary component. The apparent scarcity of the other mammalian food resources may have accounted for the sharing of butchered dog carcasses observed in the site. (Smith 1981: 103)

In view of the large number of missing "dog/seal" bones (which Smith was not aware of), his comment about the absence of sea mammal hunting should perhaps be treated with reservation.

One rat bone (now missing) was listed in the catalogue. Six coprolites, presumably from dogs, were listed; only one (now much fragmented) survives. It is from A101 Layer 6.

Birds

Bird remains were initially examined by Ron Scarlett. He did not include Pig Bay in his overviews of bird remains from New Zealand sites (Scarlett 1972, 1979), probably because the assemblage was so small and relatively uninteresting. The bird remains were subsequently studied by Trevor Worthy, whose identifications are listed here. These correspond closely with those of Scarlett, except for the specific determinations of shags and shearwaters.

The bird remains provide a striking illustration of the extent to which layers in this site had been dug over by hāngi-making and other activities and material redistributed. Two joining parts of a single little blue penguin bone were identified by Worthy from Layers 7 and 15 in square A102 and adjoining baulk.

As can be seen in Table 6, almost all the birds are sea birds – little blue penguins (*Eudyptula minor*), shags (*Phalacrocorax varius, P. carbo*, *Stictocarbus punctatus*, and undetermined), shearwaters (*Puffinus* spp.), and the single example of what is probably a white heron (*Egretta sacra*). The probable absence of forest on Motutapu after the Rangitoto eruption is reflected in the rarity of terrestrial birds – only one tui (*Prosthemadera novaeseelandiae*) and one kākā (*Nestor meridionalis*). The seabirds may have been largely by-products of fishing activities by the people occupying the site.

Fish

Fish remains were initially identified in Canberra, relying on mouth parts. Almost all were identified as snapper (*Chrysophrys auratus*), with a single example of barracouta (*Thyrsites atun*). Leach examined a sub-sample of the fish remains, identifying one example of kahawai (*Arripis trutta*), dental plates of eagle ray (*Myliobatis tenuicaudatus*) and spines of either eagle ray or sting ray (*Dasyatis brevicaudatus*). Snapper was by far the most important part of the fishing catch. Snapper predominate in many northern New Zealand archaeological sites (Leach 2006: 331–333, 336–339) but the Pig Bay case is an extreme example, which may be due to the collection methods. The distribution of surviving fish remains is shown in Table 7.

Shellfish

Although layer descriptions include frequent mention of shell and "midden", very little shell appears to have been retained. There are no records of previous shell analysis.

Forty-nine shells from 18 species are present in 17 small bags, mostly from square A101. What appears to be a small grab sample is from Layer 9 in Golson's

Table 5. Minimum numbers of individual mammals from Pig Bay (adapted from Smith 1981, Tables 1 and 2).

Stratum	Level	Major occupation layer	Pooled layers	Dog	Pilot whale	Cetacean ?sp.	Total
upper	I	6	1-6	3		1	4
	II	7	7	5			5
	III	8	8	3	1		4
middle	IV	10	9–11	5			5
	V	13	12–14	4		1	5
	VI	15	15	8	1		9
lower	VII	16	16	1			1
Total				29	2	2	33

Table 6. Minimum numbers of birds from Pig Bay.

Species	Layer									
	4	5	6	7–8	10	11	12	13	15	Total
Egretta sancta (?)								1		1
Eudyptula minor			1	4	1	1		1	1	9
Moa		p		p	p		p		p	p
Nestor meridionalis									1	1
Phalacrocorax varius					2					2
Phalacrocorax varius/carbo									2	2
Prosthemadera novaeseelandiae				1						1
Puffinus gavia	2									2
Puffinus cf. *carneipies*			1							1
Shag				1		1				2
Stictocarbus punctatus								1		1
Total	2		2	6	3	2		3	4	22

P indicates presence. The moa bone consisted of small fragments, probably brought to the site for industrial use.

Table 7. Minimum numbers of fish from Pig Bay.

