YURI CARVALHO DE CARVALHO

TERMITOPHILE ENCOUNTER MAY BE COSTLY TO THE TERMITE HOST

Dissertação apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Entomologia, para obtenção do título de *Magister Scientiae*.

VIÇOSA
MINAS GERAIS - BRASIL
2018

Ficha catalográfica preparada pela Biblioteca Central da Universidade Federal de Viçosa - Câmpus Viçosa

T
C331t
2018

Carvalho, Yuri Carvalho de, 1992-
Termitophile encounter may be costly to the termite host / Yuri Carvalho de Carvalho. – Viçosa, MG, 2018.
xi, 146 f. : il. (algumas color.) ; 29 cm.

Inclui apêndices.
Orientador: Og Francisco Fonseca de Souza.
Dissertação (mestrado) - Universidade Federal de Viçosa.
Inclui bibliografia.

1. Térmita. 2. Staphylinidae. 3. Besouros. I. Universidade Federal de Viçosa. Departamento de Entomologia. Programa de Pós-Graduação em Entomologia. II. Título.

CDD 22. ed. 595.736

YURI CARVALHO DE CARVALHO

TERMITOPHILE ENCOUNTER MAY BE COSTLY TO THE TERMITE HOST

Dissertação apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Entomologia, para obtenção do título de *Magister Scientiae.*

APROVADA: 24 de abril de 2018.

Angelo Pallini Filho

Verônica Saraiva Fialho

Og Francisco Fonseca de Souza
(Orientador)

Agradecimentos

À Universidade Federal de Viçosa e ao Programa de Pós-graduação em Entomologia pela oportunidade e infraestrutura para realizar este trabalho.

Aos técnicos-administrativos do Departamento de Entomologia, especialmente à Cheyene, Diana, Eliane e Rafael

À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) pela concessão da bolsa de mestrado.

Ao professor Og, pela oportunidade, orientação e por todos os ensinamentos.

À EMBRAPA Milho e Sorgo de Sete Lagoas - MG pelo apoio logístico em campo. E aos funcionários da Associação de Empregados da Embrapa Milho e Sorgo pela estadia e alimentação durante as coletas.

Aos amigos que fazem e fizeram parte do Laboratório de Termitologia, Vinícius, Marco, Lara, Zé, Julieth, Lívia, Danilo, Hélder e Diogo pela convivência, suporte, pela ajuda em campo e pelos cafés todos os dias.

Aos amigos que fiz em Viçosa e aos antigos amigos de JF, que se fizeram presentes em todo esse tempo.

À minha família: Dona Ana, Seu Jorge e Larissa. Muito obrigado pelo apoio que sempre me deram.

E à Kássia, por ser como é e pelo companheirismo durante essa jornada.

Contents

List of Figures

List of Tables

Abstract

CARVALHO, Yuri Carvalho de, M.Sc., Universidade Federal de Viçosa, April, 2018. **Termitophile encounter may be costly to the termite host**. Advisor: Og Francisco Fonseca de Souza.

Termites nests are commonly invaded by other arthropods looking for food or shelter. These invaders cohabit with the builder species forming a symbiotic association known as termitophily. As every interespecific interaction, symbioses are characterized in a cost-benefit perspective, which defines if the interaction is positive or negative to the species associated. However, for termitophily, such costs and benefits are still poorly understood, specially because it occurs cryptically, with the closed environment of a termitarium. Given this gap in the study of termitophily, in this dissertation we measured the costs arisen from the interespecific encounters between the termite *Constrictotermes cyphergaster* Silvestri 1901 (Termitidae: Nasutitermitinae) and the termitophilous beetle *Corotoca melantho* Schiødte 1853 (Staphylinidae: Aleocharinae), using a parameter of survival of individuals when confined in interspecific groups. To investigate what could cause such costs, we performed behavioral observations of the termitophile with its host termite in laboratory bioassays. Because termites on laboratory bioassays would be exposed to an illumination they do not experience naturally, we additionally check the effects of cold white lights and infrared lights on termites survival. The results showed that the termitophile presence was costly to termites, reducing their survival, while the termite presence was beneficial to the beetles delaying their time until death. Additionally, as termitophile numbers decreased, we observed that termites survival increased. These results seem to stem from negative effects of the

termitophiles upon termites. In mixed-species groups, termitophiles were shown to engage in mouth-to-mouth contacts with termites, and to frequently bite their hosts; such interactions resulting in significant reduction in termite survival. These effects were progressively stronger as the proportion of *C. melantho* individuals relative to their termite host increased. Very harmfull effects, however, would be only observed in *C. melantho* proportions far above the values normally observed in the field. It seems hence that termitophiles natural low abundance inside termitaria would make their costs unnoticed by their host termites. Regarding the illumination on the bioassays, when comparing survival of termites exposed to artificial lights with those kept in the dark, no statiscal difference was found. We then propose that bioassays can be conducted under infrared or cold white light as these light regimes do not affect the survival of tested individuals.

Resumo

CARVALHO, Yuri Carvalho de, M.Sc., Universidade Federal de Viçosa, abril de 2018. **Encontrar termitófilos pode ser custoso ao cupim hospedeiro**. Orientador: Og Francisco Fonseca de Souza.

Ninhos de cupins são comumente invadidos por outros artrópodes procurando comida ou abrigo. Estes invasores coabitam com a espécie construtora formando uma associação simbiótica conhecida como termitofilia. Como toda interação interespecífica, simbioses são caracterizadas em uma perspectiva de custo-benefício, que define se a interação é positiva ou negativa para as espécies associadas. Porém, para a termitofilia, tais custos e benefícios ainda são pouco entendidos, especialmente por se tratar de uma interação que ocorre dentro do ambiente fechado do cupinzeiro. Devido a essa lacuna no estudo da termitofilia, nesta dissertação nós medimos os custos resultados dos encontros interespecíficos entre os cupins *Constrictotermes cyphergaster* Silvestri 1901 (Termitidae: Nasutitermitinae) e os besouros termitófilos *Corotoca melantho* Schiødte 1853 (Staphylinidae: Aleocharinae), usando como parâmetro a sobrevivência dos indivíduos quando confinados em grupos interespecíficos. Para investigar o que poderia causar tais custos, observamos o comportamento dos termitófilos com seus cupins hospedeiros em bioensaios de laboratório. Como os cupins em condições de laboratório seriam expostos a uma iluminação que naturalmente eles não estão expostos, nós também analisamos os efeitos de luz branca fria e luz infravermelha na sobrevivência de cupins. Os resultados mostraram que a presença do termitófilo foi custosa aos cupins, reduzindo sua sobrevivência, enquanto a presença dos cupins foi benéfica aos besouros, por aumentar seu tempo de vida. Porém, enquanto os números dos termitófilos diminuíam, observamos que a sobrevivência dos cupins aumentava. Estes

resultados parecem decorrer dos efeitos negativos dos termitófilos sobre os cupins. Em grupos interespecíficos, termitófilos foram observados realizando contatos boca-a-boca com os cupins e, frequentemente, mordendo seus hospedeiros; e tais interações foram correlacionadas com uma redução significativa na sobrevivência dos cupins. Esses efeitos foram progressivamente mais fortes à medida que a quantidade de indivíduos de *C. melantho* aumentava em relação aos cupins hospedeiros. Porém, efeitos muito prejudiciais aos cupins só foram observados em proporções de *C. melantho* muito acima dos valores normalmente observados em campo. Parece, portanto, que a baixa abundância natural dos termitófilos dentro do cupinzeiro tornaria seus custos imperceptíveis aos seus cupins hospedeiros. Em relação à iluminação nos bioensaios, nós comparamos a sobrevivência dos cupins quando expostos às luzes artificiais e quando mantidos no escuro, e não encontramos diferenças estatísticas. Nós então propomos que bioensaios podem ser conduzidos sob luz branca fria e infravermelho, já que estas iluminações não afetaram a sobrevivência dos indivíduos testados.

Chapter 1

General Introduction

General Introduction

An interesting feature of social insects is nesting. These nests can provide protection against predators, temperature and humidity regulation and also food storage for thousands of individuals (Emerson, 1938). However such favorable conditions also attract other organisms, searching for shelter or for food in the form of stored resources, the hosts themselves or other invaders therein (Thomas et al., 2005). There is a wide variety of organisms recorded living associated with social insects, from vertebrates to invertebrates (Rettenmeyer et al., 2011; Cunha and Brandão, 2001; Costa and Vanin, 2010). Among all invaders, the beetle family Staphylinidae (rove beetles) stands out as the most impressive group of social insects symbionts (Seevers, 1957).

Most Staphylinidae, both adults and larvae, are free-living predators that live on soil and litter, but overall they have diverse diets, with species feeding from carrion to algae (Grimaldi and Engel, 2005). Interestingly in this family, numerous independent lineages have evolved to live as social insects symbionts, in particular in colonies of ants (myrmecophiles) and termites (termitophiles) (Kistner, 1982; Maruyama and Parker, 2017). Among these myrmecophiles and termitophiles, most species belong to the Aleocharinae (Seevers, 1957, 1965; Kistner, 1969; Parker, 2016). To live inside ants and termites nests, Aleocharinae beetles developed different morphological strategies. Some of these symbionts have a defensive body plan to avoid aggression from their hosts, while others have adapted a mimetic morphology to be socially integrated (i.e. accepted as nestmates) in the colony (Kistner, 1979; Parker, 2016).

The defensive body plan (Fig. 1.1), also called limuloid, is characterized by a posteriorly tapered abdomen, expanded lateral margins of the body and a deflexed head, protecting its appendages dorsally from host

attack (Kistner, 1979; Parker, 2016; Kanao et al., 2016). Mimetic morphology includes different adaptations according to the host group. In many army-ants symbionts, beetles have an ant-like "myrmecoid" morphology (Fig. 1.2), with a petiolate abdomen, and sometimes further similarities with their hosts, such as elongated appendages and elbowed antennae, which are thought to mediate tactile (Wasmannian) mimicry of nestmate recognition cues (Seevers, 1965; Kistner, 1979; Parker, 2016; Maruyama and Parker, 2017). Similarly, many termitophiles present a termite-like morphology (Fig. 1.3). This form is due to a physogastric (i.e. hypertrophic) abdomen (Seevers, 1957; Kistner, 1979). The swollen abdomen of these termitophiles is probably also associated with tactile nestmate recognition cues of their host termite.

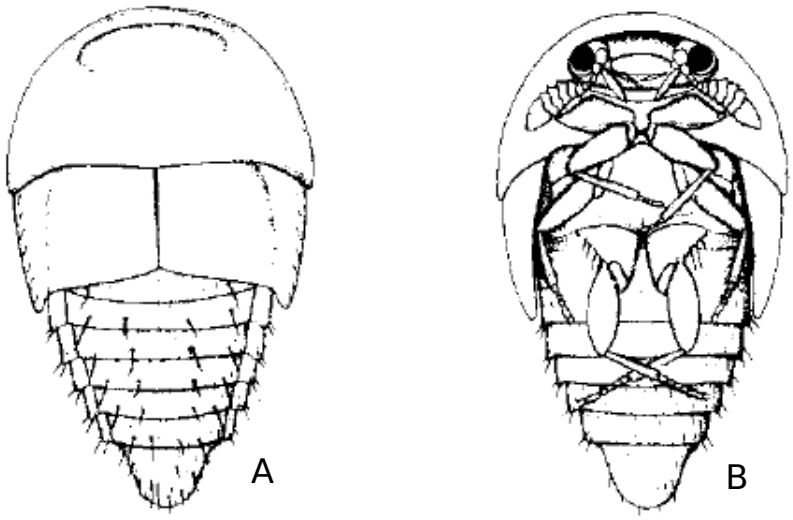

Figure 1.1: *Termitogerrus burgeoni* an example of a limuloid Aleocharinae termitophile. A: dorsal view; B: ventral view. (Source: modified from Kistner (1979)).

Besides the morphological adaptations, Aleocharinae integration on ants and termites colonies also include chemical mimicry (Howard et al., 1980, 1982) and appeasement secretions from the beetle glands (Hölldobler, 1971; Kistner, 1979). A feature common to these beetles is a complex glandular system in their abdomen, many still with unknown effects. The free-living

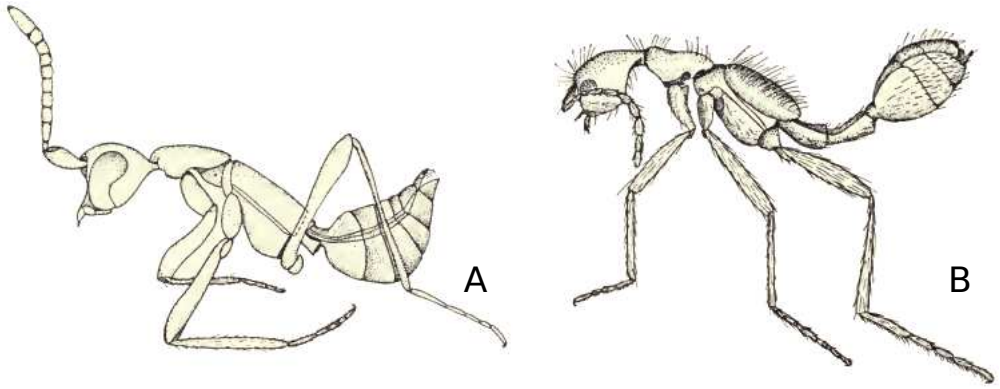

Figure 1.2: Examples of myrmecoid Aleocharinae. A: lateral view of *Parasahlbergius liberiae*; B: lateral view of *Crematoxenus aenigma*. (Source: modified from Seevers (1965)).

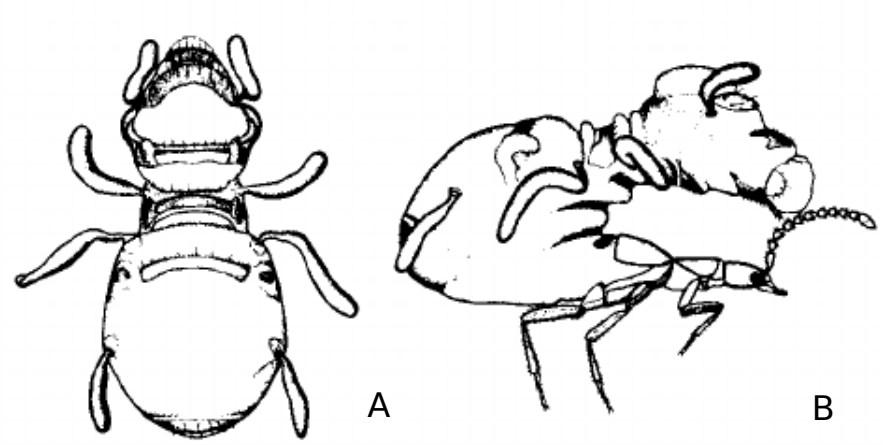

Figure 1.3: *Coatonachthodes ovambolandicus*, an extreme example of physogastry on the Aleocharinae that includes lateral projections in the abdomen that resemble legs of termites larvae. A: dorsal view; B: lateral view. (Source: modified from Kistner (1979)).

