**Electronic supplementary material**

Current indirect fitness and future direct fitness are not incompatible

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**Natural history of *Ropalidia marginata***

*Ropalidia marginata* is a primitively eusocial tropical paper wasp. Colonies consist of a single queen and varying numbers of workers rarely exceeding 50. Workers can have a varying degree of genetic relatedness with the queen and the brood, including that of daughters, sisters, nieces, cousins and so on; some workers even join unrelated nests [1]. The average tenure of queens is 79.71 ± 72.36 days with a variation ranging from 7 to 236 days [1]. A worker has four options to choose from during its lifetime: 1) leave nest and initiate a new nest as queen, 2) leave nest and initiate nest as a cofoundress, 3) stay back in nest and replace the existing queen, and 4) stay back and remain as a worker [1]. A total of 76 workers left from 9 parent nests to initiate 29 new nests; the average proportion of workers leaving the parent nests to initiate new nest is 0.12 ± 0.06 during an observation period ranging from 133 to 174 days (Brahma and Gadagkar, unpublished data).

**Materials and methods**

*Behavioural observation*

For each of the six experimental nests, we collected quantitative behavioural data for 20 hours over a span of four days. On the first day, we observed the nest from 0800 to 1030 hours and 1300 to 1530 hours and on the second day we observed it from 1030 to 1300 hours and 1530 to 1800 hours; we repeated the same schedule for the third and fourth days of observation. These behavioural observations consisted of randomly commingled scans to record long-duration behaviour and all-occurrence sessions to record short duration behaviour of wasps at any moment (for details of the behaviour, please see [1]). Each scan and all occurrence session lasted for five minutes with a one-minute break in between. We recorded a total of 100 scans and 100 all occurrence sessions (AOS) for each nest. The scans and AOS enabled us to get detailed behaviour profiles all the wasps. At the end of the fourth day of behavioural observation of a nest, at night, we collected all the wasps in 15 ml glass vials.

Behaviours studied included frequencies per hour of dominance behaviour, self-feeding behaviour, and work done. Work included both intranidal and extranidal work. Intranidal work was calculated as the sum of the frequencies per hour of maintenance, inspect cells and feed larva behaviours. Extranidal work was calculated as the sum of the frequencies per hour of bring food, bring building material and bring liquid behaviours. In each nest, we identified the queen based on egg-laying behaviour, before the start of the 20 hours observation period.

*Statistical analysis*

We performed all statistical analyses using the statistical interface R-studio version 3.3.2 [3]. We used the “lme4” package for fitting generalised linear mixed effects model to the data [4].

We fitted the following global model:

model 1 = glmer(initiation ~ age + db + work + fe + age x work + (1|nest ID), data=data.q, family=binomial(link="logit")).

In model 1, ‘initiation’ is a binomial response variable having value of either 1 (if a wasp initiates a nest) or 0 (if a wasp does not initiate a nest) for each wasp. For continuous predictor variables, we had ‘age’ (on the day of isolation), ‘db’ (frequency per hour of dominance behaviour on parent nests), ‘work’ (frequency per hour of total work done i.e. intranidal and extranidal work on parent nests) and ‘fe’ (frequency per hour of self-feeding behaviour on parent nests). We had nest ID as a random effect in our analysis. Next, we dropped the non-significant interaction term from model1 for model simplification and obtained our final model (model 2).

model 2 = glmer(initiation ~ age + db + work + fe + (1|nest ID),

data=data.q, family=binomial(link="logit"))

We used Cohen’s D as the estimators of effect size for continuous predictor variables (‘age’, ‘db’, ‘work’ and ‘fe’). The codes used for calculating Cohen’s D are given in the section ‘R-codes for calculating effect sizes’.

**Results**

The main results that age and self-feeding behaviour are significant predictors of the probability of initiating nests and laying eggs mentioned in the main text are also corroborated by the pair comparisons using Mann-Whitney U test. Egg layers were significantly younger than non-egg layers (Mann-Whitney U test; U=1354, *p* < 0.001; Figure S1). Egg layers demonstrated significantly greater self-feeding behaviour before isolation compared to non-egg layers (Mann-Whitney U test; U=2192.5, *p* = 0.003; Figure S2). There were no significant differences between egg layers and non-egg layers in the frequency per hour of work done (Mann-Whitney U test; U = 1761.5, *p* = 0.59; Figure S3) or dominance behaviour (Mann-Whitney U test; U = 1875.5, *p* = 0.25; Figure S4).

**References**

1. Gadagkar, R. 2001 *The Social Biology of Ropalidia marginata: Toward Understanding the Evolution of Eusociality*. Cambridge,Massachusetts; London, England: Harvard University Press.

2. Hunt, J. H. 1991 Nourishment and the Evolution of the Social Vespidae. In *The Social Biology of Wasps* (eds K. G. Ross & R. W. Matthews), pp. 426–450. Ithaca: Cornell University Press.

3. RStudio Team 2015 RStudio. *Integr. Dev. R. RStudio, Inc.*

4. Bates, D., Mächler, M., Bolker, B. & Walker, S. 2015 Fitting Linear Mixed-Effects Models using lme4. *J. Stat. Softw.* **67**. (doi:10.18637/jss.v067.i01)

**Figures**



**Figure S1.** Mean ± bootstrap confidence intervals of age at isolation for egg layers and non-egg layers. Egg layers were significantly younger than non-egg layers (Mann-Whitney U test; U=1354, *p* < 0.001; N = 49 and 68).



