snpReady

Roberto Fritsche Neto

12/2/2016

snpReady example

http://www.genetica.esalq.usp.br/alogamas/R.html

https://github.com/italo-granato/SnpReady

Granato, ISC and Fritsche-Neto, R (2016)

Install

```
library(devtools)
```

```
## Warning: package 'devtools' was built under R version 3.2.5
```

```
install_github("italo-granato/snpReady")
```

```
## Downloading GitHub repo italo-granato/snpReady@master
## from URL https://api.github.com/repos/italo-granato/snpReady/zipball/master
```

```
## Installing snpReady
```

```
## "C:/PROGRA~1/R/R-32~1.2/bin/x64/R" --no-site-file --no-environ --no-save  \
##   --no-restore --quiet CMD INSTALL "C:/Users/Italo  \
##   Granato/AppData/Local/Temp/Rtmp0u9jgT/devtools28f8180a16dd/italo-granato-snpReady-d940117"  \
##   --library="C:/Users/Italo Granato/Documents/R/win-library/3.2"  \
##   --install-tests
```

```
##
```

```
library(snpReady)
```

```
## Loading required package: Matrix
```

```
## Warning: package 'Matrix' was built under R version 3.2.5
```

```
## Loading required package: matrixcalc
```

```
## Warning: package 'matrixcalc' was built under R version 3.2.3
```

uploading the files

A, C, G, and T or A, AB, and B # If base is FALSE dataset must be coded as 0,1,2 # The file's shape can be long or wide # They must be matrices # NA's as missing data (identify when upload the file)

```
geno <- read.table("geno.txt", header = TRUE, na.strings = "NA") # long dataset form
head(geno)
```

```
##   sample     marker allele.1 allele.2
## 1    A01 PHM4468.13        G        G
## 2    A01 PHM2770.19        G        G
## 3    A01 PZA00485.2        A        A
## 4    A01 PZA00522.7        A        A
## 5    A01 PZA00627.1        G        G
## 6    A01 PZA00473.5        G        G
```

```
tail(geno)
```

```
##       sample     marker allele.1 allele.2
## 34491    E12 PHM3963.33        C        C
## 34492    E12 PHM2691.31        G        G
## 34493    E12 PZA03036.6        C        C
## 34494    E12 PHM3337.23        A        C
## 34495    E12 PHM10525.9        G        G
## 34496    E12 PZA01280.2        G        G
```

```
dim(geno)
```

```
## [1] 34496     4
```

```
length(levels(geno$marker)) # number of SNP
```

```
## [1] 539
```

```
length(levels(geno$sample)) # number of lines
```

```
## [1] 64
```

```
geno <- as.matrix(geno)


hapmap <- as.matrix(read.table("hapmap.txt", header = TRUE))
head(hapmap)
```

```
##   marker       chr  pos
## 1 "PHM175.25"  " 1" "  3554762"
## 2 "PZA02129.1" " 1" "  3733167"
## 3 "PZA00181.2" " 1" "  8351543"
## 4 "PHM13094.8" " 1" "  8353186"
## 5 "PZA00175.2" " 1" "  8558256"
## 6 "PZA00447.6" " 1" "  9052677"
```

```
dim(hapmap)
```

```
## [1] 539   3
```

raw data()

Reshape, quality control, inputation, and recode the dataset. It also clean the hapmap based on the procedures done in the raw dataset

Input based on these probabilities: # AA = pi^2 + pi(1-pi)Fj # Aa = 2pi(1-pi) - 2pi(1-pi)Fj # aa = (1-pi)^2 + pi(1-pi)*Fj Where pi is the frequency of the major allele for an specific SNP i, and Fj is the level of homosigosity of individual j In average 62% of coincidence - it depends on many factors