Layer	snapper	kahawai	barracouta	rays
3	8			3
4	7			
5	10			
6	27			
7B	13			1
8	9		1	3
9-14=	1			
11	14	1		
12	2			
13	22			1
14	1			
15	14			
16	3			
Total	?????	1	1	8

final account of site stratigraphy. It contained two pieces of greywacke and considerable sandy residue as well as the following: 1 *Cabestana spengleri*, 1 *Haustrum haustorium*, 5 *Lunella smaragdus* (plus 3 opercula), 12 *Nerita melanotragus*, 1 *Saccostrea glomerata*, 1 *Cellana* sp., 1 *Paphies australis*, 7 mussels (*Perna* sp.), and 1 fragment of *Austrovenus stutchburyi*. There were also several fragments of fish bone, including a left premaxilla of snapper (*Pagrus auratus*). This sample is in line with the shells from the small bags, which also contained 11 *Dicathais orbita*, 12 *Lunella smaragdus*, 3 mussels, and 1 or 2 of each of the following: *Cookia sulcata*, *Struthiolaria papulosa*, *Saccostrea glomerata*, *Alcithoe arabica*, *Cellana* sp., *Haliotis iris*, *Austrovenus stutchburyi*, *Pecten novaezelandiae*, *Paphies australis, Scutus breviculus*, *Evechinus cloroticus*, *Haustrum haustorium*, *Cabestrana spengleri*, and *Nerita melanotragus*.

In complete contrast is a "grab sample" from A 103, Layer 15, which contained a minimum number of 56 cockles (*Austrovenus stutchburyi*) and 5 pipi (*Paphies australis*).

The small grab sample and the small bags may reflect the usual collecting of shellfish from the rocky shore in the immediate vicinity of the site; the second grab sample suggests collecting expeditions slightly further afield, to the Islington Bay area, where Rangitoto created the sort of estuarine environment where cockles and pipi could be easily gathered.

It is interesting that the both the grab sample and the small bags contain *Nerita melanotragus*. Szabó (2001a) commented on the absence of this gastropod species in a terraced site (R10/494) on the island, excavated in 1998, and proposed that this absence was due to climate fluctuations during the period of Māori occupation of the island. She noted that the species was present in the pre-eruption occupation at the Sunde Site and absent from the later "soft shore" midden, although it is common on the rocky shore today. She pointed out that *Nerita melanotragus* is particularly susceptible to temperature fluctuations. Szabo's carefully reasoned interpretation was strongly challenged by McFadgen and Goff (2001), who argued that the species was always uncommon and could easily be affected by human predation. Szabó (2001b) replied with a further well reasoned justification of her interpretation. Although the shell samples from Pig Bay are small and unsystematic, they are all from a relatively early context, and suggest that early visitors to the site on what were probably numerous occasions had little or no impact on the *Nerita* population.

Discussion

In view of the sampling problems and relatively small amount of faunal material still available for study, it is hard to say much about subsistence at Pig Bay. It is notable that there is virtually no indication of change through time. This is clearest in the bird and mammal remains, which are far more numerous (despite the disappearance of a large quantity of seal/dog remains) than those of fish and shellfish. The absence of forest birds is unsurprising on an island on which forest had probably been destroyed by the Rangitoto eruption and regeneration hampered by frequent cultivation. The absence of moa (apart from small pieces of probably industrial bone) on a relatively small island is also not surprising. On the surviving faunal evidence, it would seem that seals did not visit the inner Hauraki Gulf to any great extent. Thus the people who went to Pig Bay, on what may have been repeated brief visits, took dogs with them at least partly for meat and took advantage of nearby fishing grounds and shellfish populations.

There is, however, a difference in the faunal remains from Pig Bay and those from predominantly later sites; in particular, the three excavated sites at Station Bay on the northeast coast of the island (Allo 1970; Smith and McPherson 2013). The difference is in mammal remains. No mammal bones were identified at the two undefended sites at Station Bay, and although there were some dog remains at the pā, they were very few, compared with Pig Bay, where there were also seal bones, probably many more than appear in the surviving collection. Again in contrast, there were quite a few rat bones at the Station Bay pā, although retention practices may partly account for the finding of only one rat bone at Pig Bay.