Aleocharinae possess a tergal gland that secretes defensive compounds (Steidle and Dettner, 1993). On myrmecophiles, the same gland is associated with host manipulation. For example, the beetles of the genera *Pella* can mimic the chemicals of the "panic-alarm" of their host ant *Lasius fuliginosus* in order to avoid aggression (Stoeffler et al., 2007). Novel glands related to integration into ants societies are also present on myrmecophiles. On *Lomechusa* spp., a genus of aleocharines socially integrated into Myrmica and Formica ants, beetles produce from one gland a compound to appease aggressive workers, and from another gland, they produce a compound related to their adoption in ants society (Parker, 2016). On termi-

tophiles, the tergal gland is usually reduced or even absent (Jacobson and Pasteels, 1985). However, other glands present in their abdomen are supposed to take part in the integration in termites societies. In fact, termites were observed licking and antennating termitophile's abdomen in the postion the glands are (Kistner, 1979).

The ecology and the interactions of such invaders with their hosts are well studied for ants (for a revision of myrmecophily in general, check Thomas et al. (2005), for myrmecophilous beetles, check Parker (2016)). However, for termitophiles, most studies are focused on describing and reporting new species. Despite the little knowledge on termitophiles ecology, there are more than 600 Aleocharinae species recorded associated with termites, with eleven tribes comprised exclusively of termitophilous species (Kanao et al., 2012). One of these tribes is Corotocini, which is also the largest and most highly specialized tribe of termitophilous Aleocharinae (Seevers, 1957). Corotocini are usually found on Nasutitermitinae nests, and like their hosts, these beetles are pantropical (Jacobson and Pasteels, 1985). This termitophile tribe is also host-specific, with species found only with one termite's species (Jacobson and Pasteels, 1985). Due to its specificity and also specialized morphology and the fact that none of its species was ever captured outside the nests or out of termite's forage trails, it is believed that these beetles are obligate guests in termites nests (Jacobson and Pasteels, 1985). Also, as most termitophiles, corotocine die shortly after being taken from their hosts' nest (Kistner, 1969; Jacobson and Pasteels, 1985).

Every Corotocini species have morphological traits to live as termitophiles. All corotocines have physogastry to some degree, although there is a variety of expression within the tribe (Seevers, 1957), with some extreme cases of abdomens with pairs of membranous lobes that resemble legs, providing the beetle the appearance of a termite (Jacobson and Pas-

teels, 1985). This is possibly a form of tactile (Wasmannian) mimicry as a way to integrate into termite societies (Kistner, 1979). In fact, Sands and Lamb (1975) showed for the corotocine *Spirachtodes madecassus* that its size is nearly the same of second instar larvae of its host *Kaudernitermes kaudernianus*. Cunha et al. (2015) also showed that the body of *C. melantho* is morphometrically indistinct from the body of the workers of its host *C. cyphergaster*. Mouthparts are also modified in Corotocini. Although the Aleocharinae, in general, have mentum free and movable, the corotocines have mentum fused to the submentum to form a shield-like sclerite (Seevers, 1957). It is considered that this stationary condition of the mentum has some implications for feeding behavior. Seevers (1957) suggests that this condition may facilitate the process of ingestion of liquid food, and it might favor the beetle to receive food from its host.

Myrmecophiles appear to behave primarily as social parasites, imposing costs on their host ants through resource exploitation and brood predation (Kistner, 1979; Thomas et al., 2005; Parker, 2016). However, termitophiles relationships with their hosts are not well known. Termitophile studies are probably hindered by the fact that termitophiles are challenging to collect due to their low abundances (Kistner, 1979) and difficulty in extracting them from inside the nests (Kistner, 1998).

Due to the high specialization of physogastric species, it has been assumed that they produce nutritious substances from their abdominal glands, and thus could have established a mutualistic interaction with termites (Seevers, 1957). This assumption has not been tested, so termitophiles may also interact with their hosts similarly to myrmecophiles. It is known at least for some termitophile Aleocharinae that they might engage on trophallactic interactions with their host, either through stomodeal or proctodeal trophallaxis, such as *Philotermes howardi* with their host *Reticulitermes virginicus* (Howard, 1978). Evidence for proctodeal exchanges from *R.*

virginicus to *P. howardi* was found when Howard (1978) observed, in this termitophile hindgut, fragments of Protozoa usually found in the hindgut of their host termite. These fragments were present after the termitophile was seen to engage in mouth-to-anus contact with its host. Pasteels (1969) observing *Termitopullus sociusculus* interaction with its host *Nasutitermes lujae* saw that the beetle bites workers and larvae at the level of the pleurite. Pasteels (1969) further says that these termitophile mandibles, similar to others from its tribe Corotocini, are sharp and lacking marginal teeth and possibly used to pierce, instead of grind, and thus supposes that these termitophiles are parasites that suck termites hemolymph. Such findings imply that termitophiles, like myrmecophiles, also exploit their host as resources.

In this work, we will focus on the interactions between termites and termitophiles and in the measurement of the costs involved under laboratory conditions. By doing so, the aim of this study is to have a better understanding of why termites tolerate such intruders.

The System

Constrictotermes cyphergaster Silvestri 1901 (Termitidae: Nasutitermitinae) is a common termite species in Brazil, Paraguay, Bolivia, and Northern Argentina (Mathews, 1977), that forages at night in exposed columns (Moura et al., 2006b). It feeds on leaf litter (Moura et al., 2006a) and on lichens (Silva, 2014). *Constrictotermes cyphergaster* usually build their nests on trees (Moura et al., 2006b), although nests can also be built on rocks (Vasconcellos et al., 2007). In this species, incipient nests are epigeous while mature nests are usually arboreal (Vasconcellos et al., 2007). *Constrictotermes cyphergaster* builds fragile nests with weak walls made from a thin layer of soil. These nests walls tend to harden and cure with age. In the "Caatinga"

biome, it was observed that this species can build polycalic nests (Bezerra-
144 Gusmao et al., 2009). On *C. cyphergaster* nests there is no distinct royal cell and the royal pair and eggs are found in the inner part of the nest, close to the stem of the support tree (Cunha and Brandão, 2002). The royal pair can
147 also be found hiding in depressions of the bark of the support tree (Cunha and Brandão, 2002). The colony population can be found all over the nest (Cunha et al., 2003), and multiple reproductives can be found (Cunha and
150 Brandão, 2002). Active nests of this species can harbor many other organisms, including other termites species (what termitologists usually call inquilinism) and termitophiles, which are mainly Staphylinidae (Insecta:
153 Coleoptera) (Seevers, 1957). Arboreal nests seems to have a critical size of 2.2 litters which nests are more likely to be invaded by termitophiles (Cristaldo et al., 2012).

156 The most frequent termitophile in *C. cyphergaster* nests is *Corotoca melantho* Schiødte, 1853 (Staphylinidae: Aleocharinae: Corotocini). This termitophile was recorded in 80% of the nests collected by Cunha and Brandão
159 (2001) and 83% of all nests collected by Cristaldo et al. (2012). Although frequent, as other termitophiles, *C. melantho* is found on low abundances on *C. cyphergaster* nests. For example, Cunha et al. (2015) found, on average,
162 1 *C. melantho* individual for 500 termite workers. *C. melantho* is reported to live in close contact with their host termite with no antagonist interactions from workers (Cunha et al., 2015). It is also supposed that this species is fed
165 by their host termites. As all species of the subtribe Corotocini, *C. melantho* have the mentum fused to the submentum, forming a shield-like sclerite, and Seevers (1957) supposes that this trait may facilitate receiving liquid
168 aliment from termites. However, if this termitophile actually receives food from its host is not yet known. Another feature common to all Corotocini is physogastry, which in *C. melantho* is so pronounced that its morphology
171 is similar from workers of its host termite (Cunha et al., 2015). The genus

Corotoca was considered to be viviparous due to the presence of larvae of different sizes in females abdomen (Seevers, 1957). However, as the females lack milk glands to nourish larvae, the genus should be classified as ovoviviparous (Pisno, 2016). It is considered *C. melantho* is highly dependent on its host's nests. This is due to its ovoviparity, that might imply on prolonged periods of vulnerability for pregnant females, and other characters such as physogastry and wing vestialization that could impair their mobility (Pisno, 2016). Findings on *C. melantho* reproductive traits suggest that on this termitophile recurrent matings happens. For males, a full developing sequence of sperm cells is present in the testes. And for females, oocytes in different development stages and the absence of spermatheca (Pisno, 2016). Furthermore, *C. melantho* females have a reduced number of ovarioles in each ovary: two, which contrasts with other Staphylinidae that commonly have six ovarioles in each ovary (Pisno, 2016).

Overview of chapters

This dissertation is divided into 4 chapters, with this one being the first. This chapter is a introduction and overview of the dissertation to provide the reader a summary of the topics approached in the following chapters.

For the purpose of this dissertation, we needed to record termites behavior in bioassays. However, for that, termites would be exposed to a possibly stressful condition: light. Being a condition opposed to what termites naturally experience, light might easily stress such insects or might not affect them at all. So on chapter 2, we checked the effect of artificial lights on the survival of termites. Distinct light regimes were tested: dark, cold white light and infrared on termites confined in a typical bioassay setup involving footage. No statistical difference was found in termites survival between the three light regimes. Thus, at least in regard to survival, bioas-

says using termites can be conducted under infrared or cold white LEDs, as these treatments did not affect the survival of tested individuals. This work was accepted in 2018, in the journal *Sociobiology*.

On chapter 3 we investigated the interaction involved in the cohabitation between a termite species *C. cyphergaster* and its beetle guest *C. melantho*. Firstly, the costs arisen from interspecific direct contacts were measured through survival of termite and beetle individuals confined together in experimental arenas. The hypothesis here was that termites survival would decrease in the presence of the beetle, while *C. melantho* survival would increase in the presence of its host. Then we inspected the effects of the populational density of the guest upon the survival of the host. It was hypothesized that as termitophile numbers diminished, their burden on the host would also decrease. Lastly, the behavioral interactions between the termite and the beetle were also investigated in order to explain the observed costs in previous experiments. Here, interactions that could possibly decrease termites survival were surveyed and quantified. The hypothesis was that survival would be decreased with the increase of such interactions.

Finally, on the fourth and last chapter, the general conclusions of the results obtained and discussed in this dissertation are presented.

Bibliography

Bezerra-Gusmao, M. A., Kogiso, K. A., Honorato, T. O., de Melo, T. X., Barbosa, J. R. C., Bandeira, A. G., et al. (2009). Polycalic nest systems and levels of aggression of *Constrictotermes cyphergaster* (Isoptera, Termitidae, Nasutitermitinae) in the Semi-Arid region of Brazil. *Sociobiology*, 53(1):101.

Costa, C. and Vanin, S. A. (2010). Coleoptera larval fauna associated with termite nests (Isoptera) with emphasis on the "bioluminescent termite nests" from Central Brazil. *Psyche: A Journal of Entomology*, 2010:1–13.

Cristaldo, P. F., Rosa, C. S., Florencio, D. F., Marins, A., and DeSouza, O. (2012). Termitarium volume as a determinant of invasion by obligatory termitophiles and inquilines in the nests of *Constrictotermes cyphergaster* (Termitidae, Nasutitermitinae). *Insectes sociaux*, 59(4):541–548.

Cunha, H. F. and Brandão, D. (2001). Invertebrates associated with the Neotropical termite *Constrictotermes cyphergaster* (Isoptera: Termitidae, Nasutitermitinae). *Sociobiology*, 37(3):593–600.

Cunha, H. F. and Brandão, D. (2002). Multiple reproductives in nests of the Neotropical termite *Constrictotermes cyphergaster* (Isoptera, Termitidae, Nasutitermitinae). *Revista Brasileira de Entomologia*, 46(1):21–24.

Cunha, H. F., Costa, D. A., Espirito Santo Filho, K., Silva, L. O., and Brandão, D. (2003). Relationship between *Constrictotermes cyphergaster* and inquiline termites in the cerrado (isoptera: Termitidae). *Sociobiology*, 42(3):761–770.

Cunha, H. F., Lima, J. S., de Souza, L. F., Santos, L. G. A., and Nabout, J. C. (2015). No morphometric distinction between the host *Constrictotermes cyphergaster* (Silvestri) (Isoptera: Termitidae, Nasutitermitinae)

and its obligatory termitophile *Corotoca melantho* Schiødte (Coleoptera: Staphylinidae). *Sociobiology*, 62(1):65–69.

Emerson, A. E. (1938). Termite nests—a study of the phylogeny of behavior. *Ecological Monographs*, 8(2):247–284.

Grimaldi, D. and Engel, M. S. (2005). Coleoptera and Strepsiptera. In Grimaldi, D. and Engel, M. S., editors, *Evolution of the Insects*, pages 357–406. Cambridge University Press.

Hölldobler, B. (1971). Communication between ants and their guests. *Scientific American*, 224(3):86–95.

Howard, R. W. (1978). Proctodeal feeding by termitophilous Staphylinidae associated with *Reticulitermes virginicus* (Banks). *Science*, 201(4355):541–543.

Howard, R. W., McDaniel, C., and Blomquist, G. J. (1980). Chemical mimicry as an integrating mechanism: cuticular hydrocarbons of a termitophile and its host. *Science*, 210(4468):431–433.

Howard, R. W., McDaniel, C., and Blomquist, G. J. (1982). Chemical mimicry as an integrating mechanism for three termitophiles associated with *Reticulitermes virginicus* (Banks). *Psyche*, 89(1-2):157–168.

Jacobson, H. R. and Pasteels, J. (1985). *Generic revision, phylogenic classification, and phylogeny of the termitophilous tribe Corotocini (Coleoptera; Staphylinidae)*. Thesis (PhD in Science), Université libre de Bruxelles, Brussels.

Kanao, T., Eldredge, K. T., and Maruyama, M. (2012). Two new genera and species of the termite symbiont lineage Termitohospitini (Coleoptera, Staphylinidae, Aleocharinae) from Bolivia and peninsular Malaysia. *ZooKeys*, (254):67.

Kanao, T., Eldredge, K. T., and Maruyama, M. (2016). A defensive body plan was pre-adaptive for termitophily in the rove beetle tribe Termitohospitini (Staphylinidae: Aleocharinae). *bioRxiv*, pages 083881–.