call rate : missing data for SNP sweep.sample: missing data for individuals

```
args(raw.data)
```

```
## function (data, frame = c("long", "wide"), hapmap, base = TRUE,
##     sweep.sample = 1, call.rate = 0.95, maf = 0.05, input = TRUE,
##     outfile = c("012", "-101", "structure"))
## NULL
```

```
geno.ready <- raw.data(data = geno, frame = "long", base = TRUE, hapmap = hapmap, sweep.sample = 0.5, ca

system.time(geno.ready <- raw.data(data = geno, frame = "long", base = TRUE, hapmap = hapmap, sweep.samp
```

```
##    user  system elapsed
##    0.25    0.00    0.25
```

```
report <- geno.ready$report
report
```

```
## [[1]]
## [1] "67 Markers removed by MAF = 0.1"
##
## [[2]]
##  [1] "PHM10750.26" "PHM12693.8"  "PHM12904.7"  "PHM1506.23"  "PHM15871.11"
##  [6] "PHM16605.19" "PHM175.25"   "PHM18705.23" "PHM2159.8"   "PHM2177.85"
## [11] "PHM2770.19"  "PHM2773.30"  "PHM3612.19"  "PHM3637.15"  "PHM3688.14"
## [16] "PHM3690.23"  "PHM3691.15"  "PHM3691.18"  "PHM3931.17"  "PHM424.13"
## [21] "PHM424.16"   "PHM4313.17"  "PHM4339.79"  "PHM4349.6"   "PHM4469.13"
## [26] "PHM4552.6"   "PHM4662.153" "PHM4757.14"  "PHM4951.8"   "PHM5529.4"
## [31] "PHM5535.8"   "PHM5727.5"   "PHM574.14"   "PHM5740.9"   "PHM7616.35"
## [36] "PHM8074.6"   "PHM835.25"   "PHM9672.9"   "PZA00103.20" "PZA00192.6"
## [41] "PZA00213.19" "PZA00216.2"  "PZA00276.18" "PZA00344.10" "PZA00381.3"
## [46] "PZA00425.9"  "PZA00525.17" "PZA00573.3"  "PZA00615.3"  "PZA00658.19"
## [51] "PZA00730.2"  "PZA00804.1"  "PZA00878.2"  "PZA00881.1"  "PZA01790.1"
## [56] "PZA02151.3"  "PZA02167.2"  "PZA02820.17" "PZA02850.18" "PZA02921.9"
## [61] "PZA02923.7"  "PZA02949.22" "PZA02952.10" "PZA03011.6"  "PZA03035.5"
## [66] "PZA03063.18" "PZA03083.7"
```

```
##
## [[3]]
## [1] "201 Markers removed by Call Rate = 0.95"
##
## [[4]]
##   [1] "PHM10404.8"   "PHM10525.11"  "PHM112.8"     "PHM11226.13"
##   [5] "PHM1155.14"   "PHM11985.27"  "PHM12323.17"  "PHM12992.5"
##   [9] "PHM1307.11"   "PHM13094.8"   "PHM13639.13"  "PHM13648.11"
##  [13] "PHM13675.18"  "PHM13823.7"   "PHM1438.34"   "PHM14618.11"
##  [17] "PHM14671.9"   "PHM1505.31"   "PHM1506.23"   "PHM1511.14"
##  [21] "PHM15331.16"  "PHM1534.45"   "PHM15449.10"  "PHM15501.9"
##  [25] "PHM15961.13"  "PHM1684.20"   "PHM1745.16"   "PHM175.25"
##  [29] "PHM17698.8"   "PHM18513.156" "PHM1870.20"   "PHM18887.12"
##  [33] "PHM1899.157"  "PHM1932.51"   "PHM1978.111"  "PHM2006.57"
##  [37] "PHM2177.85"   "PHM229.15"    "PHM2343.25"   "PHM2350.14"
##  [41] "PHM2487.6"    "PHM259.11"    "PHM2691.31"   "PHM2749.10"
##  [45] "PHM3094.23"   "PHM3147.18"   "PHM3155.14"   "PHM3171.5"
##  [49] "PHM3309.8"    "PHM3337.23"   "PHM3463.18"   "PHM351.36"
##  [53] "PHM3512.186"  "PHM3626.3"    "PHM3627.11"   "PHM3631.47"
##  [57] "PHM3668.12"   "PHM3676.33"   "PHM3691.18"   "PHM3844.14"
##  [61] "PHM3852.15"   "PHM3963.33"   "PHM4196.27"   "PHM4348.16"
##  [65] "PHM4662.153"  "PHM4720.12"   "PHM4818.15"   "PHM4880.179"
##  [69] "PHM4905.6"    "PHM5158.13"   "PHM5181.10"   "PHM5296.6"
##  [73] "PHM533.46"    "PHM5480.17"   "PHM5572.19"   "PHM5622.21"
##  [77] "PHM563.9"     "PHM5637.15"   "PHM574.14"    "PHM5798.39"
##  [81] "PHM5805.19"   "PHM5822.15"   "PHM597.18"    "PHM662.27"
##  [85] "PHM7417.21"   "PHM7898.10"   "PHM8074.6"    "PHM8527.2"
##  [89] "PHM904.21"    "PHM9162.135"  "PHM9241.13"   "PHM9418.11"
##  [93] "PHM9635.30"   "PHM9676.10"   "PHM9914.11"   "PZA00004.2"
##  [97] "PZA00006.13"  "PZA00010.5"   "PZA00049.12"  "PZA00050.9"
## [101] "PZA00058.5"   "PZA00061.1"   "PZA00084.2"   "PZA00099.6"
## [105] "PZA00153.3"   "PZA00182.4"   "PZA00188.1"   "PZA00192.6"
## [109] "PZA00193.2"   "PZA00214.1"   "PZA00216.2"   "PZA00219.7"
## [113] "PZA00220.11"  "PZA00233.8"   "PZA00276.18"  "PZA00289.11"
## [117] "PZA00311.4"   "PZA00323.3"   "PZA00332.5"   "PZA00334.2"
## [121] "PZA00345.15"  "PZA00395.2"   "PZA00399.10"  "PZA00405.7"
## [125] "PZA00423.16"  "PZA00425.9"   "PZA00439.6"   "PZA00447.6"
## [129] "PZA00449.2"   "PZA00453.2"   "PZA00463.3"   "PZA00473.5"
## [133] "PZA00492.26"  "PZA00494.2"   "PZA00516.3"   "PZA00522.7"
## [137] "PZA00524.2"   "PZA00525.17"  "PZA00540.3"   "PZA00562.4"
## [141] "PZA00588.2"   "PZA00603.1"   "PZA00636.6"   "PZA00653.5"
## [145] "PZA00670.2"   "PZA00672.6"   "PZA00684.12"  "PZA00714.1"
## [149] "PZA00725.4"   "PZA00730.2"   "PZA00804.1"   "PZA00881.1"
## [153] "PZA00934.2"   "PZA00941.2"   "PZA01073.1"   "PZA01280.2"
## [157] "PZA01327.1"   "PZA01342.2"   "PZA01359.1"   "PZA01451.1"
## [161] "PZA01462.1"   "PZA01623.3"   "PZA01713.4"   "PZA01715.1"
## [165] "PZA01751.2"   "PZA01765.1"   "PZA01796.1"   "PZA01810.2"
## [169] "PZA01866.1"   "PZA01887.1"   "PZA01946.7"   "PZA02049.1"
## [173] "PZA02058.1"   "PZA02090.1"   "PZA02247.1"   "PZA02249.4"
## [177] "PZA02462.1"   "PZA02478.7"   "PZA02688.2"   "PZA02727.1"
## [181] "PZA02731.1"   "PZA02746.2"   "PZA02779.1"   "PZA02820.17"
## [185] "PZA02872.1"   "PZA02890.4"   "PZA02948.21"  "PZA02949.22"
## [189] "PZA02957.5"   "PZA02958.17"  "PZA03027.23"  "PZA03028.5"
## [193] "PZA03036.6"   "PZA03043.14"  "PZA03063.18"  "PZA03076.10"
```

```
## [197] "PZA03090.31"  "PZA03092.7"   "PZA03527.1"   "PZA03659.1"
## [201] "PZB00752.1"
##
## [[5]]
## [1] "2 Samples removed by sweep.sample = 0.5"
##
## [[6]]
## [1] "E08" "E09"
##
## [[7]]
## [1] "273 markers were inputed =  1.52 %"
```

```
M.clean <- geno.ready$M.clean
dim(M.clean)
```

```
## [1]  62 289
```

```
M.clean[1:5,1:5]
```

```
##     PHM10225.15 PHM10321.11 PHM10525.9 PHM11000.21 PHM11114.7
## A01           2           0          0           0          0
## A02           1           2          2           0          0
## A03           2           0          0           0          0
## A04           2           0          2           0          0
## A05           2           0          2           2          2
```

```
hapmap.clean <- geno.ready$Hapmap
dim(hapmap.clean)
```

```
## [1] 289   3
```

```
head(hapmap.clean)
```

```
##    SNP          Chromosome Position
## 2  "PZA02129.1" " 1"       "  3733167"
## 3  "PZA00181.2" " 1"       "  8351543"
## 5  "PZA00175.2" " 1"       "  8558256"
## 7  "PZA00731.6" " 1"       "  9304156"
## 8  "PHM1653.31" " 1"       " 14959203"
## 10 "PHM13619.5" " 1"       " 22253283"
```

G.matrix()

estimates the G matrix: A nd D by three different methods two shapes: wide (n x n matrix) and long (ASREML-R)

```
args(G.matrix)
```

```
## function (M, method = c("VanRaden", "UAR", "UARadj"), format = c("wide",
##     "long"))
## NULL
```

```
system.time(G <- G.matrix(M = M.clean, method = "VanRaden", format = "wide") )
```

```
##    user  system elapsed
##    0.00    0.00    0.02
```

```
Ga <- G$Ga
Ga[1:5,1:5]
```

```
##             A01         A02         A03         A04         A05
## A01  1.83965493 -0.37245854 -0.04124009 -0.18947368 -0.17058399
## A02 -0.37245854  1.81398802  0.00850757 -0.05926460 -0.03143475
## A03 -0.04124009  0.00850757  1.75227209 -0.03201154 -0.03994232
## A04 -0.18947368 -0.05926460 -0.03201154  1.76871044  0.10684932
## A05 -0.17058399 -0.03143475 -0.03994232  0.10684932  2.00317331
```

```
Gd <- G$Gd
Gd[1:5,1:5]
```

```
##           A01       A02       A03       A04       A05
## A01 0.9273716 0.3834356 0.4354469 0.4192377 0.5058063
## A02 0.3834356 0.9309476 0.3542343 0.4173512 0.4711254
## A03 0.4354469 0.3542343 0.8458722 0.4063139 0.4735671
## A04 0.4192377 0.4173512 0.4063139 0.8537503 0.4796345
## A05 0.5058063 0.4711254 0.4735671 0.4796345 1.0518828
```

popgen()