There are also striking differences between the faunal remains from Pig Bay and those from Nichol's excavations at the nearby Sunde site, where the early "oyster lens" beneath the Rangitoto ash deposits reflects the environment before the eruption. The most numerous bird species was the spotted shag with a minimum number of 80 individuals. Fourteen other sea bird species were mostly represented by one or, in a few cases, possibly two individuals. There were four grey ducks and one individual each of three other duck species. Terrestrial birds were dominated by 59 tui, 29 kākā, 15 red-crowned parakeets and seven pigeons, with single individuals of nine other species (Nichol 1988: 242). In contrast, there were only two fur seals, two sea lions, one elephant seal, one rat and four dogs (*ibid.*: 246). There were also three tuatara, one individual each of two species of gecko and 11 skinks of four or five species (*ibid.*: 240). The small number of sea mammals supports Smith's suggestion that they were probably uncommon in the Hauraki Gulf, even in earliest times, and further suggests that the large number of now missing "dog/seal" bones from Pig Bay were mostly, or entirely, from dogs. The molluscs from beneath the ash at the Sunde site were overwhelmingly from the rocky shore, dominated by rock oysters, followed by green mussels, blue mussels, sea eggs and white rock shells, with 42 other species of gastropods. Sixteen other species of bivalves included seven cockles and no pipi (*ibid.*: 233). Fish were, not surprisingly, dominated by 390 snapper, followed by 175 yellow-eyed mullet, eight kahawai, two trevally, two labrids and probably one example each of seven other species (*ibid.*: 238).

The later "soft shore midden" produced only two spotted shags, single individuals of seven other sea birds, and 16 terrestrial birds, including seven parakeets, three tui and two kākā. There were one fur seal, one cetacean (possibly a pilot whale), two rats, and two or three dogs. Fish were again mostly snapper (388), with only two yellow-eyed mullet, and single individuals of 12 other species (Nichol 1988: 391). The shellfish were dominated by pipi (6400) and cockles (4600), with 379 rock oysters and small numbers of nine other, mostly rocky shore, species (*ibid.*: 389). The soft shore midden dates to the latter half of the prehistoric sequence on the island (NZ6955A, Nichol 1988: 403).

DISCUSSION AND CONCLUSION

Chronology looms as an important issue in understanding Pig Bay. In the late 1950s, the site seemed to reflect periodic Māori occupation from immediately after (and probably just before) a single blanketing of the island by ash from nearby Rangitoto Island until a late point in the prehistoric sequence, during which the material recovered appeared to be "Archaic throughout" (Golson 1959: 46). Although Golson noted that the site stratigraphy had been greatly disturbed by the constant digging of hāngi pits, he did not see this as challenging his interpretation of continuity in "Archaic" occupation.

In the intervening years, the chronology of Rangitoto eruptions has been extended and the dating somewhat altered. It is now thought that the volcanic history of Rangitoto spans a period of about 1000 years from c. 1500 to 500 BP (Shane *et al*. 2013). Much of this sequence is documented from cores in Lake Pupuke on Auckland's north shore, to the west of Rangitoto. However, Needham *et al*. (2011) reported two separate ash layers in the northeast of Motutapu. Although most archaeological excavations on the island have revealed no evidence of more than one primary ash shower, Nichol reported human footprints on the surface of four successive ash showers at the Sunde site, apparently in quick succession. He considered these to be part of a single eruptive event, dating "to around 1400 A.D. or perhaps a little earlier" (1988: 413). There is much better evidence of pre-eruption occupation at the Sunde site than at Pig Bay.

As noted above, the context of the mid-sequence date (NZ8126) at Pig Bay is not clear. However, it suggests that much, if not all, of the occupation of the site, including most of the adze making activity, probable dates to a relatively brief period between the eruption and about AD 1500. This is a far cry from a long sequence that was "Archaic throughout".

In 1959 there were no other excavated sites on Motutapu, or indeed in the wider Auckland area, with which Pig Bay could be compared. In the intervening years, 11 more sites have been excavated on the island, some in great detail, others only minimally. It is in this context that Pig Bay can now be considered.