Kistner, A. C. (1998). *An Affair with Africa: Expeditions and Adventures Across a Continent*. Island Press.

Kistner, D. H. (1969). The biology of termitophiles. In Krishna, K. and Weesner, F. M., editors, *Biology of termites*, volume 1, pages 525–557. Elsevier.

Kistner, D. H. (1979). Social and evolutionary significance of social insect symbionts. In Hermann, H. R., editor, *Social insects*, volume 1, pages 339–413. Academic press New York.

Kistner, D. H. (1982). The social insects' bestiary. In Hermann, H. R., editor, *Social insects*, volume 3, pages 1–244. Academic Press New York.

Maruyama, M. and Parker, J. (2017). Deep-time convergence in rove beetle symbionts of army ants. *Current Biology*, 27(6):920–926.

Mathews, A. A. (1977). *Studies on termites from the Mato Grosso state, Brazil*. Academia brasileira de ciências Rio de Janeiro.

Moura, F. M. S., Vasconcellos, A., Araujo, V. F. P., and Bandeira, A. G. (2006a). Feeding habit of *Constrictotermes cyphergaster* (Isoptera, Termitidae) in an area of caatinga, northeast brazil. *Sociobiology*, 48(1):21–26.

Moura, F. M. S., Vasconcellos, A., Araújo, V. F. P., and Bandeira, A. G. (2006b). Seasonality in foraging behaviour of *Constrictotermes cyphergaster* (Termitidae, Nasutitermitinae) in the Caatinga of northeastern Brazil. *Insectes Sociaux*, 53(4):472–479.

Parker, J. (2016). Myrmecophily in beetles (Coleoptera): evolutionary patterns and biological mechanisms. *Myrmecological News*, 22:65–108.

Pasteels, J. M. (1969). Les glandes tégumentaires des staphylins termitophiles. *Insectes Sociaux*, 16(1):1–26.

Pisno, R. M. (2016). Bases da coabitação entre besouros Staphylinidae e cupins Termitidae. Dissertation (MSc in Entomology), Universidade Federal de Viçosa, Viçosa, MG.

Rettenmeyer, C. W., Rettenmeyer, M., Joseph, J., and Berghoff, S. (2011). The largest animal association centered on one species: the army ant *Eciton burchellii* and its more than 300 associates. *Insectes Sociaux*, 58(3):281–292.

Sands, W. A. and Lamb, R. W. (1975). The systematic position of Kaudernitermes gen. n. (Isoptera: Termitidae, Nasutitermitinae) and its relevance to host relationships of termitophilous staphylinid beetles. *Systematic Entomology*, 44(2):189–200.

Seevers, C. H. (1957). A monograph on the termitophilous Staphylinidae (Coleoptera). *Fieldiana: Zoology*, 40:1–334.

Seevers, C. H. (1965). The systematics, evolution and zoogeography of staphylinid beetles, associated with army ants (Coleoptera, Staphylinidae). *Fieldiana: Zoology*, 47(2):1–351.

Silva, A. M. B. (2014). Liquens associados à alimentação de *Constrictotermes cyphergaster* (Silvestre, 1901) (Isoptera, Termitidae) no semiárido brasileiro. Dissertation (MSc in Ecology and Conservation), Universidade Estadual da Paraíba, Joao Pessoa, PB.

Steidle, J. L. and Dettner, K. (1993). Chemistry and morphology of the tergal gland of freeliving adult Aleocharinae (Coleoptera: Staphylinidae) and its phylogenetic significance. *Systematic Entomology*, 18(2):149–168.

Stoeffler, M., Maier, T. S., Tolasch, T., and Steidle, J. L. (2007). Foreign-language skills in rove-beetles? evidence for chemical mimicry of

ant alarm pheromones in myrmecophilous *Pella* beetles (Coleoptera: Staphylinidae). *Journal of chemical ecology*, 33(7):1382–1392.

Thomas, J. A., Schönrogge, K., and Elmes, G. W. (2005). Specializations and host associations of social parasites of ants. In Fellowes, M. D. E., Holloway, G. J., and Rolff, J., editors, *Insect evolutionary ecology*, pages 479–518. Royal Entomological Society, CABI Publishing UK.

Vasconcellos, A., Araújo, V. F. P., Moura, F. M. S., and Bandeira, A. G. (2007). Biomass and population structure of *Constrictotermes cyphergaster* (Silvestri)(Isoptera: Termitidae) in the dry forest of caatinga, northeastern Brazil. *Neotropical Entomology*, 36(5):693–698.

Chapter 2

Suitable light regimes for filming termites in laboratory bioassays

Sociobiology 65(1): 108-111 (March, 2018) Special Issue DOI: 10.13102/sociobiology.v65i1.2095

Sociobiology
An international journal on social insects

RESEARCH ARTICLE - TERMITES

Suitable Light Regimes for Filming Termites in Laboratory Bioassays

YC Carvalho, LO Clemente, MP Guimarães, O DeSouza

Lab of Termitology, Department of Entomology, Federal University of Viçosa, Viçosa-MG, Brazil

Article History

Edited by
Gilberto M. M. Santos, UEFS, Brazil
Received 26 September 2017
Initial acceptance 06 January 2018
Final acceptance 06 January 2018
Publication date 30 March 2018

Keywords
Cornitermes cumulans, infrared, LED, Isoptera.

Corresponding author
Og de Souza
Lab of Termitology
Depto Entomology
Federal University of Viçosa
CEP 36570-900, Viçosa-MG, Brazil
E-Mail: og.souza@ufv.br

Abstract

Laboratory bioassays require strategies to minimize stress and keep animals alive as long as the test demands. Sometimes, however, experimental procedures seem notoriously stressful as, for instance, when exposing termites to the illumination needed for video recordings. Being a condition opposed to what termites naturally experience, light might easily stress such insects or might not affect them at all, as they are blind. Here we check for the effects of distinct light regimes on the survival of termites confined in a typical bioassay setup involving footage. The survival of Cornitermes cumulans (Termitidae: Syntermitinae) workers kept in the dark, or subjected to infrared or to cold white light was compared, finding no statistical difference in their survival in these three treatments. While pointing directions for further research on the reasons for such results, we conclude that video recordings of *C. cumulans* termite workers can be conducted under infrared or cold white LEDs, as these light regimes do not affect the survival of tested individuals.

Introduction

Laboratory bioassays require methods to keep animals in conditions as close as possible to their natural ambiance, so that to minimize stress and keep individuals alive as long as the test demands. However, some experimental procedures do require unnatural, potentially stressful conditions, such as the illumination demanded for video recordings of termite behavior. After all, by living inside nests and galleries and foraging only inside tunnels, most termites are better thought as accustomed to dark than to light conditions. Illumination normally needed for video recordings would, hence, be a potential source of stress for these insects.

In fact, termite workers and soldiers – the castes normally used in bioassays – show some aversion to open air conditions, ducking to darker places when their mound is opened (Williams, 1959) or when exposed to incandescent light in experimental arenas (Park & Raina, 2005). Being eyeless, these termites would not be thought to be bothered by light, escaping to darken areas for reasons other than typical photophobia. Further studies, however, have shown that ultraviolet light percolating through the unpigmented cuticle of *Reticulitermes* spp. can harmfully react with an alkaloid norharmane present in their hemolymph, impairing these termites' survival (Siderhurst et al., 2006)

Whether or not unpigmented termites other than *Reticulitermes* would equally be harmed by UV-light exposure, remains to be tested. After all, norharmane is produced by endosymbionts (Siderhurst et al., 2005) whose species composition varies across termites (Ohkuma, 2008). It also remains to be tested whether other electromagnetic wavelengths could harm termites as UV-light does.

On the other hand, even species such as *Coptotermes formosanus*, presenting low norharmane amounts (Itakura et al., 2008), do show aversion to light (Park & Raina, 2005), reinforcing the idea of light as a potential source of stress, irrespective of norhamane content, at least for the so called "lower termites".

On their turn, many "higher termites", belonging to the family Termitidae, present unpigmented workers and cryptic habits similar to those of *Reticulitermes* and *Coptotermes*, being hence potentially affected by light exposure. Among

these, the Neotropical *Cornitermes cumulans*, would seem to deserve attention. Being easily captured from conspicuous and populous nests, this species large individuals allow video recording without macro lenses, and are hence an obvious choice for lab bioassays footage. Miramontes et al. (2014), for instance, studying patterns of spatial exploratory behavior in individual termites, video-recorded the movement of *C. cumulans* workers continuously for 5-6 hours. In order to accurately track every termite cartesian location during the assay, the arena was constantly illuminated by a cold white fluorescent lamp.

Here we intend to contribute to this type of study, testing the effects of distinct light regimes on the survival of *C. cumulans* workers confined in arenas, as typically done in many lab bioassays. Three light regimes were tested: no lights (*i.e.* darkness), infrared, and cold white lights. Infrared illumination is the closest to darkness an affordable camera could record whereas cold white illumination is suitable to footage by any type of camera. If *C. cumulans* is harmed by illumination (as in *Reticulitermes* affected by UV-lights), we expect their survival to differ between these light regimes, no difference in survival being found otherwise.

Materials and Methods

Focal species

C. cumulans live inside epigeous nests and feed on living and dead grasses and herbs, which they reach through subterranean tunnels, occasionally foraging under a fine layer of soil-sheeting (de Negret & Redford, 1982). Their mounds are abundant in grasslands in the Neotropics, and are found in pastures, monocultures, savannas (Araujo, 1970) and even in gardens in urban areas. This species builds mounds with a very hard outer shell of soil which surrounds a soft inner core of carton (fecal material, comminuted plant material and bits of soil) (de Negret & Redford, 1982). *C. cumulans* is a key species in grasslands, providing stable and predictable shelter for other termites, invertebrates, and vertebrates (Redford, 1984; Campbell et al., 2016).

Data collection

The study was carried out in Viçosa, in the state of Minas Gerais State, Southeastern Brazil, located at 20º45' S 42º51' W, in the facilities of the Lab of Termitology, Federal University of Viçosa ('UFV' in Brazilian acronym). The experiment aimed to verify the effect of distinct illumination regimes on the survival of *C. cumulans* workers kept in Petri dishes in the lab. Termites were collected from colonies found in the UFV's *campus* on three occasions: 30 May, 2nd June and 5th June 2017. Fragments from three different nests were collected per date, totaling nine nests. Each nest fragment was taken to the lab, where 20 workers (third instar and beyond) were extracted to form an experimental unit confined in a closed Petri dish (59 mm internal diameter). A total of nine experimental units were formed, three for each illumination regime: (i) dark; (ii) cold white LED (OUROLUX™12W; color temperature: 6500K; luminous flux: 1200lm; luminous efficacy: 100lm/W); (iii) infrared light (ILS, OSLON IR 1 PowerStar IR Star LED, peak wavelength: 850nm, radiant flux 1070mW, radiance angle: ±45, 2-pin, SMD, using current=1.12A;voltage=15v). Experimental units were then taken to BOD incubator, under 25ºC±1, within which one of the three types of illumination regimes was set up. No food or water was provided in the Petri dishes.

Since group size can affect survival in termites, and this survival is associated with the spatial density termites are subjected to, we kept each experimental group at a density of 0.14 (the ratio between the total area occupied by termites and the total area of the arena's floor). This is within the range 0.10 to 0.19 considered to favor survival in termites (Miramontes & DeSouza, 1996; DeSouza et al., 2001; DeSouza & Miramontes, 2004)

Counting of dead and live individuals proceeded every hour in each Petri dish for the first 12 h after which it was halted for the next 8 hours. Then the hourly tally was resumed until all individuals were dead.

Data analysis

Data were subjected to censored survival analysis under Weibull distribution, similar to what DeSouza et al. (2009) have done, using survival package in R (R Core Team, 2015). Survival analysis is the statistical analysis of data where the response of interest is the time, t, from a well-defined time origin to the occurrence of some given event (end-point) (Martinussen & Scheike, 2006). In our case, time origin is when we put the Petri dish inside the BOD incubator and the end-point is when we record the death of a termite worker in this arena.
The general model for this analysis follows the equation:

$$\log_e S(t) = \mu^{-\alpha} t^{\alpha}$$

Where $S(t)$ is the accumulated proportion of dead termites until time, t; the mean time μ is the time elapsed until 50% of termites are dead in a given treatment; and α is the shape parameter for the survival curve. When α=1, the probability of a termite dying does not change as time elapses. If α<1 this probability reduces as time elapses, the opposite happening when α>1.

Statistical analysis was used to check whether the light regime would affect the mean time, μ, until termites are found dead in a given treatment. Under the null hypothesis, the mean time, μ, does not differ between light regimes, hence, time, t, alone explains S(t). That is, under the null hypothesis, termite deaths are not speeded up nor delayed by the light regime. Alternatively, if the light regime affects the time at which a termite dies, a typical μ can be calculated for each regime.

Modelling proceeded by building a full model with a single term, light regime, represented by a categorical variable with three levels: darkness, infrared light, and white light. Model simplification was performed removing this term from the full model and inspecting the consequent change

in deviance. In case of significant changes (*i.e.*, $P \leq 0.05$), the term would have been returned to the model to proceed further simplification amalgamating its levels.

Results

Cornitermes cumulans termite workers confined in Petri dishes in a BOD incubator kept at 25ºC did not show any obvious quantitative changes in behavior along the whole experiment. Within each of these experimental arenas, termites circulated normally, stopping to interact or simply passing by when meeting a given conspecific. Interactions involved antennations, allogrooming, mouth-to-mouth contacts (presumably, oral trophallaxis), and occasional mouth-to-anus contacts (presumably, anal trophallaxis).

Survival curves presented a shape parameter $\alpha>1$ ($\alpha=3.369$), implying that mortality tended to be more expressive towards the end of the experiment. In fact, after 500 min had elapsed, more than 80% of the termites were still alive in all treatments. Mortality crossed the 50% threshold more than 1000 min after the beginning of the experiment (Fig 1).

Light intensity experienced by termites in the experimental units varied from 0 lux (darkness) to 5 lux (infrared) to 672 lux (white LED light). This has led to an average survival time of 1085 min for termites kept in the dark, 1065 min for termites kept under white LED light and 1102 min for termites exposed to infrared light. These timings and hence their respective light regimes, however, did not differ statistically (Table 1, $P=0.31$).