Estimate DG, PIC, MAF, He, Ho, Fst, S, Ne for whole population and for each group Identify fixed alleles and exclusive allelos

```
args(popgen)
```

```
## function (M, subgroups)
## NULL
```

```
# need information of subpopulations
subgroups <- as.matrix(c(rep("HNE", 10), rep("LNE", 52)))
dim(subgroups)
```

```
## [1] 62  1
```

```
t(subgroups)
```

```
##      [,1]  [,2]  [,3]  [,4]  [,5]  [,6]  [,7]  [,8]  [,9]  [,10] [,11]
## [1,] "HNE" "HNE" "HNE" "HNE" "HNE" "HNE" "HNE" "HNE" "HNE" "HNE" "LNE"
##      [,12] [,13] [,14] [,15] [,16] [,17] [,18] [,19] [,20] [,21] [,22]
## [1,] "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE"
##      [,23] [,24] [,25] [,26] [,27] [,28] [,29] [,30] [,31] [,32] [,33]
## [1,] "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE"
##      [,34] [,35] [,36] [,37] [,38] [,39] [,40] [,41] [,42] [,43] [,44]
## [1,] "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE"
##      [,45] [,46] [,47] [,48] [,49] [,50] [,51] [,52] [,53] [,54] [,55]
## [1,] "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE"
##      [,56] [,57] [,58] [,59] [,60] [,61] [,62]
## [1,] "LNE" "LNE" "LNE" "LNE" "LNE" "LNE" "LNE"
```

```
system.time(pop.gen <- popgen(M = M.clean, subgroups = subgroups))
```

```
##    user  system elapsed
##    0.06    0.00    0.06
```

```
# for whole population
head(pop.gen$general[[1]])
```

```
##                p    q  MAF   He   Ho   DG  PIC
## PHM10225.15 0.90 0.10 0.10 0.19 0.01 0.19 0.17
## PHM10321.11 0.32 0.68 0.32 0.44 0.02 0.44 0.34
## PHM10525.9  0.74 0.26 0.26 0.38 0.00 0.38 0.31
## PHM11000.21 0.15 0.85 0.15 0.25 0.02 0.25 0.22
## PHM11114.7  0.45 0.55 0.45 0.50 0.02 0.50 0.37
## PHM11946.17 0.27 0.73 0.27 0.40 0.00 0.40 0.32
```

```
head(pop.gen$general[[2]])
```

```
##       Ho   Fi   Si
## A01 0.01 0.97 0.98
## A02 0.03 0.92 0.96
## A03 0.01 0.98 0.99
## A04 0.01 0.98 0.99
## A05 0.02 0.96 0.98
## A06 0.02 0.95 0.97
```

```
pop.gen$general[[3]]
```

```
##     mean lower upper
## DG  0.39  0.17  0.50
## PIC 0.31  0.16  0.38
## MAF 0.29  0.10  0.50
## Ho  0.02  0.00  0.07
## F   0.95  0.82  1.00
## S   0.98  0.90  1.00
```

```
pop.gen$general[[4]]
```

```
##                      estimate
## Ne                      32.50
## Va                     111.85
## Vd                      46.18
## number.of.groups         2.00
## number.of.genotypes     62.00
## number.of.markers      289.00
```

```
# by group
pop.gen$bygroup$`1`
```

```
## $markers
##                  p    q  MAF   He   Ho   DG  PIC
## PHM10225.15 0.95 0.05 0.05 0.10 0.05 0.10 0.09
## PHM10321.11 0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM10525.9  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM11000.21 0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM11114.7  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM11946.17 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM1218.6   0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM12625.18 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM12706.14 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM12749.13 0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PHM12794.47 0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM13020.10 0.70 0.30 0.30 0.42 0.10 0.42 0.33
## PHM13174.18 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM13183.12 0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM13191.8  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM13420.11 0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM13440.11 0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM13451.15 0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM13619.5  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM13673.53 0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM13681.12 0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM13696.11 0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PHM13942.10 0.60 0.40 0.40 0.48 0.10 0.48 0.36
## PHM14046.9  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PHM1447.89  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PHM14475.7  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PHM14519.8  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PHM15251.3  0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM15251.5  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PHM15278.6  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM15427.11 0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM15474.5  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM15475.27 0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM1572.17  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM15744.10 0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM1576.25  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PHM16125.47 0.10 0.90 0.10 0.18 0.00 0.18 0.16
```

```
## PHM1653.31  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PHM16607.11 0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM16788.6  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PHM17210.5  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PHM1725.34  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PHM1752.36  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM1766.1   0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM1812.32  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PHM18195.6  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM191.12   0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM191.18   0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM1911.173 0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM1956.90  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM1959.26  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM1962.33  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM1968.22  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM1971.20  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PHM2187.46  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PHM2350.17  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PHM2438.28  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM2518.28  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PHM2672.19  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PHM2769.43  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM2828.83  