The Sunde Site, on a nearby coastal flat that is also adjacent to the main greywacke outcrops in the northwestern part of the island (Scott 1970; Nichol 1981, 1988), is the only other excavated site directly comparable to Pig Bay. The Auckland Museum research project on the island, in addition to detailed site surveys (Davidson 1970a, 1978), involved the excavation of two "undefended sites" on ridges and a headland pā at Station Bay in the northeast of the island (Davidson 1970b, 1972, 2013; Leahy 1970, 1972; Allo 1970; Sullivan 1972), and what proved to be a natural terrace used for cooking activities at the lower end of another "undefended site" on a ridge nearer Pig Bay (Leahy 1986).

The Auckland University project on the island in the 1990s involved excavations on another six undefended ridge sites, and a thorough review of all site recording episodes on the island (Doherty 1996). Doherty's study raised important issues about what constituted a "site" and showed how different recorders at different seasons found or missed "sites" and grouped features differently. This point had previously been made by Law (1987). Of the undefended sites, R10/497 was reported in detail by Watson (2004) and the excavation of R10/494 was summarised by Ladefoged and Wallace (2010) with references to student projects for specific details. These included Szabó's (1999) BA Hons dissertation, which provided the basis for her publication about *Nerita melanotragus*, discussed above. A house floor was found at both these sites. A house floor surrounded by small pits was found on one terrace at R10/496; a house floor was also exposed on one of two terraces at R10/557. Results of small test excavations at R10/47 and R11/1277 were inconsequential (Irwin pers. comm.), although site records for R11/1277 mention "stone working evidence found at western terrace rim."[5]

Chronology poses problems for these other sites too. In the case of the three Station Bay sites, bone dates for human burials were consistently older than charcoal and shell dates. Only fairly general conclusions could be drawn:

> The results suggest that the site on the headland [R10/26], including the external pits as well as the pā, was periodically occupied over a period of up to three centuries, with the final occupation probably close to the end of the eighteenth century or early in the nineteenth century. Of the two undefended sites, the Leahy site [R10/31] is earlier, perhaps close to the initial use of the headland for pits, and the Davidson site [R10/38], in its final use at least, is later, perhaps close to the final occupation of the pā. (Davidson 2013: 18)

Unpublished dates for R10/496 (1), R10/497 (2) and R10/557(2) (Irwin pers. comm.) are also not particularly helpful in identifying changing patterns of land use, material culture, or faunal exploitation.

Both Pig Bay and the Sunde Site have been seen as temporary camps of people visiting from the mainland to enjoy local foods and exploit the resources of greywacke and perhaps also chert on the island. Nichol (1988: 357) drew on historical sources to suggest:

> … that settlement patterns reconstructed for the proto-historic period, involving temporary occupation of camp-sites by people based on the fertile horticultural soils of the isthmus, may have already been in occupation at the time the Sunde site was first occupied.

Although this interpretation applies mainly to Pig Bay and the early occupation of the Sunde Site, many sites on the island were clearly occupied long enough for houses and food storage pits to be constructed. Such sites may well have been occupied by people who also sometimes lived on the volcanic cones and other suitable locations on the mainland, taking advantage of the fertile soils in both areas. In times of trouble, when danger threatened, the tops of the volcanic cones and the headlands of the mainland and Motutapu (and other islands) were fortified.

Evidence of continuing use of local greywacke for tool manufacture was found in several of the "undefended sites", mostly notably R10/497, where 3026 greywacke flakes, 29 adzes in various stages of manufacture, and 29 flake tools were excavated (Watson 2004: 124), along with numerous hammering and grinding tools. Interestingly, there was cortex on 60% of the flakes (*ibid.*: 127), suggesting that chunks or rough-outs of greywacke were being carried up to the site for further work. Manufacturing activities were also revealed at R10/494, although ochre grinding and obsidian working seem to have been the main activities there. Much of the evidence of activity was concentrated in the porch of a substantial house.

One of the Station Bay undefended sites (R10/31) revealed a sequence from a storage pit and house with a cache of greywacke adzes and a few flakes but no real evidence of manufacturing activity, to a stone working, cooking and general activity area, but no house. As the excavated area was one small terrace at the base of a long flight of terraces and other features, it can be assumed that there was probably a later house on a nearby terrace.