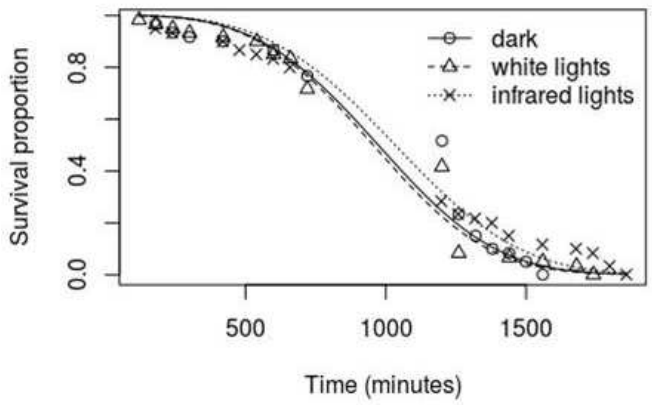

Fig 1. Survival of *C. cumulans* workers confined in Petri dishes in the dark, exposed to white lights, or exposed to infrared lights, in a BOD incubator kept at 25ºC. Curves do not differ statistically ($P=0.31$).

Table 1. Analysis of deviance for the effects of light regime on the survival of *C. cumulans* termite workers confined in Petri dishes. Three light regimes were applied continuously to the experimental arenas: darkness, infrared light, and cold white light. See Material & Methods for more detail. "LL" = log-likelihood.

	Df	Deviance	Resid. Df	-2*LL	Pr (> χ^2)
Null			178.00	2660.90	
Light regime	2.00	2.31	176.00	2658.59	0.31

Discussion

We did not observe any effect of the distinct light regimes on the mortality of *C. cumulans* workers in this work: such termites presented similar survival patterns when confined in darkness, under cold white light, or under infrared light (Fig 1, Table 1). While arising intriguing theoretical issues, these results have important practical connotations.

On the theoretical front, these results would evoke the question of why these termites, as opposed to *Reticulitermes*, were not harmed by the light regimes under test? Among plausible hypotheses, one has to consider the possibility that the light regime of highest intensity here applied (672 lux) was still below any harmful potential. This hypothesis, still to be tested, gains significance from the fact that daylight illuminance under bright sun attains not less than 100,000 lux, or 20,000 lux in the shade. An alternative hypothesis would point to the absence of phototoxic compounds in the hemolymph of *C. cumulans*. In order to answer it, one would have to inspect the presence of compounds such as norhamane, which is responsible for phototoxic effects in other termites (Siderhurst et al., 2006). Clearly, these hypotheses are beyond the aims of this work but we present them here in an attempt to sign the research avenues they could open.

On the practical front, our results validate the use of infrared and cold white lights in studies that demand video recording with *C. cumulans*, as none of these light regimes affected workers survival. Being closest to dark that we can record with a video camera, infrared would seem the best choice for such assays. As a drawback, not any camera can record video under infrared, and those which can, are normally more expensive (albeit many are still within the affordable price range). Compared to infrared lights, cold white LEDs are cheaper and easier to find. Better still, all cameras can record under this type of light.

As a word of caution, it must be considered that our test regards survival only. Despite not observing any obvious behavioral changes while counting dead and alive individuals for our test, no quantitative behavioral parameter was inspected (and this is, incidentally, another possible development from the current work). We conclude, therefore, that video recordings of *C. cumulans* termite workers can be conducted under infrared or cold white LEDs, as these light regimes do not affect the survival of tested individuals.

Acknowledgements

We thank Helder Hugo dos Santos for providing us the infrared lights used in this study. This work was partially supported by CNPq, Fapemig, Capes. YCC, LOC, MPG hold MSc grants from CAPES. ODS holds a CNPq fellowship (#307990/2017-6). This work is part of the IV SymTermes Community at https://zenodo.org/communities/symtermes/?page=1&size=20, where it is identified by DOI 10.5281/zenodo.894421. This is contribution # 71 from the Lab of Termitology at Federal Univ. of Viçosa, Brazil (http://www.isoptera.ufv.br).

References

Araujo, R.L. (1970). Termites of the Neotropical region. In K. Krishna & F.M. Weesner (Eds.), Biology of Termites, vol II (pp. 527–576). New York: Academic Press.

Campbell, C., Russo, L., Marins, A., DeSouza, O., Schönrogge, K., Mortensen, D., Tooker, J., Albert, R. & Shea, K. (2016). Top-down network analysis characterizes hidden termite-termite interactions. Ecology and Evolution. doi: 10.1002/ece3.2313.

de Negret, H.R.C. & Redford, K.H. (1982). The biology of nine termite species (Isoptera: Termitidae) from the cerrado of central Brazil. Psyche, 89: 81–106.

DeSouza, O., Araújo, A. & Reis-Jr, R. (2009). Trophic controls delaying foraging by termites: reasons for the ground being brown? Bulletin of Entomological Research, 99: 603–609.

DeSouza, O. & Miramontes, O. (2004). Non-asymptotic trends in the social facilitated survival of termites (Isoptera). Sociobiology, 44: 527–538.

DeSouza, O., Miramontes, O., Santos, C. & Bernardo, D. (2001). Social facilitation affecting tolerance to poisoning in termites (Insecta, Isoptera). Insectes Sociaux, 48: 21–24.

Itakura, S., Kawabata, S., Tanaka, H. & Enoki, A. (2008). Effect of norharmane in vitro on juvenile hormone epoxide hydrolase activity in the lower termite, *Reticulitermes speratus*. Journal of Insect Science, 8: 13.

Martinussen, T. & Scheike, T.H. (2006). Dynamic Regression Models for Survival Data. Statistics for Biology and Health. 470 pp., New York: Springer Science+Business Media, Inc.

Miramontes, O. & DeSouza, O. (1996). The nonlinear dynamics of survival and social facilitation in termites. Journal of Theoretical Biology, 181: 373–380.

Miramontes, O., DeSouza, O., Paiva, L.R., Marins, A. & Orozco, S. (2014). Lévy flights and self-similar exploratory behaviour of termite workers: beyond model fitting. PLoS One, 9: e111183. doi: 10.1371/journal.pone.0111183.

Ohkuma, M. (2008). Symbioses of flagellates and prokaryotes in the gut of lower termites. Trends in Microbiology, 16: 345–352. doi: 10.1016/j.tim.2008.04.004.

Park, Y. & Raina, A. (2005). Light sensitivity in workers and soldiers of the formosan subterranean termite, *Coptotermes formosanus* (Isoptera: Rhinotermitidae). Sociobiology, 45: 367-376.

R Core Team (2015). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Redford, K.H. (1984). The termitaria of *Cornitermes cumulans* (Isoptera, Termitidae) and their role in determining a potential keystone species. Biotropica, (pp. 112–119).

Siderhurst, M.S., James, D.M. & Bjostad, L.B. (2006). Ultraviolet light induced autophototoxicity and negative phototaxis in *Reticulitermes* termites (Isoptera: Rhinotermitidae). Sociobiology, 48: 27–49.

Siderhurst, M.S., James, D.M., Blunt, T.D. & Bjostad, L.B. (2005). Endosymbiont biosynthesis of norharmane in *Reticulitermes* termites (Isoptera: Rhinotermitidae). Sociobiology, 45: 687–705.

Williams, R. (1959). Flight and colony foundation in two *Cubitermes* species (Isoptera: Termitidae). Insectes Sociaux, 6: 203–218.

Chapter 3

Biting the hand that feeds: The interaction between a termitophile and its host

Abstract

Symbioses are ubiquitous in nature and, as every interespecific interaction, are characterized by costs and benefits. However, characterizing such interactions in a cost-benefit perspective might be challenging. This is because there is a broad continuum of interactions from mutualism to parasitism that difficult quantifying such costs. Thus, the balance of costs and benefits for many interactions are still open to investigation. One of these associations is termitophily, in which an organism invades a termite nest and cohabit with the builder species. Termitophily is commonly observed, however, the nature of this interaction is still poorly understood, specially because it occurs cryptically, with the closed environment of a termitarium. Here we measured the costs arisen from the interespecific encounters between the termite *Constrictotermes cyphergaster* (Silvestri, 1901) (Termitidae: Nasutitermitinae) and the termitophilous beetle *Corotoca melantho* Schiødte 1853 (Staphylinidae: Aleocharinae), using a parameter of survival of individuals when confined in interspecific groups. With that, we aimed to have a better understanding of the association between termites and termitophiles. We also investigated what could cause such costs through behavior observations. The results showed that the termitophile presence was costly to termites, reducing their survival, while the termite presence was beneficial to the beetle delaying their time until death. Additionally, as termitophile numbers decreased, we observed that termites survival increased. These results seem to stem from negative effects of the termitophiles upon termites. In mixed-species groups, termitophiles were shown to engage in mouth-to-mouth contacts with termites, and to frequently bite their hosts; such interactions resulting in significant reduction in termite survival. These effects were progressively stronger as the proportion of *C. melantho* individuals relative to their termite host increased. Very harmfull effects, however, would be only observed in *C. melantho* proportions far above the values normally observed in the field. It seems hence that termitophiles natural low abundance inside termitaria would make their costs unnoticed by their host termites.

Keywords: Isoptera, Termitidae, Staphylinidae, symbiosis, social parasitism, survival, density

Introduction

Symbioses — different organisms living together (De Bary, 1879) — are ubiquitous in nature and may play a central role in ecological processes (Douglas, 1995). As every interaction, symbioses are characterized by costs and benefits, which results in fitness consequences for the individuals associated (Bronstein, 1994). Traditionally under such costs/benefits perspective, symbiosis can be labeled as mutualism (i.e. when the interaction is beneficial to both partners), commensalism (i.e. when the interaction is positive to one partner and neutral to the other) and parasitism (i.e. when the interaction is positive to one partner and negative to the other). However, placing interactions in such labels might be challenging. That is because these interactions are parts of a broad continuum, from mutualism to parasitism, and it is difficult to know where one type of association ends and another begins (Parmentier and Michel, 2013). Moreover the costs and benefits of a given interaction can vary depending on the context, changing its placement in the continuum (Bronstein, 1994; Johnstone and Bshary, 2002; Johnson et al., 1997; Lee et al., 2009; Manley et al., 2017; Yoo and Holway, 2011).

Interactions can be shifted by both biotic factors, such as symbiont density (Breton and Addicott, 1992), starvation (Manley et al., 2017),epibiont abundance (Lee et al., 2009) and parasitoid presence (Okabe and Makino, 2008), or abiotic factors, such as temperature (Frydenborg et al., 2014) or water availability (Davitt et al., 2011). For example, increases in symbiont density can change the effect on the host as it was shown by Hughes et al. (2004) in the interaction between the entomopathogenic fungus *Metarhizium anisopliae* var. *anisopliae* and the leaf-cutting ant *Acromyrmex echinator*. At small densities of the fungus, infected ants survival was the same as that of uninfected, but when a threshold of the fungus is reached, survival

of infected ants decreased. As fungus densities raised, ant mortality also increased, until another threshold was reached, and then mortality was the same for the higher densities, as ant mortality was almost 100%.

Beyond the classical examples of host-microbe associations, symbiosis also occurs at a different scale on social insects: at the colony level (Hovestadt et al., 2011). Several macroorganisms, mostly arthropods, infiltrate social insects' nests in order to exploit the rich resources concentrated therein (Hovestadt et al., 2011), or to find refuge in the enemy-free (Thomas et al., 2005), temperature and humidity regulated environment of nests (Korb and Linsenmair, 2000). This association at colony level is usually designated by the group of social insects which they cohabit. Thus, these macro symbionts are called myrmecophiles when associated with ants colonies, melittophiles when in bees colonies, sphecophiles for symbionts of wasps colonies and termitophiles when associated with termites (Kistner, 1979). Besides being an interesting case of interaction, this association at colony level provides a macroscopic scenario to study symbiosis, with organisms more easily observed and handled than in the classical host-microbe associations. Thus, macro symbionts provide a suitable model to study how associations occur and how they are kept in nature, without even needing any sophisticated apparatus to inspect their interactions.

In the family Staphylinidae (Coleoptera), many independent lineages have evolved to live as social insects' cohabitants, associating mainly with ants and termites (Seevers, 1957, 1965; Kistner, 1979; Maruyama and Parker, 2017), with the subfamily Aleocharinae standing out as the most successful group of myrmecophiles and termitophiles (Seevers, 1957, 1965; Kistner, 1969; Parker, 2016). Aleocharinae beetles developed different strategies to live inside their hosts' colonies. Some of these symbionts have a defensive body plan to avoid aggression from their hosts, while others have an adapted morphology to be socially integrated (i.e. accepted as nestmates)

in the colony (Kistner, 1979; Parker, 2016).

In many army-ants symbionts, beetles have an ant-like "myrmecoid" morphology, with a petiolate abdomen, and sometimes further similarities with their hosts, such as elongated appendages and elbowed antennae, which are thought to mediate tactile mimicry of nestmate recognition cues (Seevers, 1965; Kistner, 1979; Parker, 2016; Maruyama and Parker, 2017). Similarly, many termitophiles present a termite-like morphology. This form is due to a physogastric (i.e. hypertrophic) abdomen (Seevers, 1957; Kistner, 1979). The swollen abdomen of these termitophiles, is probably also associated with tactile nestmate recognition cues of their host termite. Other Aleocharinae's strategies associated with the life of social insect symbionts includes chemical mimicry (Howard et al., 1980, 1982); trail-following (Howard, 1980); appeasement secretions from beetle glands (Hölldobler, 1971; Kistner, 1979); begging food to their hosts (Howard, 1978; Kistner, 1973); and a population at a low abundance inside the nest (Kistner, 1979).

These beetles are usually regarded as social parasites, imposing costs on their hosts through resource exploitation and brood predation (Kistner, 1979), mainly on ants (Witte et al., 2008; Von Beeren et al., 2011; Parker, 2016; Parmentier et al., 2016). However, for physogastric termitophiles it was even assumed that they may have established a mutualistic relationship with their host (Seevers, 1957). Despite these assumptions, quantifying the costs and benefits of this group of termitophiles in regard to their hosts has never been done. In fact, for termitophiles in general, studies regarding the interactions with their termites hosts are scarce (but see Higashi and Ito, 1989; Leponce et al., 1999; Rosa et al., 2008). Thus, the ecological mechanisms of termitophily are still unclear, with not enough data to place this association along the mutualism-parasitism continuum.