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM2865.8   0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM2871.188 0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM2885.31  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM3034.3   0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PHM3078.12  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM3103.47  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM3112.5   0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM3312.23  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM3342.31  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM3352.19  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PHM3402.11  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM3435.6   0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM3457.6   0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM3587.6   0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM3712.18  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PHM3736.11  0.40 0.60 0.40 0.48 0.10 0.48 0.36
## PHM3856.10  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM3896.9   0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM3922.32  0.20 0.80 0.20 0.32 0.10 0.32 0.27
## PHM4135.15  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PHM4145.18  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM4165.14  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PHM4185.17  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM4303.16  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PHM4310.112 0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PHM4353.31  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM4468.13  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PHM448.23   0.95 0.05 0.05 0.10 0.05 0.10 0.09
## PHM4512.38  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM4531.46  1.00 0.00 0.00 0.00 0.00 0.00 0.00
```

```
## PHM4560.54  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PHM4597.14  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM4620.24  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM4647.8   0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM4677.11  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM4748.16  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM4752.14  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM4942.12  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM4955.12  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM4978.27  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PHM4992.10  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM5232.11  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM5235.8   0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PHM5306.16  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM532.23   0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM5359.10  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PHM5395.34  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM5481.94  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM5502.31  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM5526.25  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM565.31   0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM5665.26  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM5794.13  0.70 0.30 0.30 0.42 0.10 0.42 0.33
## PHM5817.15  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM595.30   0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM6111.5   0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PHM635.23   0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PHM6386.11  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PHM759.24   0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PHM765.24   0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PHM7916.4   0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PHM7922.8   0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM793.25   0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM7953.11  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PHM816.25   0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM816.29   0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PHM8327.18  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PHM8352.4   0.95 0.05 0.05 0.10 0.05 0.10 0.09
## PHM8828.7   0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PHM8909.12  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PHM9009.13  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PHM934.19   0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PHM9807.9   0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00005.5  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA00043.1  0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PZA00045.1  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA00060.2  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA00069.4  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00078.2  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PZA00088.3  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00102.8  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA00108.12 1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00109.3  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA00112.4  0.30 0.70 0.30 0.42 0.00 0.42 0.33
```

```
## PZA00125.2  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PZA00130.9  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00139.4  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00143.5  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00155.1  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00163.4  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PZA00175.2  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA00177.4  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00181.2  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00200.8  0.40 0.60 0.40 0.48 0.10 0.48 0.36
## PZA00205.7  0.30 0.70 0.30 0.42 0.10 0.42 0.33
## PZA00218.1  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00234.19 0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PZA00235.6  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00243.24 0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA00245.14 0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA00255.15 