Evidence of stone working was also found at R10/38 at Station Bay, which was a more puzzling undefended site. Situated on a broad relatively flat area of ridge, its extent was not clear and some of the rather variable, relatively shallow structures could have functioned as either houses or storage pits. Here too, however, evidence of cooking and stone working was found, although the artefactual evidence was relatively limited. This site is more recent than nearby R10/31, and suggests that use of local greywacke for tool manufacture may have continued into the late eighteenth century.

In contrast, only one small adze, of a squat "2B" form, and no evidence of greywacke working were found on the Station Bay pā. However, it is entirely possible that greywacke working did take place on an unexcavated

5 htpps://nzaa.eaglegis.co.nz/NZAA/Site/?id=Rll/1277 accessed 3/11/2016

part of this relatively extensive site (Davidson 2013: 20). Thus, with the possible exception of the pā, greywacke working seems to be a feature of both beach front and inland sites on Motutapu throughout the sequence. There is, however, no evidence that typically Archaic forms, such Duff's Types 1A or IV, continued to be made beyond the early deposits at Pig Bay.

Much has been learned about the prehistory of Motutapu Island in the 60 years since Jack Golson first went there. However, much still remains to be learned. The island offers a wonderful ongoing opportunity to develop further knowledge about Māori life here and in the wider Auckland region.

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APPENDIX 1. THE CHARCOAL ASSEMBLAGE FROM PIG BAY

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Twenty charcoal samples from Pig Bay were examined. The assemblage is dominated by forest species (79%), which occur consistently throughout all layers. On the face of this, broadleaf/podocarp forest seems to have been adjacent to the site over the whole period it was occupied. The commonest species is beech, which elsewhere on Motutapu I have only ever found to be abundant in the palaeosol buried by the Rangitoto ash. This is an unexpected outcome, as all other post-eruption charcoal assemblages I have analysed from Motutapu suggest that most primary forest had been destroyed by fire at the time of the eruption.

A close examination of the stratigraphy of the site suggests an alternative explanation for the above pattern. The site was in a dune formed by a mixture of windblown sand and lake sediments within which the cultural material was intimately inter-lensed. It was deduced that the dune sands derived from volcanic ash lying on the hill slopes behind the site that had washed down and dammed the mouth of the Pig Bay stream creating a temporary lake (Brothers and Golson, 1959: 572). Since the Rangitoto eruption fired the beech-dominated forest cover on the island, it seems inevitable that charcoal from that conflagration would have been washed down

with the ash. It thus seems likely a significant proportion of the charcoal in the dune sediments was of natural origin rather than from cultural fires. The species content, especially the abundance of beech, certainly matches the Rangitoto eruption era forests of the island rather than the post-eruption beach vegetation we might expect. The abundance of beech in pre-eruption Motutapu forests is not unexpected, as it was recorded in considerable quantity on neighbouring Waiheke Island in the nineteenth century (Kirk 1878: 444).

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Table A1. Charcoal identifications from Pig Bay.

Species	Plant type	#IDs	%
Kawakawa *Macropiper excelsum*	Shrubs and small trees	1	20.5
Rangiora *Brachyglottis repanda*		9	
Coprosma spp.		23	
Pittosporum spp.		3	
Akeake *Dodonaea viscosa*		1	
Māhoe *Melicytus ramiflorus*		1	
Supplejack *Rhipogonum scandens*	Other large broadleaf trees	2	52.5
Tītoki *Alectryon excelsum*		8	
Maire *Nestegis cunninghami*		4	
Mangeao *Litsaea calicaris*		7	
Taraire *Beilschmiedia tarairi*		1	
Pōhutukawa *Metrosideros excelsa*		20	
Beech *Nothofagus* sp.		55	
Matai *Prumnopitys taxifolia*	Conifers	10	26.5
Rimu *Dacrydium cupressinum*		6	
Tānekaha *Phyllocladus trichomanoides*		6	
Tōtara *Podocarpus totara*		7	
Kauri *Agathis australis*		20	
Total		194	

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