Here, we will focus on the interactions between *Corotoca melantho* Schiødte,

1853 (Staphylinidae: Aleocharinae: Corotocini), an obligatory physogastric termitophile exclusively found inside nests of *Constrictotermes cyphergaster* (Silvestri, 1901) (Termitidae: Nasutitermitinae), and their host termite in laboratory conditions. We aimed to estimate some of the costs involved in hosting termitophiles, inspecting the effects of termite-termitophile interactions upon termite survival. As a method to provides hints on the nature of the interaction, we will expose the host termites to increasing symbiont populations, similarly to dose-ranging studies. In doing so, we simulate increments in termitophile density within termitaria being thence able to observe whether such a populational boost would impact host termites in any extent. It is irrelevant whether or not such an increment would be ever observed in nature, what matters here is the potential it could represent. Here we show that although *C. melantho* could cause a cost upon termite individuals, their overall effect on *C. cyphergaster* colonies would be negligible because it keeps very low populations within termitaria. Nevertheless we suggest that such a result may help to explain why termites tolerate such invaders in their nests and why such interaction is kept along the evolutionary timescale.

Materials and Methods

Terms and definitions

The terms "nest" and termitarium used here denote the physical structure built by termites. "Colony" refers to the living termite individuals, including the reproductive pair, workers, soldiers, immatures, and eggs within the nest. Termitophily refers to the organisms that live inside termite nests, associated with the colony. The pair of symbionts here studied is composed by the "host", *Constrictotermes cyphergaster* and the "termitophile", *Corotoca melantho*. The terms "parasitism" and "commensalism" refers only to the

balance of costs associated with these interactions (respectivelly positive to one partner and negative to the other; and positive to one partner and neutral to the other), and do not refer directly to a trophical interaction.

Focal species

C. cyphergaster[f] (Termitidae: Nasutitermitinae) is a common termite species in Brazil, Paraguay, Bolivia, and Northern Argentina (Mathews, 1977), that forages at night in exposed columns (Moura et al., 2006b). It feeds on leaf litter (Moura et al., 2006a) and on microepiphytes (Bourguignon et al., 2011). *C. cyphergaster* usualy build their nests on trees (Moura et al., 2006b), although nests can also be built on rocks (Vasconcellos et al., 2007). Active nests of this species can harbour many termitophiles, mainly Staphylinidae (Insecta: Coleoptera) (Seevers, 1957).

The most frequent termitophile in *C. cyphergaster* nests is *Corotoca melantho* Schiødte, 1853 (Staphylinidae: Aleocharinae: Corotocini). This termitophile was recorded in about 80% of the nests collected by Cunha and Brandão (2001) and Cristaldo et al. (2012), *C. melantho* is reported to live in close contact with their host termite with no antagonist interactions from workers (Cunha et al., 2015). It is also supposed that this species is fed by their host termites. As all species of the subtribe Corotocini, *C. melantho* have the mentum fused to the submentum, forming a shield-like sclerite, and Seevers (1957) supposes that this trait may facilitate receiving liquid aliment from termites. Another feature common to all Corotocini is physogastry, which in *C. melantho* is so pronounced that their morphology is similar from workers of their host termite (Cunha et al., 2015).

Sampling

C. cyphergaster[f] nests were collected in the Brazilian "Cerrado" biome on two expeditions, the first on January 2017 in the municipality of Divinópolis (20°08′ S 44°53′ W) and the second on April 2017 on the municipality of Sete Lagoas (19°24′ S 44°09′ W), both from Minas Gerais State, Southeastern Brazil. According to Köppen's classification, both study areas lies in Aw (equatorial with dry winter) climate (Kottek et al., 2006).

For *C. cyphergaster* there is a critical nest size of 2.2 litters, above which nests are more likely to be invaded by staphylinids (Cristaldo et al., 2012). Thus, we only collected nests bigger than 2.2 litters in the field. Nests were removed from the field, put into plastic bags, labeled and taken to the facilities of the Lab of Termitology, Federal University of Viçosa (20°45′ S 42°51′ W), Minas Gerais State, Southeastern Brazil. The first collection provided the specimens for the Survival experiment I, and the second collection for the subsequent experiments.

Once in the lab, each nest was kept inside an open plastic bag. Nests were kept entire to maintain temperature and humidity close to what the termites are naturally exposed. Water was supplied through test tubes with water closed with a piece of cotton. These tubes were changed for new ones with water every three days. Also, every three days, tree bark lichens were offered as food. To extract the individuals, the nest was carefully opened and inspected, capturing them with a soft hair brush.

Rationale

Three experiments were performed. Firstly a survival experiment to check how the presence of the termitophile affects its host termite and vice versa. Then another survival experiment was performed to check if the effects of *C. melantho* were density dependent, and thus would diminish according

to decreases in their numbers. Lastly, the behavior performed by the termitophile was observed in search of interactions that could have caused the effects on the host termites. Each one of these experiments will be explained as shown bellow.

Survival experiment I

The experiment aimed to verify the effect of *C. melantho* beetles upon the survival of *C. cyphergaster* termites, and vice-versa. To do so, we confined individuals of both species in Petri dish arenas and followed their survival in time. Three treatment groups were set up: (i) monospecific group with only termites, (ii) a monospecific group with only termitophiles and (iii) a heterospecific group with termites and termitophiles together. Each one of these groups was replicated three times. Host groups, in both monospecific and heterospecific groups, consisted of 8 workers and 2 soldiers, while termitophile number consisted of 20 *C. melantho*, with an equal proportion of males and females. The number of workers and soldiers was based on natural caste proportions (Cunha et al., 2003). A high proporion of the beetle was used to force the encounter with the termites and to evince any effect it could have on its host.

Petri dishes floor (85mm internal diameter) were covered with filter paper to facilitate individuals mobility, after all, the absence of arolia in termite tarsi (Crosland et al., 2005) could potentially impair their locomotion on a glass floor. The experiment was performed in a controlled temperature room, with (25°C$\pm$ 1).

Dead and alive termites and termitophiles were counted every hour in each Petri dish until all individuals were found dead.

Survival analysis I

Data were subjected to censored survival analysis under Weibull distribution, similar to what DeSouza et al. (2009) have done, using survival package in R (R Core Team, 2015). Survival analysis is the statistical analysis of data where the response of interest is the time, t, from a well-defined time origin to the occurrence of some given event (end-point) (Martinussen and Scheike, 2006). In our case, time origin was when we started the experiment and the end-point is when we recorded the death of an individual in this arena.

The general model for this analysis follows the equation 3.1:

$$log_e S(t) = \mu^{-\alpha} t^{\alpha} \tag{3.1}$$

Where $S(t)$ is the accumulated proportion of dead individuals until time, t; the mean time μ is the time elapsed until 50% of individuals are dead in a given treatment; and α is the shape parameter for the survival curve. When $\alpha = 1$, the probability of an individual dying does not change as time elapses. If $\alpha < 1$ this probability reduces as time elapses, the opposite happening when $\alpha > 1$

Statistical analysis was used to check whether the group composition (monospecific or heterospecific) affected the mean time, μ, until termites and termitophiles are found dead in a given treatment. Under the null hypothesis, the mean time, μ, does not differ in the presence of the other species, hence, time, t, alone explains S(t). That is, under the null hypothesis, termite and termitophile deaths are not speeded up nor delayed by the presence of each other. Alternatively, if the company of the other species affects the time at which a termite or termitophile dies, a typical μ can be calculated for each regime.

Survival analysis was made separated for each species (that is, for *C.*

cyphergaster and for *C. melantho*). Modelling proceeded by building a model with the term "group composition" – represented by a categorical variable with two levels monospecific and heterospecific – and contrasting it with the null model. Significance level was fixed at $p < 0.05$.

Survival experiment II

The experiment aimed to verify the effect of the number of termitophiles on the survival of *C. cyphergaster* kept in Petri dish arenas in the lab. Two arenas were set up from each nest. One dish contained a monospecific group, with only host individuals, and the other dish contained a heterospecific group, with host and termitophile individuals. Host groups, in both monospecific and heterospecific groups, consisted of 28 workers and 7 soldiers, while termitophile number increased in each sample (2, 4, 8, 12, 16, 18, 20, 24, 26, 28, 32, 36), with an equal proportion of males and females. This number of workers and soldiers is based on the natural caste proportions found for the species (Cunha et al., 2003). These numbers were also chosen to keep each experimental group within the density range 0.10 to 0.20, which is known to favour termite survival (Miramontes and DeSouza, 1996; DeSouza et al., 2001; DeSouza and Miramontes, 2004). Density here is understood as the ratio between the total area occupied by individuals in the experimental group and the total area of the arena's floor. The densities actually used for each experimental group are listed at Supplementary material I Table 3.8.

As in the previous experiment, we also used Petri dishes (85mm internal diameter) covered with filter paper. The experiment was performed in a controlled temperature room, with ($25^{\circ}C \pm 1$). Termites were kept under white cold lights (LED). Although the setting of lights is an unnatural condition compared to what termites usually face inside their nests, previous experiments demonstrated that these artificial lights did not affect termites

survival (Carvalho et al., 2018).

Dead and alive termites and termitophiles were counted every hour in each Petri dish until all individuals were found dead.

After termites were dead, they were observed in a stereo microscope to check if they had any sign of predation or attack.

Survival analysis II

Data were subjected to censored survival analysis as described above. In order to verify the effect of the amount of termitophiles on the survival of their host termites, we first estimated the mean time to death for termites in each of the experimental groups, either monospecific or heterospecific. To to so, we subjected the data to censored survival analysis, as describe above. Then, with such mean times at hand, we calculated the effects of the presence of termitophiles upon termite survival according to the equation:

$$SR = TH/TM \tag{3.2}$$

where SR is the survival rate of termites (that is, the net effect of termitophiles upon termite effects, discounting other factors such as the overal health of termites in that nest); TH is the mean time to death of termites confined in heterospecific groups and TM is this mean time for termites confined in monospecific groups. When SR $=$ 1, TH $=$ TM and termite survival is not affected by the presence of termitophiles. When SR $<$ 1, TH $<$ TM and termite survival dimished by the presence of termitophiles. When SR $>$ 1, TH $>$ TM and termite survival is increased by the presence of termitophiles.

After obtaining SR for all pairs fo monospecific + heterospecific groups, we run a linear regression to inspect whether the amount of termitophiles would affect SR. In doing so, we could check whether there was a general trend for SR to increase or decrease as the proportion of termitophiles was

enhanced in a grive experimental group.

Behavioral experiment

Here we hypothesize that the interactions of these termitophiles with their hosts could explain the survival results. That is, as termites survival decreases, *C. melantho* interactions with their hosts would increase.

Prior to running the assays, *ad libitum* observations (Altmann, 1974), using video records, were performed to survey *C. melantho* behaviors. Such behaviors are presented in Table 3.1. Termites and termitophiles confined in Petri dish arenas, with arena's floor covered with filter papaer, were filmed using a digital camera (Nikon P510) under white cold lights (LED).

Table 3.1: Description of behaviors performed by *C. melantho* in the presence of their host termite *C. cyphergaster* based on *ad libitum* observations in experimental arenas. Abreviations: w = host worker; s = host soldier; c = *C. melantho*.

Behavior	Target	Description
Mouth-to-mouth contact	w;s;c	Approaches another individual and perform a mouth-to-mouth interaction, possibly stomodeal trophallaxis.
Bite	w;s;c	Bite and grasp, mostly on the abdomen of its target, sometimes even when the target walks, the beetle keeps holding it with its mandibles
Droplet deposit	-	Extend its abdomen and deposit a droplet on the floor.
Atennation	w;s;c	Waves the antennae or use it to touch another individual or the substract.
Allogrooming	w;s;c	Performs grooming with its mouthparts on another individual
Walking	-	Moves around the arena
Penis eversion	c	When close to a female, males would raise their abdomens and evert their penis, probably trying to copulate
Rest	-	Remains stationary in the same place. Sometimes, groups of *Corotoca* would rest together, forming clusters in the arena.

In order to access behaviors performed by individuals at host-symbiont encounters, the same groups used in Survival Experiment II were filmed in its first hour. Both species were kept in separated arenas containing only termites and others containing only termitophiles and were acclimatized for 2 hours. After this time, termitophiles were gathered with termites for video recording. For each arena, 58 minutes videos were recorded under the same conditions previously described for the *ad libitum* observations.

On every video, the interactions between the termitophile *C. melantho* and their host *C. cyphergaster* were investigated using instantaneous sampling (Altmann, 1974; Lehner, 1998), in which behaviors are recorded from regular intervals. Here, every two minutes, three second observations were made to verify the interactions in each arena, totalizing 30 observations per arena. Data were recorded by a single observer (YCC) in every video.

Statistical analysis was performed, using R (R Core Team, 2015), to check, in a linear regression whether and how SR (y-var) would be affected by either the number of bites or the number of mouth-to-mouth events performed by C. melatho (x-vars), along with the covariable density in each experimental heterospecific arena. The package MuMin was used for Model simplification and selection by Akaike information criterion (AIC) and the model selected was chosen by the lower Δ value and highest weight value (Symonds and Moussalli, 2011).

Corotoca population inside the nests

To check the population size of *C. melantho* beetles inside the nests, we used the nests collected in Sete Lagoas. To collect the beetles, termitaria were completely dissected while the colony was still alive, and every *C. melantho* was collected using a soft hair brush.

Results

Survival Experiment I

The mean time to death of *C. melantho* confined in Petri dishes with only conspecifics was 415 $\pm$ 24.57 minutes (mean $\pm$ SE), while the mean time to death of the termitophiles in the presence of their host termite was 573 $\pm$ 33.69 minutes (mean $\pm$ SE). The mean time was significantly different from

monospecific and heterospecific groups (Table 3.2, $p < 0.005$), with the ter-
684 mitophiles surviving longer in the presence of the termites as opposed to when they were confined in monospecific groups. Survival curves presented a shape parameter of $\alpha > 1$ ($\alpha = 2.254$), which implies that mortality
687 was higher towards the end of the experiment.

For termites, the mean time to death was also significantly different in the different groups (Table 3.3, $p < 0.005$). Termites kept on monospecific
690 groups survived an average of 1734 $\pm$ 179.15 minutes (mean $\pm$ SE), while termites kept with *C. melantho* individuals survived an average of 522 $\pm$ 53.25 minutes (mean $\pm$ SE). Survival curves also presented a shape param-
693 eter $\alpha > 1$ ($\alpha = 1.825$), implying in a higher mortality towards the end of the experiment. Differently from *C. melantho*, termites survived less in the presence of the termitophiles than when kept in monospecific groups.