0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA00256.27 0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00266.5  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00294.20 0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA00300.11 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA00309.1  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00310.5  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PZA00328.1  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00337.3  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA00348.11 0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00364.2  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PZA00367.6  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00369.1  0.95 0.05 0.05 0.10 0.05 0.10 0.09
## PZA00378.9  0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PZA00379.2  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00385.1  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA00396.9  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00398.4  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PZA00403.5  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PZA00422.2  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PZA00436.7  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00462.2  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA00472.2  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA00485.2  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00503.5  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA00511.3  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA00527.6  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA00536.2  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA00543.2  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA00566.5  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00568.19 0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00571.2  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA00578.1  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00587.3  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PZA00623.2  0.05 0.95 0.05 0.10 0.05 0.10 0.09
## PZA00627.1  0.80 0.20 0.20 0.32 0.10 0.32 0.27
## PZA00637.4  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA00647.9  0.85 0.15 0.15 0.26 0.05 0.26 0.22
```

```
## PZA00663.5  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA00664.3  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00667.1  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA00680.3  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00682.2  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00695.1  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA00731.6  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA00749.1  0.05 0.95 0.05 0.10 0.05 0.10 0.09
## PZA00755.2  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00795.1  0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PZA00817.2  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA00824.2  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA00827.1  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA00856.2  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA00904.1  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PZA00908.2  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA00920.1  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA00981.3  0.50 0.50 0.50 0.50 0.10 0.50 0.38
## PZA00987.1  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA01257.1  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA01289.1  0.15 0.85 0.15 0.26 0.05 0.26 0.22
## PZA01292.1  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA01294.1  0.55 0.45 0.45 0.50 0.15 0.50 0.37
## PZA01321.1  0.75 0.25 0.25 0.38 0.05 0.38 0.30
## PZA01332.2  0.60 0.40 0.40 0.48 0.00 0.48 0.36
## PZA01386.3  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA01396.1  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA01456.2  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA01468.1  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA01470.1  0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA01477.3  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA01537.2  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA01613.1  0.30 0.70 0.30 0.42 0.10 0.42 0.33
## PZA01618.2  0.20 0.80 0.20 0.32 0.10 0.32 0.27
## PZA01672.1  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA01753.1  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PZA01791.2  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA01884.1  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PZA01935.10 1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA01978.23 0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA01983.1  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PZA02012.7  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02048.2  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA02129.1  0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA02138.1  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA02148.1  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PZA02174.2  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA02209.2  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02239.12 0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA02266.3  0.80 0.20 0.20 0.32 0.10 0.32 0.27
## PZA02281.3  0.10 0.90 0.10 0.18 0.00 0.18 0.16
## PZA02299.16 0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02337.4  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02344.1  0.50 0.50 0.50 0.50 0.00 0.50 0.38
```

```
