Rapa Nui Mataa Morphometric Analyses

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```
require(knitr)
```

```
## Loading required package: knitr
```

```
opts_chunk$set(fig.align='left')
require(devtools)
```

```
## Loading required package: devtools
##
## Attaching package: 'devtools'
##
## The following objects are masked from 'package:utils':
##
##     ?, help
##
## The following object is masked from 'package:base':
##
##     system.file
```

```
install_github("vbonhomme/Momocs")
```

```
## Installing github repo Momocs/master from vbonhomme
## Downloading master.zip from https://github.com/vbonhomme/Momocs/archive/master.zip
## Installing package from /var/folders/vd/xwg_55w560v5djfwqmqgnc2r0000gn/T//RtmpnPCTtH/master.zip
## arguments 'minimized' and 'invisible' are for Windows only
## Installing Momocs
## '/Library/Frameworks/R.framework/Resources/bin/R' --vanilla CMD INSTALL  \
##   '/private/var/folders/vd/xwg_55w560v5djfwqmqgnc2r0000gn/T/RtmpnPCTtH/devtools10cc6b371bdc/Momocs-ma
##   --library='/Library/Frameworks/R.framework/Versions/3.1/Resources/library'  \
##   --install-tests
```

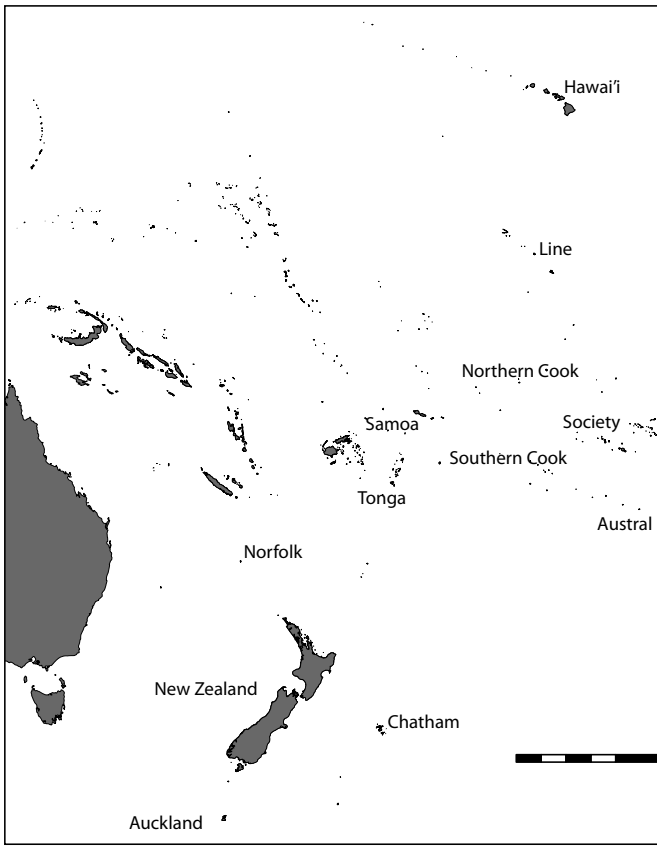
```
require(Momocs)
```

```
## Loading required package: Momocs
```

```
setwd("/Volumes/Macintosh HD/users/clipo/mataaMorphometrics/")
```

Introduction

Rapa Nui is a tiny island located in a remote corner of Eastern Polynesia, more than 2000km from the nearest inhabited body of land. The island was first colonized by Polynesians who sailed from central East Polynesia in voyaging canoes during the 13th century AD (Hunt and Lipo 2008; Wilmshurst et al. 2011).



HD/users/clipo/mataaMorphometrics/Figures/Figure1.pdf

It is often assumed that prehistoric Rapa Nui populations experienced intense warfare during late prehistory (Bahn and Flenley 1992; Diamond 1995, 2005; Flenley and Bahn 2002). One line of evidence used to make this assumption is the presence of mata'a, flaked obsidian stemmed tools. Mata'a are a class of hafted flaked obsidian artifacts that are found commonly on Rapa Nui. They are similar in form to tools found on other islands such as New Britain, Papua New Guinea (e.g., Torrence et al. 2008).

Previous stylistic analysis and evaluation of usewear contradict claims of weapons and instead point to their use as either some kind of symbolic implement or their use in cultivation activities (Bollt et al. 2006; Lipo et al. 2010). Here, we use shape morphometric analysis to examine mata'a shape variability and to look for areas of shape that are constrained versus those that are free to vary. Our results conclude that mata'a were only functionally constrained in terms of the haft. These results continue to support the alternative hypotheses that these artifacts were not used as weapons.

Mataa

Data

‘‘‘

```
data.path <- "/Volumes/Macintosh HD/users/clipo/mataaMorphometrics/Data/RapaNuiMataaData.txt"
# We read the whole file
```