Table 3.2: Analysis of deviance for the effect of group composition on the survival of *C. melantho* individuals confined in Petri dishes. Two group compositions were tested: monospecific (with only *C. melantho* individuals) and heterospecific (with *C. melantho* individuals confined with their host *C. cyphergaster*). See Materials and Methods for more detail. LL = log-likelihood

	Df	Deviance	Resid. Df	-2*LL	Pr(>Chi)
NULL			118.00	1643.73	
group composition	1.00	14.60	117.00	1629.13	0.0001

Table 3.3: Analysis of deviance for the effect of group composition on the survival of *C. cyphergaster* termites confined in Petri dishes. Two group compositions were tested: monospecific (with only *C. cyphergaster* individuals) and heterospecific (with *C. cyphergaster* individuals confined with their termitophile *C. melantho*). See Materials and Methods for more detail. LL = log-likelihood

	Df	Deviance	Resid. Df	-2*LL	Pr(>Chi)
NULL			58.00	958.52	
group composition	1.00	41.29	57.00	917.23	0.0000

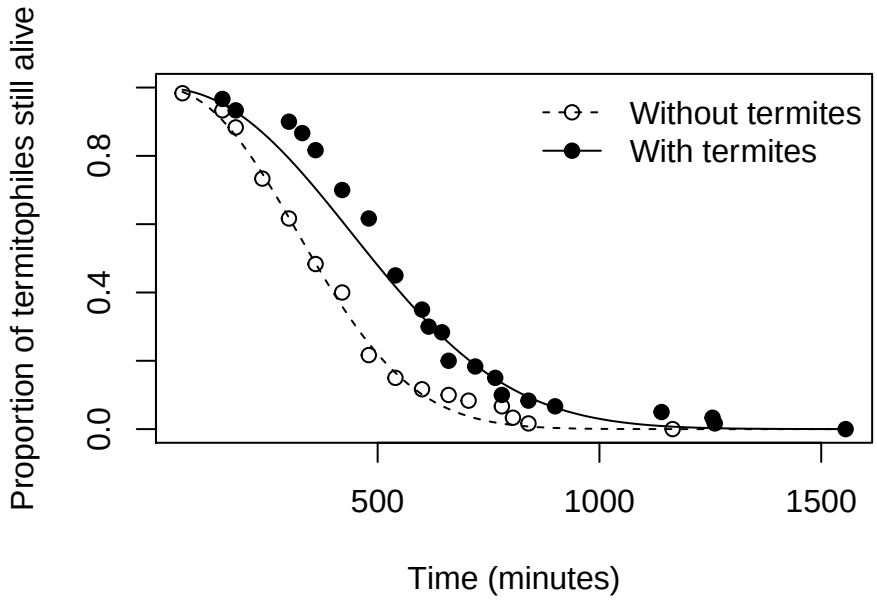

Figure 3.1: Survival of *C. melantho* individuals confined in Petri dishes with and without individuals of their host termite *C. cyphergaster*. Monospecific and heterospecific groups were statistically different ($p < 0.005$). Solid line and closed dots represent the heterospecific groups and dashed line and open dots represent the monospecific groups.

Survival Experiment II

The mean time to death of *Constrictotermes cyphergaster* was significantly different between the groups in the presence and absence of *Corotoca melantho*. On every survival assay, survival curves presented a shape parameter $\alpha > 1$, implying that mortality was higher towards the end of the experiment. At lower *C. melantho* numbers, *C. cyphergaster* survival was higher, and as termitophile/termite rate increased, the termites survival decreased (Fig. 3.3, Table 3.4, $p = 0.0135$). Unlike termites, the mean time to death of *C. melantho* individuals was not affected by increments in termitophile/termite rates (Fig. 3.4, Table 3.5, $p = 0.84$).

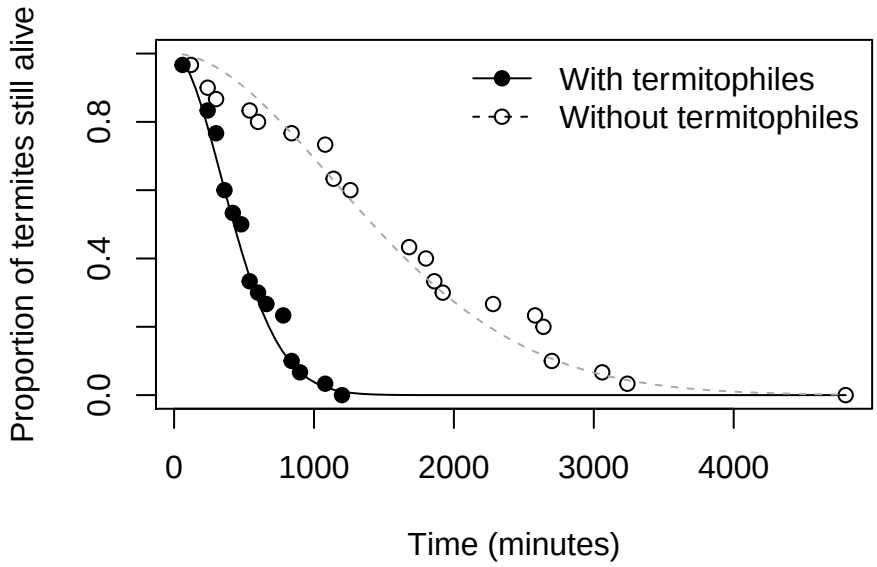

Figure 3.2: Survival of *C. cyphergaster* termites confined in Petri dishes with and without individuals of *C. melantho*. Monospecific and heterospecific groups were statistically different ($p < 0.005$). Solid line and closed dots represent the heterospecific groups and dashed line and open dots represent the monospecific groups.

Table 3.4: Analysis of variance for the effect of termitophile/termites rates on the survival ratio of *C. cyphergaster* termites confined in Petri dishes. See Materials and Methods for more detail.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Termitophile/termite rate	1	0.19	0.19	8.96	0.0135
Residuals	10	0.21	0.02		

Behavioral Experiment

As previously stated, no aggressive interaction from host to the termitophile was observed, not even when the beetle bit termites abdomen. *C. melantho* walked freely among the termites. No signs of predation or attack were found on termites and on termitophiles when observed in a stereo microscope. A general account of the behaviors performed by the beetles can be seen in Table 3.1. Beetles performed mostly bites, and also mouth to mouth interactions, which could be easily interpreted as stomodeal trophallaxis. Termite survival was affected by the number of mouth-

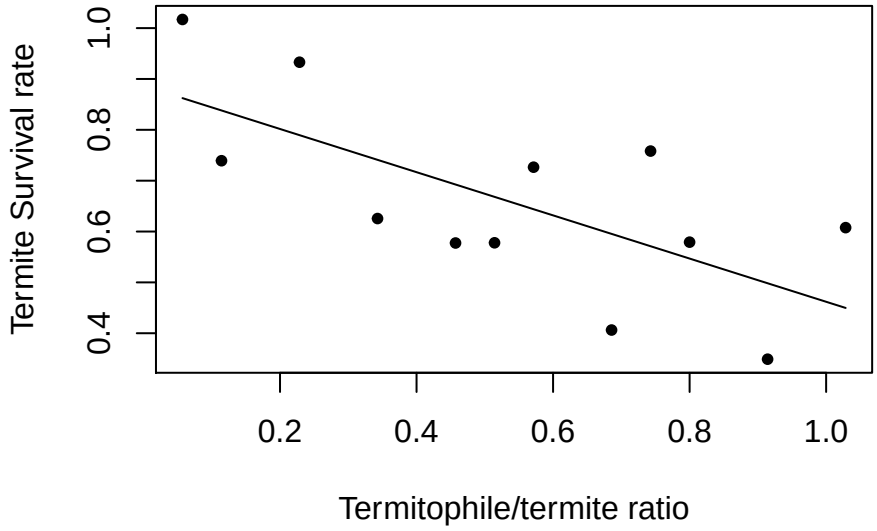

Figure 3.3: Survival rate (SR) of *C. cyphergaster* confined in Petri dishes with increasing termitophile/termites ratios. Survival rate was affected by the increase in numbers of *C. melantho* (p=0.0135).

Table 3.5: Analysis of deviance for the effect of the numbers of *C. melantho* on *C. melantho* individuals confined in Petri dishes in the presence of their host *C. cyphergaster*. See Materials and Methods for more detail. "LL" = log-likelihood

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	224	3086.06				
2	ncorotoca	223	3086.02	=	1	0.04	0.84

to-mouth interactions and density (Supplementary material II, Table 3.9, AIC=-10.9, Δ=0.00,weight=0.3). Survival rate was lower as density (Table 3.6, F=5.16,p=0.0492) and mouth-to-mouth contacts increased (Fig. 3.5, Table 3.6, F=11.01,p=0.009)

Corotoca population inside the nests

12 nests of *C. cyphergaster* were collected and dissecated to quantify termitophiles. Numbers found can be seen on Table 3.7. Total numbers of *C. melantho* ranged from 11 to 147 individuals.

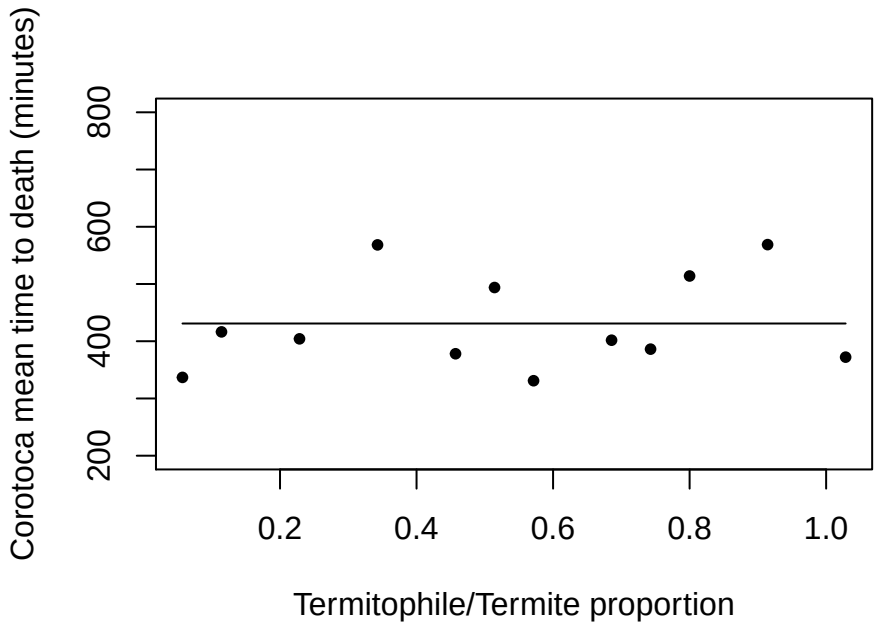

Figure 3.4: Mean time to death of *C. melantho* confined in Petri dishes with their host *C. cyphergaster* on increasing numbers of *C. melantho*. Tertmitophile's mean time to death was not affected by the increase in their numbers (p=0.84).

Table 3.6: Analysis of variance for the effect of mouth-to-mouth interactions recorded between *C. melantho* and *C. cyphergaster* on termites survival rates. See Materials and Methods for more detail.

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
NULL			11	0.41		
mouth-to-mouth	1	0.18	10	0.23	11.01	0.0090
density	1	0.08	9	0.15	5.16	0.0492

Discussion

C. melantho survived longer in the presence of their host than when kept only with their conspecifics (Fig. 3.1). This suggests that these termitophiles profit from the presence of their hosts. One possible benefit would be the obtention of valuable nutrition from termite fluids such as termite stomodeal food and hemolymph which could be obtained, respectivelly, via mouth-to-mouth contacts and biting. However, hemolymph could be obtained by bites only if termitophiles were able to pierce termites abdomen.

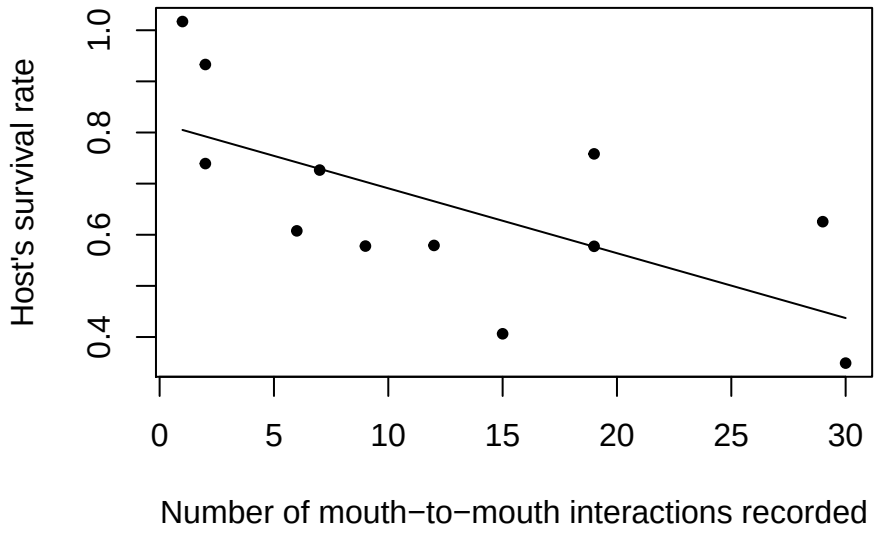

Figure 3.5: Effect of mouth-to-mouth interactions recorded between *C. melantho* and *C. cyphergaster* on termites survival rates. Survival rate was affected by increasing mouth-to-mouth contacts between the termitophile and its host (p=0.009).

But we did not observe any signs of attack or predation on termites after the forced contact with the beetles, hence it is improbable that termitophiles had perfurated their host to obtain hemolymph. Also, regarding the behaviors, we only found a significant effect of mouth-to-mouth interaction on the survival of *C. cyphergaster*. Thus, if termitophiles were taking resources from termites individuals, it would be more likely through stomodeal trophallaxis.

Host-guest interactions observed here (Table1 3.1) are not a novelty for termites and their Corotocini guests. Seevers (1957) mentions that the mentum fused to the submentum, common to all Corotocini, would facilitate receiving liquid food from their host. Pasteels (1969) also observed a behavior strikingly similar to the bites here recorded, on *Termitopullus sociusculus*, a Corotocini that lives inside *Nasutitermes lujae* nests. *T. sociusculus* bites workers and larvae at the level of the pleurite. Termites, on the other hand, did not react to most of these interactions, and when did, they

Table 3.7: Total number of *C. melantho* individuals found inside nests of *C. cyphergaster* from Sete Lagoas, Minas Gerais State Southeastern Brazil on Appril 2017.