## PZA02358.1  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA02359.10 0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PZA02383.1  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA02402.1  0.45 0.55 0.45 0.50 0.05 0.49 0.37
## PZA02418.2  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA02457.1  0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA02519.7  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA02577.1  0.25 0.75 0.25 0.38 0.05 0.38 0.30
## PZA02589.1  0.55 0.45 0.45 0.50 0.05 0.50 0.37
## PZA02633.4  0.90 0.10 0.10 0.18 0.00 0.18 0.16
## PZA02665.2  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02722.1  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA02763.1  0.80 0.20 0.20 0.32 0.00 0.32 0.27
## PZA02792.16 0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA02811.4  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA02812.43 0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA02817.15 0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA02818.10 0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA02862.10 0.85 0.15 0.15 0.26 0.05 0.26 0.22
## PZA02938.3  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA02945.10 0.35 0.65 0.35 0.45 0.15 0.46 0.35
## PZA02964.7  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA02965.13 0.50 0.50 0.50 0.50 0.10 0.50 0.38
## PZA02966.11 0.50 0.50 0.50 0.50 0.00 0.50 0.38
## PZA02969.9  0.30 0.70 0.30 0.42 0.00 0.42 0.33
## PZA02981.2  0.20 0.80 0.20 0.32 0.00 0.32 0.27
## PZA02982.5  0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA02993.14 0.00 1.00 0.00 0.00 0.00 0.00 0.00
## PZA03005.19 0.65 0.35 0.35 0.45 0.05 0.45 0.35
## PZA03024.16 0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA03047.12 0.60 0.40 0.40 0.48 0.10 0.48 0.36
## PZA03062.7  0.70 0.30 0.30 0.42 0.00 0.42 0.33
## PZA03064.6  0.40 0.60 0.40 0.48 0.00 0.48 0.36
## PZA03067.17 0.35 0.65 0.35 0.45 0.05 0.46 0.35
## PZA03559.1  1.00 0.00 0.00 0.00 0.00 0.00 0.00
## PZA03583.1  0.75 0.25 0.25 0.38 0.15 0.38 0.30
##
## $genotypes
##       Ho   Fi   Si
## A01 0.01 0.96 0.98
## A02 0.03 0.91 0.96
## A03 0.01 0.98 0.99
## A04 0.01 0.97 0.99
## A05 0.02 0.95 0.98
## A06 0.02 0.94 0.97
## A07 0.06 0.84 0.91
## A08 0.01 0.98 0.99
## A09 0.02 0.93 0.96
## A10 0.03 0.91 0.96
##
## $population
##     mean lower upper
## DG  0.34  0.00  0.50
## PIC 0.27  0.00  0.38
```

```
## MAF 0.26  0.00  0.50
## Ho  0.02  0.01  0.06
## F   0.94  0.84  0.98
## S   0.97  0.91  0.99
##
## $variability
##                      estimate
## Ne                       5.32
## Va                      98.92
## Vd                      40.60
## number.of.groups         1.00
## number.of.genotypes     10.00
## number.of.markers      289.00
```

```
pop.gen$bygroup$`2`
```

```
## $markers
##                 p    q  MAF   He   Ho   DG  PIC
## PHM10225.15 0.88 0.12 0.12 0.20 0.00 0.20 0.18
## PHM10321.11 0.33 0.67 0.33 0.44 0.02 0.44 0.34
## PHM10525.9  0.75 0.25 0.25 0.38 0.00 0.38 0.30
## PHM11000.21 0.15 0.85 0.15 0.26 0.02 0.26 0.23
## PHM11114.7  0.50 0.50 0.50 0.50 0.02 0.50 0.38
## PHM11946.17 0.25 0.75 0.25 0.38 0.00 0.38 0.30
## PHM1218.6   0.16 0.84 0.16 0.27 0.01 0.27 0.24
## PHM12625.18 0.39 0.61 0.39 0.48 0.03 0.48 0.36
## PHM12706.14 0.40 0.60 0.40 0.48 0.04 0.48 0.37
## PHM12749.13 0.43 0.57 0.43 0.49 0.03 0.49 0.37
## PHM12794.47 0.72 0.28 0.28 0.40 0.01 0.40 0.32
## PHM13020.10 0.88 0.12 0.12 0.20 0.02 0.20 0.18
## PHM13174.18 0.30 0.70 0.30 0.42 0.01 0.42 0.33
## PHM13183.12 0.88 0.12 0.12 0.20 0.02 0.20 0.18
## PHM13191.8  0.68 0.32 0.32 0.43 0.01 0.43 0.34
## PHM13420.11 0.47 0.53 0.47 0.50 0.01 0.50 0.37
## PHM13440.11 0.62 0.38 0.38 0.47 0.01 0.47 0.36
## PHM13451.15 0.12 0.88 0.12 0.22 0.01 0.22 0.19
## PHM13619.5  0.85 0.15 0.15 0.26 0.00 0.26 0.23
## PHM13673.53 0.89 0.11 0.11 0.19 0.01 0.19 0.17
## PHM13681.12 0.79 0.21 0.21 0.33 0.00 0.33 0.28
## PHM13696.11 0.28 0.72 0.28 0.40 0.03 0.40 0.32
## PHM13942.10 0.45 0.55 0.45 0.50 0.03 0.50 0.37
## PHM14046.9  0.25 0.75 0.25 0.38 0.02 0.38 0.30
## PHM1447.89  0.53 0.47 0.47 0.50 0.03 0.50 0.37
## PHM14475.7  0.18 0.82 0.18 0.30 0.01 0.30 0.25
## PHM14519.8  0.80 0.20 0.20 0.32 0.01 0.32 0.27
## PHM15251.3  0.49 0.51 0.49 0.50 0.03 0.50 0.37
## PHM15251.5  0.54 0.46 0.46 0.50 0.02 0.50 0.37
## PHM15278.6  0.31 0.69 0.31 0.43 0.02 0.43 0.34
## PHM15427.11 0.39 0.61 0.39 0.48 0.01 0.48 0.36
## PHM15474.5  0.64 0.36 0.36 0.46 0.03 0.46 0.35
## PHM15475.27 0.34 0.66 0.34 0.45 0.05 0.45 0.35
## PHM1572.17  0.62 0.38 0.38 0.47 0.05 0.47 0.36
## PHM15744.10 0.76 0.24 0.24 0.37 0.01 0.37 0.30
## PHM1576.25  0.82 0.18 0.18 0.30 0.01 0.30 0.25
```

```
## PHM16125.47 0.29 0.71 0.29 0.41 0.02 0.41 0.33
## PHM1653.31  0.36 0.64 0.36 0.46 0.01 0.46 0.35
## PHM16607.11 0.88 0.12 0.12 0.20 0.02 0.20 0.18
## PHM16788.6  0.77 0.23 0.23 0.36 0.02 0.36 0.29
## PHM17210.5  0.51 0.49 0.49 0.50 0.03 0.50 0.37
## PHM1725.34  0.33 0.67 0.33 0.44 0.02 0.44 0.34
## PHM1752.36  0.84 0.16 0.16 0.27 0.01 0.27 0.24
## PHM1766.1   0.34 0.66 0.34 0.45 0.01 0.45 0.35
## PHM1812.32  0.77 0.23 0.23 0.36 0.00 0.36 0.29
## PHM18195.6  0.41 0.59 0.41 0.49 0.03 0.49 0.37
## PHM191.12   0.38 0.62 0.38 0.47 0.02 0.47 0.36
## PHM191.18   0.62 0.38 0.38 0.47 0.02 0.47 0.36
## PHM1911.173 0.73 0.27 0.27 0.39 0.02 0.39 0.32
## PHM1956.90  0.19 0.81 0.19 0.31 0.02 0.31 0.26
## PHM1959.26  0.26 0.74 0.26 0.38 0.01 0.38 0.31
## PHM1962.33  0.35 0.65 0.35 0.45 0.00 0.45 0.35
## PHM1968.22  0.52 0.48 0.48 0.50 0.02 0.50 0.37
## PHM1971.20  0.56 0.44 0.44 0.49 0.02 0.49 0.37
## PHM2187.46  0.88 0.12 0.12 0.20 0.02 0.20 0.18
## PHM2350.17  0.49 0.51 0.49 0.50 0.03 0.50 0.37
## PHM2438.28  0.34 0.66 0.34 0.45 0.01 0.45 0.35
## PHM2518.28  0.85 0.15 0.15 0.26 0.00 0.26 0.23
## PHM2672.19  0.67 0.33 0.33 0.44 0.02 0.44 0.34
## PHM2769.43  0.31 0.69 0.31 0.43 0.00 0.43 0.34
## PHM2828.83  0.58 0.42 0.42 0.49 0.04 0.49 0.37
## PHM2865.8   0.70 0.30 0.30 0.42 0.03 0.42 0.33
## PHM2871.188 0.12 0.88 0.12 0.20 0.00 0.20 0.18
## PHM2885.31  0.20 0.80 0.20 0.32 0.01 0.32 0.27
## PHM3034.3   0.67 0.33 0.33 0.44 0.04 0.44 0.34
## PHM3078.12  0.25 0.75 0.25 0.38 0.04 0.38 0.30
## PHM3103.47  0.33 0.67 0.33 0.44 0.02 0.44 0.34
## PHM3112.5   0.86 0.14 0.14 0.25 0.01 0.25 0.22
## PHM3312.23  0.20 0.80 0.20 0.32 0.03 0.32 0.27
## PHM3342.31  0.19 0.81 0.19 0.31 0.00 0.31 0.26
## PHM3352.19  0.24 0.76 0.24 0.37 0.03 0.37 0.30
## PHM3402.11  0.19 0.81 0.19 0.31 0.00 0.31 0.26
## PHM3435.6   0.26 0.74 0.26 0.38 0.03 0.38 0.31
## PHM3457.6   0.36 0.64 0.36 0.46 0.01 0.46 0.35
## PHM3587.6   0.83 0.17 0.17 0.29 0.04 0.29 0.25
## PHM3712.18  0.09 0.91 0.09 0.16 0.03 0.16 0.15
## PHM3736.11  0.44 0.56 0.44 0.49 0.06 0.49 0.37
## PHM3856.10  0.87 0.13 0.13 0.23 0.00 0.23 0.21
## PHM3896.9   0.88 0.12 0.12 0.22 0.01 0.22 0.19
## PHM3922.32  0.24 0.76 0.24 0.37 0.01 0.37 0.30
## PHM4135.15  0.24 0.76 0.24 0.37 0.01 0.37 0.30
## PHM4145.18  0.31 0.69 0.31 0.43 0.02 0.43 0.34
## PHM4165.14  0.44 0.56 0.44 0.49 0.02 0.49 0.37
## PHM4185.17  0.91 0.09 0.09 0.16 0.01 0.16 0.15
## PHM4303.16  0.11 0.89 0.11 0.19 0.01 0.19 0.17
## PHM4310.112 0.74 0.26 0.26 0.38 0.01 0.38 0.31
## PHM4353.31  0.78 0.22 0.22 0.34 0.03 0.34 0.29
## PHM4468.13  0.62 0.38 0.38 0.47 0.00 0.47 0.36
## PHM448.23   0.69 0.31 0.31 0.43 0.00 0.43 0.34
## PHM4512.38  0.49 0.51 0.49 0.50 0.01 0.50 0.37
```