**Figure S2.** Mean ± bootstrap confidence intervals of frequency per hour of self-feeding behaviour on parent nests for egg layers and non-egg layers. Egg layers fed significantly more than non-egg layers (Mann-Whitney U test; U=2192.5, *p* = 0.003; N = 49 and 68).



**Figure S3.** Mean ± bootstrap confidence intervals of frequency per hour of work done on parent nests for egg layers and non-egg layers. There was no significant difference between them (Mann-Whitney U test; U = 1761.5, *p* = 0.59; N = 49 and 68).

 

**Figure S4.** Mean ± bootstrap confidence intervals of frequency per hour of dominance behaviour on parent nests for egg layers and non-egg layers. There was no significant difference between them (Mann-Whitney U test; U=1875, *p* = 0.25; N = 49 and 68).

**R-codes**

**R-codes for GLMM analysis**

Data: Dataset-Brahma-Mandal-Gadagkar-2017.xlxs (uploaded separately)

Test performed: Generalised linear mixed effects model with binomial error structure

library(lme4)

data <- read.csv("C:/Users/Dataset\_GLMM.csv")

fnest <- factor(data$nest)

model 1 <- glmer(initiation ~ age + db + work + fe + age x work + (1|fnest) , data=data, family=binomial(link="logit"), control=glmerControl(optimizer="bobyqa",optCtrl=list(maxfun=100000000)))

summary(model1)

##drop age x work

model 2 <- glmer(initiation ~ age + db + work + fe + (1|fnest),

data=data, family=binomial(link="logit"), control=glmerControl(optimizer="bobyqa",optCtrl=list(maxfun=100000000)))

summary(model2)

**R-codes for calculating effect sizes**

Data: Dataset-Brahma-Mandal-Gadagkar-2017.xlxs (uploaded separately)

# Cohen's D#

library(effsize)

##age##

age <- read.csv("C:/Users/ age.csv")

age.ini <- age$age.ini[1:40]

age.non.ini <- age$age.non.ini[1:47]

cohen.d(age.ini, age.non.ini, pooled=TRUE, paired=FALSE, na.rm=FALSE,

hedges.correction = FALSE, conf.level = 0.95, noncentral = FALSE)

##fe##

fe <- read.csv("C:/Users/ fe.csv")

fe.ini <- fe$fe.ini[1:49]

fe.non.ini <- fe$fe.non.ini[1:68]

cohen.d(fe.ini, fe.non.ini, pooled=TRUE, paired=FALSE, na.rm=FALSE,

hedges.correction = FALSE, conf.level = 0.95, noncentral = FALSE)

##work##

work <- read.csv("C:/Users/work.csv")

work.ini <- work$work.ini[1:49]

work.non.ini <- work$work.non.ini[1:68]

cohen.d(work.ini, work.non.ini, pooled=TRUE, paired=FALSE, na.rm=FALSE, hedges.correction = FALSE, conf.level = 0.95, noncentral = FALSE)

##db##

db <- read.csv("C:/Users/db.csv")

db.ini <- db$db.ini[1:49]

db.non.ini <- db$db.non.ini[1:68]

cohen.d(db.ini, db.non.ini, pooled=TRUE, paired=FALSE, na.rm=FALSE,

hedges.correction = FALSE, conf.level = 0.95, noncentral = FALSE)

**R-codes for calculating bootstrap confidence intervals**

Data: Dataset-Brahma-Mandal-Gadagkar-2017.xlxs (uploaded separately)

library(boot)

##age##

age <- read.csv("C:/Users/age.csv")

fun.boot <- function(x, i) {

mean(x[i])}

res.boot <- boot(data = age$age.ini[1:40], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot, conf=0.95, type="norm")

res.boot1 <- boot(data = age$age.non.ini[1:47], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot1, conf=0.95, type="norm")

##fe##

fe <- read.csv("C:/Users/fe.csv")

fun.boot <- function(x, i) {

mean(x[i])}

res.boot1 <- boot(data = fe$fe.ini[1:49], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot1, conf=0.95, type="norm")

res.boot2 <- boot(data = fe$fe.non.ini[1:68], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot2, conf=0.95, type="norm")

##work##

work <- read.csv("C:/Users/ work.csv")

fun.boot <- function(x, i) {

mean(x[i])}

res.boot1 <- boot(data = work$work.ini[1:49], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot1, conf=0.95, type="norm")

res.boot2 <- boot(data = work$work.non.ini[1:68], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot2, conf=0.95, type="norm")

##db##

db <- read.csv("C:/Users/ db.csv")

fun.boot <- function(x, i) {

mean(x[i])}

res.boot1 <- boot(data = db$db.ini[1:49], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot1, conf=0.95, type="norm")

res.boot2 <- boot(data = db$db.non.ini[1:68], statistic = fun.boot, R = 1000)

boot.ci(boot.out = res.boot2, conf=0.95, type="norm")