Termitarium id.	utm zone	utm northing	utm easting	Corotoca numbers	Nest volume (liters)
2017-04-07-ycc-n01	23k	588398	7853003	147	17.115
2017-04-07-ycc-n03	23k	588448	7853073	84	9.898
2017-04-07-ycc-n04	23k	588381	7852958	20	12.377
2017-04-07-ycc-n05	23k	588397	7852922	11	8.597
2017-04-07-ycc-n06	23k	588401	7852917	37	12.483
2017-04-07-ycc-n07	23k	588416	7852897	76	15.000
2017-04-07-ycc-n08	23k	588409	7852900	58	6.951
2017-04-07-ycc-n10	23k	588391	7852890	76	8.269
2017-04-07-ycc-n11	23k	588358	7852966	20	7.027
2017-04-07-ycc-n12	23k	588350	7852968	26	15.181
2017-04-07-ycc-n13	23k	588222	7852764	41	9.480
2017-04-07-ycc-n14	23k	588235	7852769	44	10.816

would simply move away abruptly, never attacking the beetle. The same was observed here for *C. melantho* and *C. cyphergaster*. Pasteels (1969) also supposed that these beetles are parasites of their host of their host, sucking termite's hemolymph. Unfortunately, he did not run any test to verify the extent of cost/benefit that hosts and guests would experience from these bites. Our results, however, cover such a gap, pointing out that, such bites did not affect termite survival. Besides, the lack of puncture signs on *C. cyphergaster* abdomen suggests that although termitophiles bit, and sometimes even grabbed, their hosts abdomen, it was not enough to get to termites hemolymph. Thus, Seevers (1957) hypothesis on Corotocini being fed by their host seem to be more likely correct, indeed, at least for the case of *C. melantho*. After all, *C. cyphergaster* mortality was faster with increased mouth-to-mouth contacts with *C. melantho* (Fig. 3.5).

A faster mortality of *C. cyphergaster* when in the presence of the *C. melantho*, suggests that harboring termitophiles can be costly to the hosts. However, if *C. melantho* is damaging to their host, what could explain their prevalence in *C. cyphergaster* nests? It is been hypothesized that virulence (i.e. the damage done to the host) could decrease according to the degree of parasite's host specialization (Hughes et al., 2008). In fact, *C. melantho*

765 is a specialized symbiont on *C. cyphergaster* colonies, living exclusively on host's nests, thus strategies to avoid such damage would be expected. That is indeed the direction pointed out by our results. Firstly the costs im-
768 posed to hosts by the termitophiles seem to decrease as their populations are low. Accordingly, the natural proportion of *C. melantho* numbers, relative to their total host population, is indeed very low, as recorded by Cunha
771 et al. (2015) and ourselves (Table1 3.7).

Reinforcing this notion, increased proportions of termitophiles in the arenas did not result in decrements of *C. melantho* survival (Fig. 3.4). This
774 seems to imply that even in such crowded conditions, there were enough resources for every individual, so each termitophile might take small amounts of food from the termites. Survival curves for *C. melantho*, on its turn, al-
777 ways presented an $\alpha > 1$, which means that mortality was higher towards the end of the experiment. It implies that the effect of the beetle on its host was not instantaneous. Therefore, although *C. melantho* when in high
780 proportions seems to be harmful to termite individuals, it is possible that selection might have acted on this beetle to reduce the costs to its host.

Similar effects happen commonly on host-microbe systems. There are
783 symbionts that can provoke host damage but usually are found in such small populations that the interaction is kept as commensalism. However, when symbionts undergo an increase in numbers, it results on host
786 damage. This increase in symbionts population is usually associated with weakened immune defenses on hosts (Hall and Noverr, 2017), but can also be linked to environmental conditions that can trigger symbiont growth,
789 such as temperature changes (Frydenborg et al., 2014). Therefore, these associations can change from an usual commensal interaction to a parasitic one. Classical examples of this change are found on *Candida* spp. in the hu-
792 man mucosa (Hall and Noverr, 2017) and on overgrowths of the gut flora, as in Small Intestinal Bacterial Overgrowth syndrome (SIBO) (Bures et al.,

2010).

To the best of our knowledge, there is no record of any populational outbreak of these beetles in termite nests, so that we can not be sure whether or not they could ever become damaging to the whole colony. Nevertheless field data seem to point to this possibility: *C. melantho* is not found in very small nests (volume < 2.2 L, Cristaldo et al. (2012)) of *C. cyphergaster* termites. This could indicate that in such small nests, infections by *C. melantho* would quickly attain unbearable beetle densities and thus result in colony death.

What would be, then, the mechanisms preventing populational build up of *C. melantho* in these termite nests? A classical regulatory effect of resource competition seems not very likely because even under proportions much higher than what is found in nature, *C. melantho* had no decrements in survival (Fig. 3.4). Likewise, a possible regulation by termites themselves is made unlikely by the absence of agonistic host-guest interactions. A third possibility seems a bit more promissing to explain such low populations: as with other viviparous insects (Strand, 2013), *C. melantho*'s females are not too prolific. Unfortunately, we are currently lacking data to test such ideas, but we present them here in an effort to point to research avenues still open for this particular case of termitophily.

In summary, we have quantified here the costs inflicted by direct contacts between *C. melantho* termitophile beetles and their termite host, *C. cyphergaster* under laboratory conditions. Despite speeding up individual termite mortality, evidence favours the notion that such costs would not percolate to the whole termite colony, because these termitophiles normally occur in low densities therein. We also warn that our data refer only to a single aspect of their interaction with their host, that is, the direct contact between them. It remains to be inspected whether these termitophiles could also offset their costs to termite individuals even further as occurring,

for instance, with some termitophile ants which help in nest defense (Higashi and Ito, 1989; Monteiro et al., 2017). All in all, our results provide the first quantification of the symbiotic mechanisms involving the termitophile *C. melantho* and its host termite *C. cyphergaster*.

Bibliography

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour*, 49(3):227–266.

Bourguignon, T., ŠObotnÍK, J., Lepoint, G., Martin, J. M., Hardy, O. J., Dejean, A., and Roisin, Y. (2011). Feeding ecology and phylogenetic structure of a complex neotropical termite assemblage, revealed by nitrogen stable isotope ratios. *Ecological Entomology*, 36(2):261–269.

Breton, L. M. and Addicott, J. F. (1992). Density-dependent mutualism in an aphid-ant interaction. *Ecology*, 73(6):2175–2180.

Bronstein, J. L. (1994). Conditional outcomes in mutualistic interactions. *Trends in Ecology & Evolution*, 9(6):214–217.

Bures, J., Cyrany, J., Kohoutova, D., Förstl, M., Rejchrt, S., Kvetina, J., Vorisek, V., and Kopacova, M. (2010). Small intestinal bacterial overgrowth syndrome. *World journal of gastroenterology: WJG*, 16(24):2978.

Carvalho, Y. C., Clemente, L. O., Guimarães, M. P., and DeSouza, O. (2018). Suitable light regimes for filming termites in laboratory bioassays. *Sociobiology*, 65(1).

Cristaldo, P. F., Rosa, C. S., Florencio, D. F., Marins, A., and DeSouza, O. (2012). Termitarium volume as a determinant of invasion by obligatory termitophiles and inquilines in the nests of *Constrictotermes cyphergaster* (Termitidae, Nasutitermitinae). *Insectes sociaux*, 59(4):541–548.

Crosland, M. W. J., Su, N. Y., and Scheffrahn, R. H. (2005). Arolia in termites (Isoptera): functional significance and evolutionary loss. *Insectes Sociaux*, 52(1):63–66.

Cunha, H. F. and Brandão, D. (2001). Invertebrates associated with the Neotropical termite *Constrictotermes cyphergaster* (Isoptera: Termitidae, Nasutitermitinae). *Sociobiology*, 37(3):593–600.

Cunha, H. F., Costa, D. A., Espirito Santo Filho, K., Silva, L. O., and Brandão, D. (2003). Relationship between *Constrictotermes cyphergaster* and inquiline termites in the cerrado (isoptera: Termitidae). *Sociobiology*, 42(3):761–770.

Cunha, H. F., Lima, J. S., de Souza, L. F., Santos, L. G. A., and Nabout, J. C. (2015). No morphometric distinction between the host *Constrictotermes cyphergaster* (Silvestri) (Isoptera: Termitidae, Nasutitermitinae) and its obligatory termitophile *Corotoca melantho* Schiødte (Coleoptera: Staphylinidae). *Sociobiology*, 62(1):65–69.

Davitt, A. J., Chen, C., and Rudgers, J. A. (2011). Understanding context-dependency in plant–microbe symbiosis: the influence of abiotic and biotic contexts on host fitness and the rate of symbiont transmission. *Environmental and Experimental Botany*, 71(2):137–145.

De Bary, A. (1879). *Die erscheinung der symbiose*. Verlag von Karl J. Trübner.

DeSouza, O., Araújo, A. P. A., and Reis-Jr, R. (2009). Trophic controls delaying foraging by termites: reasons for the ground being brown? *Bulletin of Entomological Research*, 99(6):603–609.

DeSouza, O. and Miramontes, O. (2004). Non-asymptotic trends in the social facilitated survival of termites (Isoptera). *Sociobiology*, 44(3):527–538.

DeSouza, O., Miramontes, O., Santos, C. A., and Bernardo, D. L. (2001). Social facilitation affecting tolerance to poisoning in termites (Insecta, Isoptera). *Insectes Sociaux*, 48(1):21–24.

Douglas, A. E. (1995). The ecology of symbiotic micro-organisms. *Advances in Ecological Research*, 26:69–103.

Frydenborg, B. R., Krediet, C. J., Teplitski, M., and Ritchie, K. B. (2014). Temperature-dependent inhibition of opportunistic vibrio pathogens by native coral commensal bacteria. *Microbial ecology*, 67(2):392–401.

Hall, R. A. and Noverr, M. C. (2017). Fungal interactions with the human host: exploring the spectrum of symbiosis. *Current opinion in microbiology*, 40:58–64.

Higashi, S. and Ito, F. (1989). Defense of termitaria by termitophilous ants. *Oecologia*, 80(2):145–147.

Hölldobler, B. (1971). Communication between ants and their guests. *Scientific American*, 224(3):86–95.

Hovestadt, T., Thomas, J. A., Mitesser, O., Elmes, G. W., and Schönrogge, K. (2011). Unexpected benefit of a social parasite for a key fitness component of its ant host. *The American Naturalist*, 179(1):110–123.

Howard, R. W. (1978). Proctodeal feeding by termitophilous Staphylinidae associated with *Reticulitermes virginicus* (Banks). *Science*, 201(4355):541–543.

Howard, R. W. (1980). Trail-following by termitophiles. *Annals of the Entomological Society of America*, 73(1):36–38.

Howard, R. W., McDaniel, C., and Blomquist, G. J. (1980). Chemical mimicry as an integrating mechanism: cuticular hydrocarbons of a termitophile and its host. *Science*, 210(4468):431–433.

Howard, R. W., McDaniel, C., and Blomquist, G. J. (1982). Chemical mimicry as an integrating mechanism for three termitophiles associated with *Reticulitermes virginicus* (Banks). *Psyche*, 89(1-2):157–168.

Hughes, D. P., Pierce, N. E., and Boomsma, J. J. (2008). Social insect symbionts: evolution in homeostatic fortresses. *Trends in Ecology & Evolution*, 23(12):672–677.

Hughes, W. O., Petersen, K. S., Ugelvig, L. V., Pedersen, D., Thomsen, L., Poulsen, M., and Boomsma, J. J. (2004). Density-dependence and within-host competition in a semelparous parasite of leaf-cutting ants. *BMC Evolutionary Biology*, 4(1):45.

Johnson, N. C., Graham, J. H., and Smith, F. A. (1997). Functioning of mycorrhizal associations along the mutualism–parasitism continuum. *The New Phytologist*, 135(4):575–585.

Johnstone, R. A. and Bshary, R. (2002). From parasitism to mutualism: partner control in asymmetric interactions. *Ecology Letters*, 5(5):634–639.

Kistner, D. H. (1969). The biology of termitophiles. In Krishna, K. and Weesner, F. M., editors, *Biology of termites*, volume 1, pages 525–557. Elsevier.

Kistner, D. H. (1973). The termitophilous Staphylinidae associated with *Grallatotermes* in africa; their taxonomy, behavior, and a survey of their glands of external secretion. *Annals of the Entomological Society of America*, 66(1):197–222.

Kistner, D. H. (1979). Social and evolutionary significance of social insect symbionts. In Hermann, H. R., editor, *Social insects*, volume 1, pages 339–413. Academic press New York.

Korb, J. and Linsenmair, K. E. (2000). Thermoregulation of termite mounds: what role does ambient temperature and metabolism of the colony play? *Insectes Sociaux*, 47(4):357–363.

Kottek, M., Grieser, J., Beck, C., Rudolf, B., and Rubel, F. (2006). World map of the Köppen-Geiger climate classification updated. *Meteorologische Zeitschrift*, 15(3):259–263.

Lee, J. H., Kim, T. W., and Choe, J. C. (2009). Commensalism or mutualism: conditional outcomes in a branchiobdellid–crayfish symbiosis. *Oecologia*, 159(1):217–224.

Lehner, P. (1998). Data collection methods. In *Handbook of Ethological Methods*, pages 183–232. Cambridge University Press, London, UK, 2nd edition.

Leponce, M., Roisin, Y., and Pasteels, J. M. (1999). Community interactions between ants and arboreal-nesting termites in New Guinea coconut plantations. *Insectes sociaux*, 46(2):126–130.

Manley, R., Boots, M., and Wilfert, L. (2017). Condition-dependent virulence of slow bee paralysis virus in *Bombus terrestris*: are the impacts of honeybee viruses in wild pollinators underestimated? *Oecologia*, pages 1–11.

Martinussen, T. and Scheike, T. H. (2006). *Dynamic regression models for survival data*. Springer Science & Business Media.

Maruyama, M. and Parker, J. (2017). Deep-time convergence in rove beetle symbionts of army ants. *Current Biology*, 27(6):920–926.

Mathews, A. A. (1977). *Studies on termites from the Mato Grosso state, Brazil*. Academia brasileira de ciências Rio de Janeiro.

Miramontes, O. and DeSouza, O. (1996). The nonlinear dynamics of survival and social facilitation in termites. *Journal of Theoretical Biology*, 181(4):373–380.

Monteiro, I., Viana-Junior, A. B., Castro Solar, R. R., Siqueira Neves, F., and DeSouza, O. (2017). Disturbance-modulated symbioses in termitophily. *Ecology and evolution*, 7(24):10829–10838.

Moura, F. M. S., Vasconcellos, A., Araujo, V. F. P., and Bandeira, A. G. (2006a). Feeding habit of *Constrictotermes cyphergaster* (Isoptera, Termitidae) in an area of caatinga, northeast brazil. *Sociobiology*, 48(1):21–26.

Moura, F. M. S., Vasconcellos, A., Araújo, V. F. P., and Bandeira, A. G. (2006b). Seasonality in foraging behaviour of *Constrictotermes cyphergaster* (Termitidae, Nasutitermitinae) in the Caatinga of northeastern Brazil. *Insectes Sociaux*, 53(4):472–479.