```
## PHM4531.46  0.88 0.12 0.12 0.22 0.01 0.22 0.19
## PHM4560.54  0.87 0.13 0.13 0.23 0.00 0.23 0.21
## PHM4597.14  0.45 0.55 0.45 0.50 0.01 0.50 0.37
## PHM4620.24  0.89 0.11 0.11 0.19 0.01 0.19 0.17
## PHM4647.8   0.17 0.83 0.17 0.29 0.02 0.29 0.25
## PHM4677.11  0.65 0.35 0.35 0.45 0.00 0.45 0.35
## PHM4748.16  0.09 0.91 0.09 0.16 0.01 0.16 0.15
## PHM4752.14  0.39 0.61 0.39 0.48 0.01 0.48 0.36
## PHM4942.12  0.59 0.41 0.41 0.49 0.03 0.49 0.37
## PHM4955.12  0.25 0.75 0.25 0.38 0.02 0.38 0.30
## PHM4978.27  0.25 0.75 0.25 0.38 0.02 0.38 0.30
## PHM4992.10  0.25 0.75 0.25 0.38 0.02 0.38 0.30
## PHM5232.11  0.49 0.51 0.49 0.50 0.03 0.50 0.37
## PHM5235.8   0.73 0.27 0.27 0.39 0.00 0.39 0.32
## PHM5306.16  0.47 0.53 0.47 0.50 0.05 0.50 0.37
## PHM532.23   0.17 0.83 0.17 0.29 0.02 0.29 0.25
## PHM5359.10  0.69 0.31 0.31 0.43 0.02 0.43 0.34
## PHM5395.34  0.16 0.84 0.16 0.27 0.01 0.27 0.24
## PHM5481.94  0.89 0.11 0.11 0.19 0.03 0.19 0.17
## PHM5502.31  0.55 0.45 0.45 0.50 0.01 0.50 0.37
## PHM5526.25  0.52 0.48 0.48 0.50 0.02 0.50 0.37
## PHM565.31   0.43 0.57 0.43 0.49 0.01 0.49 0.37
## PHM5665.26  0.61 0.39 0.39 0.48 0.01 0.48 0.36
## PHM5794.13  0.68 0.32 0.32 0.43 0.03 0.43 0.34
## PHM5817.15  0.31 0.69 0.31 0.43 0.00 0.43 0.34
## PHM595.30   0.75 0.25 0.25 0.38 0.04 0.38 0.30
## PHM6111.5   0.44 0.56 0.44 0.49 0.04 0.49 0.37
## PHM635.23   0.30 0.70 0.30 0.42 0.03 0.42 0.33
## PHM6386.11  0.79 0.21 0.21 0.33 0.02 0.33 0.28
## PHM759.24   0.18 0.82 0.18 0.30 0.03 0.30 0.25
## PHM765.24   0.12 0.88 0.12 0.20 0.00 0.20 0.18
## PHM7916.4   0.65 0.35 0.35 0.45 0.00 0.45 0.35
## PHM7922.8   0.30 0.70 0.30 0.42 0.01 0.42 0.33
## PHM793.25   0.37 0.63 0.37 0.46 0.02 0.46 0.36
## PHM7953.11  0.62 0.38 0.38 0.47 0.03 0.47 0.36
## PHM816.25   0.58 0.42 0.42 0.49 0.00 0.49 0.37
## PHM816.29   0.57 0.43 0.43 0.49 0.01 0.49 0.37
## PHM8327.18  0.52 0.48 0.48 0.50 0.04 0.50 0.37
## PHM8352.4   0.72 0.28 0.28 0.40 0.03 0.40 0.32
## PHM8828.7   0.25 0.75 0.25 0.38 0.02 0.38 0.30
## PHM8909.12  0.61 0.39 0.39 0.48 0.01 0.48 0.36
## PHM9009.13  0.23 0.77 0.23 0.36 0.02 0.36 0.29
## PHM934.19   0.15 0.85 0.15 0.26 0.02 0.26 0.23
## PHM9807.9   0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA00005.5  0.42 0.58 0.42 0.49 0.04 0.49 0.37
## PZA00043.1  0.65 0.35 0.35 0.45 0.04 0.45 0.35
## PZA00045.1  0.53 0.47 0.47 0.50 0.03 0.50 0.37
## PZA00060.2  0.71 0.29 0.29 0.41 0.00 0.41 0.33
## PZA00069.4  0.66 0.34 0.34 0.45 0.01 0.45 0.35
## PZA00078.2  0.18 0.82 0.18 0.30 0.05 0.30 0.25
## PZA00088.3  0.83 0.17 0.17 0.29 0.00 0.29 0.25
## PZA00102.8  0.12 0.88 0.12 0.20 0.00 0.20 0.18
## PZA00108.12 0.85 0.15 0.15 0.26 0.00 0.26 0.23
## PZA00109.3  0.29 0.71 0.29 0.41 0.02 0.41 0.33
```

```
## PZA00112.4  0.62 0.38 0.38 0.47 0.02 0.47 0.36
## PZA00125.2  0.30 0.70 0.30 0.42 0.03 0.42 0.33
## PZA00130.9  0.65 0.35 0.35 0.45 0.02 0.45 0.35
## PZA00139.4  0.61 0.39 0.39 0.48 0.01 0.48 0.36
## PZA00143.5  0.71 0.29 0.29 0.41 0.00 0.41 0.33
## PZA00155.1  0.87 0.13 0.13 0.23 0.00 0.23 0.21
## PZA00163.4  0.33 0.67 0.33 0.44 0.04 0.44 0.34
## PZA00175.2  0.47 0.53 0.47 0.50 0.05 0.50 0.37
## PZA00177.4  0.37 0.63 0.37 0.46 0.02 0.46 0.36
## PZA00181.2  0.28 0.72 0.28 0.40 0.01 0.40 0.32
## PZA00200.8  0.29 0.71 0.29 0.41 0.04 0.41 0.33
## PZA00205.7  0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA00218.1  0.30 0.70 0.30 0.42 0.03 0.42 0.33
## PZA00234.19 0.81 0.19 0.19 0.31 0.00 0.31 0.26
## PZA00235.6  0.81 0.19 0.19 0.31 0.02 0.31 0.26
## PZA00243.24 0.39 0.61 0.39 0.48 0.03 0.48 0.36
## PZA00245.14 0.12 0.88 0.12 0.20 0.00 0.20 0.18
## PZA00255.15 0.84 0.16 0.16 0.27 0.01 0.27 0.24
## PZA00256.27 0.85 0.15 0.15 0.26 0.06 0.26 0.23
## PZA00266.5  0.56 0.44 0.44 0.49 0.00 0.49 0.37
## PZA00294.20 0.77 0.23 0.23 0.36 0.02 0.36 0.29
## PZA00300.11 0.40 0.60 0.40 0.48 0.02 0.48 0.37
## PZA00309.1  0.69 0.31 0.31 0.43 0.02 0.43 0.34
## PZA00310.5  0.66 0.34 0.34 0.45 0.03 0.45 0.35
## PZA00328.1  0.83 0.17 0.17 0.29 0.00 0.29 0.25
## PZA00337.3  0.44 0.56 0.44 0.49 0.02 0.49 0.37
## PZA00348.11 0.39 0.61 0.39 0.48 0.01 0.48 0.36
## PZA00364.2  0.12 0.88 0.12 0.22 0.01 0.22 0.19
## PZA00367.6  0.76 0.24 0.24 0.37 0.03 0.37 0.30
## PZA00369.1  0.88 0.12 0.12 0.22 0.01 0.22 0.19
## PZA00378.9  0.88 0.12 0.12 0.22 0.01 0.22 0.19
## PZA00379.2  0.52 0.48 0.48 0.50 0.02 0.50 0.37
## PZA00385.1  0.13 0.87 0.13 0.23 0.00 0.23 0.21
## PZA00396.9  0.38 0.62 0.38 0.47 0.03 0.47 0.36
## PZA00398.4  0.53 0.47 0.47 0.50 0.03 0.50 0.37
## PZA00403.5  0.10 0.90 0.10 0.17 0.02 0.17 0.16
## PZA00422.2  0.28 0.72 0.28 0.40 0.03 0.40 0.32
## PZA00436.7  0.57 0.43 0.43 0.49 0.01 0.49 0.37
## PZA00462.2  0.86 0.14 0.14 0.25 0.01 0.25 0.22
## PZA00472.2  0.64 0.36 0.36 0.46 0.01 0.46 0.35
## PZA00485.2  0.88 0.12 0.12 0.22 0.03 0.22 0.19
## PZA00503.5  0.68 0.32 0.32 0.43 0.03 0.43 0.34
## PZA00511.3  0.37 0.63 0.37 0.46 0.02 0.46 0.36
## PZA00527.6  0.83 0.17 0.17 0.29 0.02 0.29 0.25
## PZA00536.2  0.44 0.56 0.44 0.49 0.00 0.49 0.37
## PZA00543.2  0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA00566.5  0.79 0.21 0.21 0.33 0.00 0.33 0.28
## PZA00568.19 0.79 0.21 0.21 0.33 0.00 0.33 0.28
## PZA00571.2  0.29 0.71 0.29 0.41 0.02 0.41 0.33
## PZA00578.1  0.71 0.29 0.29 0.41 0.02 0.41 0.33
## PZA00587.3  0.74 0.26 0.26 0.38 0.01 0.38 0.31
## PZA00623.2  0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA00627.1  0.69 0.31 0.31 0.43 0.00 0.43 0.34
## PZA00637.4  0.65 0.35 0.35 0.45 0.02 0.45 0.35
```

```