```r
PAST <- read.table(data.path, header = TRUE, sep="\t")
last.meta <- which(colnames(PAST)=="X1") - 1
fac <- PAST[, 1:last.meta]
# xy will contain coordinates only
xy <- as.matrix(PAST[, -c(1:last.meta)])
# a short loop to reorder thing and store them in a list
coo <- list()
for (i in 1:nrow(xy)){
  coo[[i]] <- cbind(xy[i, seq(1, ncol(xy), 2)], xy[i, seq(2, ncol(xy), 2)])}
# we renames the components of the list (ie the shapes)
names(coo) <- fac[, 1]
# now we create the Out object (formerly Coo,
# but Coo became a super-class now, to handle outlines, open outlines, and
# landmarks)
RapaNui <- Out(coo, fac=fac)

panel(RapaNui, fac = "Site")
```

```r
panel(RapaNui, fac = "Island")
```

```r
panel(RapaNui, fac="Source", reorder="Source")
```

```r
# Lets begin by centering, scaling them
stack(RapaNui)
```

```r
RapaF <- eFourier(RapaNui, 12)
RapaP <- fgProcrustes(RapaNui)
```

```
##  * No landmarks defined in $ldk, so trying to work on $coo directly.
## iteration:  1    gain: 590.7
## iteration:  2    gain: 28.19
## iteration:  3    gain: 4.912
## iteration:  4    gain: 0.3123
## iteration:  5    gain: 4.159
## iteration:  6    gain: 1.111
## iteration:  7    gain: 0.7301
## iteration:  8    gain: 0.05619
## iteration:  9    gain: 0.4705
## iteration:  10   gain: 0.2913
## iteration:  11   gain: 0.06571
## iteration:  12   gain: 0.0006026
## iteration:  13   gain: 0.02029
## iteration:  14   gain: 0.03462
## iteration:  15   gain: 0.02457
## iteration:  16   gain: 0.002025
## iteration:  17   gain: 0.01128
## iteration:  18   gain: 0.01151
## iteration:  19   gain: 0.00591
## iteration:  20   gain: 0.0005012
## iteration:  21   gain: 0.002408
## iteration:  22   gain: 0.002742
## iteration:  23   gain: 0.001557
```

```
## iteration:  24   gain: 0.0001653
## iteration:  25   gain: 0.0006239
## iteration:  26   gain: 0.0007096
## iteration:  27   gain: 0.0004013
## iteration:  28   gain: 4.848e-05
## iteration:  29   gain: 0.0001532
## iteration:  30   gain: 0.0001794
## iteration:  31   gain: 0.0001039
## iteration:  32   gain: 1.423e-05
## iteration:  33   gain: 3.807e-05
## iteration:  34   gain: 4.561e-05
## iteration:  35   gain: 2.684e-05
## iteration:  36   gain: 4.087e-06
## iteration:  37   gain: 9.417e-06
## iteration:  38   gain: 1.157e-05
## iteration:  39   gain: 6.934e-06
## iteration:  40   gain: 1.161e-06
## iteration:  41   gain: 2.328e-06
## iteration:  42   gain: 2.936e-06
## iteration:  43   gain: 1.791e-06
## iteration:  44   gain: 3.262e-07
## iteration:  45   gain: 5.743e-07
## iteration:  46   gain: 7.446e-07
## iteration:  47   gain: 4.621e-07
## iteration:  48   gain: 9.089e-08
## iteration:  49   gain: 1.414e-07
## iteration:  50   gain: 1.887e-07
## iteration:  51   gain: 1.192e-07
## iteration:  52   gain: 2.515e-08
## iteration:  53   gain: 3.477e-08
## iteration:  54   gain: 4.781e-08
## iteration:  55   gain: 3.073e-08
## iteration:  56   gain: 6.912e-09
## iteration:  57   gain: 8.527e-09
## iteration:  58   gain: 1.21e-08
## iteration:  59   gain: 7.923e-09
## iteration:  60   gain: 1.892e-09
## iteration:  61   gain: 2.088e-09
## iteration:  62   gain: 3.063e-09
## iteration:  63   gain: 2.041e-09
## iteration:  64   gain: 5.166e-10
## iteration:  65   gain: 5.093e-10
## iteration:  66   gain: 7.785e-10
## iteration:  67   gain: 5.239e-10
## iteration:  68   gain: 1.382e-10
## iteration:  69   gain: 1.237e-10
## iteration:  70   gain: 1.928e-10
## iteration:  71   gain: 1.346e-10
## iteration:  72   gain: 4.002e-11
```

```
RapaFP <- eFourier(RapaP, 12, norm=FALSE)

#by source
plot(PCA(RapaF), "Source") # regular EFT with normalized coefficients
```

```r
plot(PCA(RapaFP), "Source") # Procrustes aligned (normalization of the outlines)
```

```r
# by site
plot(PCA(RapaF), "Site") # regular EFT with normalized coefficients
```

```r
plot(PCA(RapaFP), "Site") # Procrustes aligned (normalization of the outlines)
```

Some embedded plots. “‘