## PZA00647.9  0.85 0.15 0.15 0.26 0.00 0.26 0.23
## PZA00663.5  0.65 0.35 0.35 0.45 0.04 0.45 0.35
## PZA00664.3  0.53 0.47 0.47 0.50 0.01 0.50 0.37
## PZA00667.1  0.23 0.77 0.23 0.36 0.00 0.36 0.29
## PZA00680.3  0.19 0.81 0.19 0.31 0.00 0.31 0.26
## PZA00682.2  0.86 0.14 0.14 0.25 0.01 0.25 0.22
## PZA00695.1  0.67 0.33 0.33 0.44 0.02 0.44 0.34
## PZA00731.6  0.78 0.22 0.22 0.34 0.03 0.34 0.29
## PZA00749.1  0.26 0.74 0.26 0.38 0.03 0.38 0.31
## PZA00755.2  0.48 0.52 0.48 0.50 0.00 0.50 0.37
## PZA00795.1  0.64 0.36 0.36 0.46 0.03 0.46 0.35
## PZA00817.2  0.56 0.44 0.44 0.49 0.02 0.49 0.37
## PZA00824.2  0.24 0.76 0.24 0.37 0.01 0.37 0.30
## PZA00827.1  0.19 0.81 0.19 0.31 0.00 0.31 0.26
## PZA00856.2  0.73 0.27 0.27 0.39 0.02 0.39 0.32
## PZA00904.1  0.20 0.80 0.20 0.32 0.01 0.32 0.27
## PZA00908.2  0.27 0.73 0.27 0.39 0.02 0.39 0.32
## PZA00920.1  0.50 0.50 0.50 0.50 0.04 0.50 0.38
## PZA00981.3  0.43 0.57 0.43 0.49 0.01 0.49 0.37
## PZA00987.1  0.78 0.22 0.22 0.34 0.01 0.34 0.29
## PZA01257.1  0.13 0.87 0.13 0.23 0.00 0.23 0.21
## PZA01289.1  0.50 0.50 0.50 0.50 0.06 0.50 0.38
## PZA01292.1  0.69 0.31 0.31 0.43 0.02 0.43 0.34
## PZA01294.1  0.38 0.62 0.38 0.47 0.02 0.47 0.36
## PZA01321.1  0.88 0.12 0.12 0.22 0.01 0.22 0.19
## PZA01332.2  0.85 0.15 0.15 0.26 0.02 0.26 0.23
## PZA01386.3  0.19 0.81 0.19 0.31 0.00 0.31 0.26
## PZA01396.1  0.56 0.44 0.44 0.49 0.00 0.49 0.37
## PZA01456.2  0.51 0.49 0.49 0.50 0.03 0.50 0.37
## PZA01468.1  0.42 0.58 0.42 0.49 0.00 0.49 0.37
## PZA01470.1  0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA01477.3  0.52 0.48 0.48 0.50 0.04 0.50 0.37
## PZA01537.2  0.64 0.36 0.36 0.46 0.03 0.46 0.35
## PZA01613.1  0.18 0.82 0.18 0.30 0.01 0.30 0.25
## PZA01618.2  0.39 0.61 0.39 0.48 0.05 0.48 0.36
## PZA01672.1  0.49 0.51 0.49 0.50 0.03 0.50 0.37
## PZA01753.1  0.34 0.66 0.34 0.45 0.01 0.45 0.35
## PZA01791.2  0.14 0.86 0.14 0.25 0.01 0.25 0.22
## PZA01884.1  0.39 0.61 0.39 0.48 0.03 0.48 0.36
## PZA01935.10 0.86 0.14 0.14 0.25 0.01 0.25 0.22
## PZA01978.23 0.21 0.79 0.21 0.33 0.00 0.33 0.28
## PZA01983.1  0.57 0.43 0.43 0.49 0.05 0.49 0.37
## PZA02012.7  0.73 0.27 0.27 0.39 0.02 0.39 0.32
## PZA02048.2  0.71 0.29 0.29 0.41 0.02 0.41 0.33
## PZA02129.1  0.55 0.45 0.45 0.50 0.03 0.50 0.37
## PZA02138.1  0.41 0.59 0.41 0.49 0.03 0.49 0.37
## PZA02148.1  0.12 0.88 0.12 0.20 0.00 0.20 0.18
## PZA02174.2  0.26 0.74 0.26 0.38 0.01 0.38 0.31
## PZA02209.2  0.59 0.41 0.41 0.49 0.03 0.49 0.37
## PZA02239.12 0.53 0.47 0.47 0.50 0.03 0.50 0.37
## PZA02266.3  0.65 0.35 0.35 0.45 0.00 0.45 0.35
## PZA02281.3  0.13 0.87 0.13 0.23 0.00 0.23 0.21
## PZA02299.16 0.45 0.55 0.45 0.50 0.03 0.50 0.37
## PZA02337.4  0.60 0.40 0.40 0.48 0.02 0.48 0.37
```

```
## PZA02344.1  0.49 0.51 0.49 0.50 0.01 0.50 0.37
## PZA02358.1  0.54 0.46 0.46 0.50 0.02 0.50 0.37
## PZA02359.10 0.51 0.49 0.49 0.50 0.03 0.50 0.37
## PZA02383.1  0.43 0.57 0.43 0.49 0.01 0.49 0.37
## PZA02402.1  0.48 0.52 0.48 0.50 0.02 0.50 0.37
## PZA02418.2  0.83 0.17 0.17 0.29 0.00 0.29 0.25
## PZA02457.1  0.17 0.83 0.17 0.29 0.04 0.29 0.25
## PZA02519.7  0.65 0.35 0.35 0.45 0.04 0.45 0.35
## PZA02577.1  0.28 0.72 0.28 0.40 0.05 0.40 0.32
## PZA02589.1  0.59 0.41 0.41 0.49 0.01 0.49 0.37
## PZA02633.4  0.68 0.32 0.32 0.43 0.01 0.43 0.34
## PZA02665.2  0.55 0.45 0.45 0.50 0.01 0.50 0.37
## PZA02722.1  0.87 0.13 0.13 0.23 0.02 0.23 0.21
## PZA02763.1  0.65 0.35 0.35 0.45 0.02 0.45 0.35
## PZA02792.16 0.70 0.30 0.30 0.42 0.01 0.42 0.33
## PZA02811.4  0.34 0.66 0.34 0.45 0.03 0.45 0.35
## PZA02812.43 0.41 0.59 0.41 0.49 0.05 0.49 0.37
## PZA02817.15 0.18 0.82 0.18 0.30 0.01 0.30 0.25
## PZA02818.10 0.43 0.57 0.43 0.49 0.01 0.49 0.37
## PZA02862.10 0.43 0.57 0.43 0.49 0.03 0.49 0.37
## PZA02938.3  0.20 0.80 0.20 0.32 0.01 0.32 0.27
## PZA02945.10 0.34 0.66 0.34 0.45 0.03 0.45 0.35
## PZA02964.7  0.90 0.10 0.10 0.17 0.00 0.17 0.16
## PZA02965.13 0.30 0.70 0.30 0.42 0.05 0.42 0.33
## PZA02966.11 0.45 0.55 0.45 0.50 0.03 0.50 0.37
## PZA02969.9  0.36 0.64 0.36 0.46 0.01 0.46 0.35
## PZA02981.2  0.36 0.64 0.36 0.46 0.05 0.46 0.35
## PZA02982.5  0.54 0.46 0.46 0.50 0.02 0.50 0.37
## PZA02993.14 0.15 0.85 0.15 0.26 0.00 0.26 0.23
## PZA03005.19 0.74 0.26 0.26 0.38 0.01 0.38 0.31
## PZA03024.16 0.68 0.32 0.32 0.43 0.01 0.43 0.34
## PZA03047.12 0.30 0.70 0.30 0.42 0.01 0.42 0.33
## PZA03062.7  0.59 0.41 0.41 0.49 0.01 0.49 0.37
## PZA03064.6  0.33 0.67 0.33 0.44 0.02 0.44 0.34
## PZA03067.17 0.44 0.56 0.44 0.49 0.00 0.49 0.37
## PZA03559.1  0.86 0.14 0.14 0.25 0.03 0.25 0.22
## PZA03583.1  0.37 0.63 0.37 0.46 0.04 0.46 0.36
##
## $genotypes
##       Ho   Fi   Si
## A11 0.01 0.98 0.99
## A12 0.01 0.98 0.99
## B01 0.01 0.98 0.99
## B02 0.04 0.90 0.95
## B03 0.05 0.88 0.93
## B04 0.02 0.95 0.97
## B05 0.03 0.91 0.95
## B06 0.04 0.89 0.94
## B07 0.04 0.90 0.95
## B08 0.00 0.99 1.00
## B09 0.01 0.99 0.99
## B10 0.00 0.99 1.00
## B11 0.03 0.92 0.96
## B12 0.04 0.88 0.94
```

```
## C01 0.01 0.97 0.99
## C02 0.01 0.98 0.99
## C03 0.02 0.95 0.97
## C04 0.02 0.96 0.98
## C05 0.03 0.92 0.96
## C06 0.01 0.99 0.99
## C07 0.03 0.92 0.96
## C08 0.03 0.92 0.96
## C09 0.00 1.00 1.00
## C10 0.00 1.00 1.00
## C11 0.00 1.00 1.00
## C12 0.02 0.95 0.97
## D01 0.01 0.98 0.99
## D02 0.00 1.00 1.00
## D03 0.00 1.00 1.00
## D04 0.03 0.93 0.96
## D05 0.02 0.96 0.98
## D06 0.00 1.00 1.00
## D07 0.02 0.95 0.97
## D08 0.00 0.99 1.00
## D09 0.01 0.98 0.99
## D10 0.00 0.99 1.00
## D11 0.01 0.98 0.99
## D12 0.01 0.97 0.99
## E01 0.01 0.99 0.99
## E02 0.00 1.00 1.00
## E03 0.00 0.99 1.00
## E04 0.01 0.98 0.99
## E05 0.01 0.98 0.99
## E06 0.00 0.99 1.00
## E07 0.02 0.94 0.97
## E10 0.00 1.00 1.00
## E11 0.01 0.96 0.98
## E12 0.02 0.95 0.97
## F01 0.03 0.93 0.97
## F02 0.07 0.82 0.90
## F03 0.04 0.88 0.94
## F04 0.06 0.85 0.92
##
## $population
##     mean lower upper
## DG  0.39  0.16  0.50
## PIC 0.31  0.15  0.38
## MAF 0.30  0.09  0.50
## Ho  0.02  0.00  0.07
## F   0.96  0.82  1.00
## S   0.98  0.90  1.00
##
## $variability
##                       estimate
## Ne                       27.21
## Va                      112.24
## Vd                       46.51
## number.of.groups          1.00
```

```
## number.of.genotypes    52.00
## number.of.markers     289.00
```

```
# exclusive and fixed allelos and each population
pop.gen$exclusive_alleles
```

```
## [[1]]
## [1] "there are no exclusive alleles for this group"
##
## [[2]]
## [1] "there are no fixed alleles for this group"
```

```
pop.gen$fixed_alleles
```

```
## [[1]]
##  [1] "PHM15278.6"  "PHM1576.25"  "PHM1962.33"  "PHM2518.28"  "PHM2672.19"
##  [6] "PHM2885.31"  "PHM3402.11"  "PHM4531.46"  "PHM4560.54"  "PHM4647.8"
## [11] "PHM5395.34"  "PHM765.24"   "PZA00069.4"  "PZA00108.12" "PZA00155.1"
## [16] "PZA00245.14" "PZA00485.2"  "PZA00667.1"  "PZA00682.2"  "PZA00731.6"
## [21] "PZA00824.2"  "PZA00827.1"  "PZA01470.1"  "PZA01935.10" "PZA02418.2"
## [26] "PZA02722.1"  "PZA02993.14" "PZA03559.1"
##
## [[2]]
## character(0)
```