Okabe, K. and Makino, S. (2008). Parasitic mites as part-time bodyguards of a host wasp. *Proceedings of the Royal Society of London B: Biological Sciences*, 275(1648):2293–2297.

Parker, J. (2016). Myrmecophily in beetles (Coleoptera): evolutionary patterns and biological mechanisms. *Myrmecological News*, 22:65–108.

Parmentier, E. and Michel, L. (2013). Boundary lines in symbiosis forms. *Symbiosis*, 60(1):1–5.

Parmentier, T., Wenseleers, T., and Dekoninck, W. (2016). Do well-integrated species of an inquiline community have a lower brood predation tendency? a test using red wood ant myrmecophiles. *BMC evolutionary biology*, 16(1):12.

Pasteels, J. M. (1969). Les glandes tégumentaires des staphylins termitophiles. *Insectes Sociaux*, 16(1):1–26.

R Core Team (2015). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

Rosa, C. S., Marins, A., and Souza, O. D. (2008). Interactions between beetle larvae and their termite hosts (Coleoptera; Isoptera, Nasutitermitinae). *Sociobiology*, 51(1):191.

Seevers, C. H. (1957). A monograph on the termitophilous Staphylinidae (Coleoptera). *Fieldiana: Zoology*, 40:1–334.

Seevers, C. H. (1965). The systematics, evolution and zoogeography of staphylinid beetles, associated with army ants (Coleoptera, Staphylinidae). *Fieldiana: Zoology*, 47(2):1–351.

Strand, M. R. (2013). The egg and embryology. In *The Insects: Structure and Function*, pages 347–393. Cambridge University Press, 5th edition.

Symonds, M. R. E. and Moussalli, A. (2011). A brief guide to model selection, multimodel inference and model averaging in behavioural ecology using Akaike's information criterion. *Behavioral Ecology and Sociobiology*, 65(1):13–21.

Thomas, J. A., Schönrogge, K., and Elmes, G. W. (2005). Specializations and host associations of social parasites of ants. In Fellowes, M. D. E., Holloway, G. J., and Rolff, J., editors, *Insect evolutionary ecology*, pages 479–518. Royal Entomological Society, CABI Publishing UK.

Vasconcellos, A., Araújo, V. F. P., Moura, F. M. S., and Bandeira, A. G. (2007). Biomass and population structure of *Constrictotermes cyphergaster* (Silvestri)(Isoptera: Termitidae) in the dry forest of caatinga, northeastern Brazil. *Neotropical Entomology*, 36(5):693–698.

Von Beeren, C., Maruyama, M., Hashim, R., and Witte, V. (2011). Differential host defense against multiple parasites in ants. *Evolutionary ecology*, 25(2):259–276.

Witte, V., Leingärtner, A., Sabaß, L., Hashim, R., and Foitzik, S. (2008). Symbiont microcosm in an ant society and the diversity of interspecific interactions. *Animal Behaviour*, 76(5):1477–1486.

Yoo, H. J. S. and Holway, D. A. (2011). Context-dependence in an ant–aphid mutualism: direct effects of tending intensity on aphid performance. *Ecological Entomology*, 36(4):450–458.

Supplementary materials

Supplentary material I

Table 3.8: Densities used in the survival experiment

Number of termitophiles	Number of host workers	Number of host soldiers	Density
0	28	7	0.12
2	28	7	0.13
4	28	7	0.13
8	28	7	0.14
12	28	7	0.14
16	28	7	0.15
18	28	7	0.15
20	28	7	0.16
24	28	7	0.17
26	28	7	0.17
28	28	7	0.17
32	28	7	0.18
36	28	7	0.19

Supplentary material II

Table 3.9: Model selection of behavior affecting termites Survival Rate by Akaike information criterion. See Materials and Methods for more detail.

	(Intercept)	density	bites	mouth	density:bites	density:moth	bites:mouth	density:bites:mouth	df	logLik	AIC	delta	weight
6	1.58	-5.03		-0.01					4	9.4	-10.9	0.0	0.30
8	1.56	-4.85	-0.00	-0.01					5	9.5	-8.9	2.0	0.11
22	1.56	-4.91		-0.01		-0.01			5	9.4	-8.9	2.0	0.11
2	1.78	-6.94							3	7.1	-8.2	2.7	0.08
5	0.82			-0.01					3	6.7	-7.4	3.4	0.05
4	1.59	-5.30	-0.00						4	7.6	-7.3	3.6	0.05
16	1.63	-5.30	-0.01	-0.01	0.04				6	9.5	-7.0	3.9	0.04
40	1.56	-4.86	-0.00	-0.01			-0.00		6	9.5	-6.9	4.0	0.04
24	1.55	-4.82	-0.00	-0.01		-0.00			6	9.5	-6.9	4.0	0.04
7	0.86		-0.00	-0.01					4	7.4	-6.8	4.0	0.04
12	1.89	-6.99	-0.03		0.17				5	7.9	-5.9	5.0	0.02
3	0.82		-0.01						3	5.8	-5.6	5.3	0.02
48	1.86	-6.92	-0.03	-0.00	0.18		-0.00		7	9.6	-5.1	5.7	0.02
32	1.68	-5.49	-0.03	0.01	0.15	-0.12			7	9.5	-5.1	5.8	0.02
56	1.58	-5.07	-0.00	-0.01		0.02	-0.00		7	9.5	-4.9	6.0	0.02
39	0.87		-0.01	-0.01			0.00		5	7.4	-4.9	6.0	0.02
64	1.83	-6.67	-0.03	0.00	0.19	-0.05	-0.00		8	9.6	-3.2	7.7	0.01
128	2.18	-8.48	-0.05	-0.20	0.29	1.07	0.01	-0.05	9	10.3	-2.6	8.2	0.00
1	0.66								2	3.3	-2.5	8.3	0.00

Chapter 4

General conclusions

General conclusions

In Chapter 2, we found no statistical difference in the survival of termite workers when exposed to different artificial light regimes. However, we do not know if this result is because lights, in fact, are not harmful to the species tested or if the intensities tested here were below any harmful potential for this species. Those hypotheses could be tested in future works. This chapter provides a practical application as we validate both white cold lights and infrared lights for behavioral bioassays, at least according to survival.

The results obtained in Chapter 3 showed that the termitophiles may impose a potential cost to termites, when in high numbers, at least for the species here tested. This was observed by the faster mortality of *Constrictotermes cyphergaster* when confined with high densities of *Corotoca melantho* under laboratory conditions. At the same time, the termitophile survived more when confined together with its host. Evidence for how the termitophile exploit host resources were shown through the observation of the behavior of the beetle. The termitophiles were observed performing possibly stomodeal trophallaxis interactions with termites. Also, as these behaviors increased, termites survival decreased. It was also shown that the cost imposed on termites is diminished as termitophile numbers decrease in the arenas. It was discussed that possibly, under natural conditions such costs would be even smaller, and thus *C. melantho* low abundance would make these costs inconspicuous to the host colony. Such findings provide an important insight on understanding how these beetles are so common on termites nests and how this interaction was maintained.

Appendix

Statistical analyzes

Efeito da luz na sobrevivência de cupins

Yuri Carvalho

1 Rationale

Hipótese biológica: A sobrevivência de cupins pode ser afetada pela exposição à luz

Hipótese estatística: Se a sobrevivência de cupins for afetada pela luz, cupins expostos a luz sobreviverão menos que cupins mantidos no escuro.

O experimento consiste de uma placa de petri por ninho, contendo 20 operários. Foram usadas placas de 59mm de diâmetro interno, fechadas e forradas com papel vegetal. A densidade das placas estava dentro da densidade ótima, Cornitermes: 0.146. Os indivíduos vivos e mortos em cada placa eram contados de hora em hora, até completar 12h de experimento, então a contagem recomeçava 8h depois.

Foram testados três tratamentos: escuro, luz branca e luz infravermelha. Para cada tratamento, foram utilizados 3 ninhos de Cornitermes cumulans. As placas eram mantidas em uma incubadora BOD, com temperatura de 25±1.

2 Carregando os dados

```
> corni<-read.csv("corni.csv",h=T)
> attach(corni)
```

```
> options(width=120)
> corni
```

	ind	genero	censor	luz	ninho	tempo	tempo_inicio	tempo_morte
1	i61	Cornitermes	1	ausente	2017-05-30-LOC-N04	180	31/05/2017 11:25:00	31/05/2017 14:25:00
2	i62	Cornitermes	1	ausente	2017-05-30-LOC-N04	240	31/05/2017 11:25:00	31/05/2017 15:25:00
3	i63	Cornitermes	1	ausente	2017-05-30-LOC-N04	300	31/05/2017 11:25:00	31/05/2017 16:25:00
4	i64	Cornitermes	1	ausente	2017-05-30-LOC-N04	420	31/05/2017 11:25:00	31/05/2017 18:25:00
5	i65	Cornitermes	1	ausente	2017-05-30-LOC-N04	600	31/05/2017 11:25:00	31/05/2017 21:25:00
6	i66	Cornitermes	1	ausente	2017-05-30-LOC-N04	720	31/05/2017 11:25:00	31/05/2017 23:25:00
7	i67	Cornitermes	1	ausente	2017-05-30-LOC-N04	720	31/05/2017 11:25:00	31/05/2017 23:25:00
8	i68	Cornitermes	1	ausente	2017-05-30-LOC-N04	720	31/05/2017 11:25:00	31/05/2017 23:25:00
9	i69	Cornitermes	1	ausente	2017-05-30-LOC-N04	720	31/05/2017 11:25:00	31/05/2017 23:25:00
10	i70	Cornitermes	1	ausente	2017-05-30-LOC-N04	720	31/05/2017 11:25:00	31/05/2017 23:25:00
11	i71	Cornitermes	1	ausente	2017-05-30-LOC-N04	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
12	i72	Cornitermes	1	ausente	2017-05-30-LOC-N04	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
13	i73	Cornitermes	1	ausente	2017-05-30-LOC-N04	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
14	i74	Cornitermes	1	ausente	2017-05-30-LOC-N04	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
15	i75	Cornitermes	1	ausente	2017-05-30-LOC-N04	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
16	i76	Cornitermes	1	ausente	2017-05-30-LOC-N04	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
17	i77	Cornitermes	1	ausente	2017-05-30-LOC-N04	1320	31/05/2017 11:25:00	01/06/2017 09:25:00
18	i78	Cornitermes	1	ausente	2017-05-30-LOC-N04	1320	31/05/2017 11:25:00	01/06/2017 09:25:00
19	i79	Cornitermes	1	ausente	2017-05-30-LOC-N04	1380	31/05/2017 11:25:00	01/06/2017 10:25:00
20	i80	Cornitermes	1	ausente	2017-05-30-LOC-N04	1380	31/05/2017 11:25:00	01/06/2017 10:25:00
21	i81	Cornitermes	1	ausente	2017-05-30-LOC-N05	600	31/05/2017 11:25:00	31/05/2017 21:25:00
22	i82	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
23	i83	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
24	i84	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
25	i85	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
26	i86	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
27	i87	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
28	i88	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
29	i89	Cornitermes	1	ausente	2017-05-30-LOC-N05	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
30	i90	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
31	i91	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
32	i92	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
33	i93	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
34	i94	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
35	i95	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
36	i96	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
37	i97	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
38	i98	Cornitermes	1	ausente	2017-05-30-LOC-N05	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
39	i99	Cornitermes	1	ausente	2017-05-30-LOC-N05	1320	31/05/2017 11:25:00	01/06/2017 09:25:00
40	i100	Cornitermes	1	ausente	2017-05-30-LOC-N05	1500	31/05/2017 11:25:00	01/06/2017 12:25:00
41	i101	Cornitermes	1	ausente	2017-05-30-LOC-N06	180	31/05/2017 11:25:00	31/05/2017 14:25:00
42	i102	Cornitermes	1	ausente	2017-05-30-LOC-N06	240	31/05/2017 11:25:00	31/05/2017 15:25:00
43	i103	Cornitermes	1	ausente	2017-05-30-LOC-N06	720	31/05/2017 11:25:00	31/05/2017 23:25:00
44	i104	Cornitermes	1	ausente	2017-05-30-LOC-N06	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
45	i105	Cornitermes	1	ausente	2017-05-30-LOC-N06	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
46	i106	Cornitermes	1	ausente	2017-05-30-LOC-N06	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
47	i107	Cornitermes	1	ausente	2017-05-30-LOC-N06	1200	31/05/2017 11:25:00	01/06/2017 07:25:00
48	i108	Cornitermes	1	ausente	2017-05-30-LOC-N06	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
49	i109	Cornitermes	1	ausente	2017-05-30-LOC-N06	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
50	i110	Cornitermes	1	ausente	2017-05-30-LOC-N06	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
51	i111	Cornitermes	1	ausente	2017-05-30-LOC-N06	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
52	i112	Cornitermes	1	ausente	2017-05-30-LOC-N06	1260	31/05/2017 11:25:00	01/06/2017 08:25:00
53	i113	Cornitermes	1	ausente	2017-05-30-LOC-N06	1320	31/05/2017 11:25:00	01/06/2017 09:25:00
54	i114	Cornitermes	1	ausente	2017-05-30-LOC-N06	1320	31/05/2017 11:25:00	01/06/2017 09:25:00
55	i115	Cornitermes	1	ausente	2017-05-30-LOC-N06	1380	31/05/2017 11:25:00	01/06/2017 10:25:00

56	i116	Cornitermes	1	ausente	2017-05-30-LOC-N06	1440	31/05/2017 11:25:00	01/06/2017 11:25:00
57	i117	Cornitermes	1	ausente	2017-05-30-LOC-N06	1500	31/05/2017 11:25:00	01/06/2017 12:25:00
58	i118	Cornitermes	1	ausente	2017-05-30-LOC-N06	1560	31/05/2017 11:25:00	01/06/2017 13:25:00
59	i119	Cornitermes	1	ausente	2017-05-30-LOC-N06	1560	31/05/2017 11:25:00	01/06/2017 13:25:00
60	i120	Cornitermes	1	ausente	2017-05-30-LOC-N06	1560	31/05/2017 11:25:00	01/06/2017 13:25:00
61	i181	Cornitermes	1	branca	2017-06-02-LOC-N01	120	03/06/2017 08:40:00	03/06/2017 10:40:00
62	i182	Cornitermes	1	branca	2017-06-02-LOC-N01	600	03/06/2017 08:40:00	03/06/2017 18:40:00
63	i183	Cornitermes	1	branca	2017-06-02-LOC-N01	720	03/06/2017 08:40:00	03/06/2017 20:40:00
64	i184	Cornitermes	1	branca	2017-06-02-LOC-N01	720	03/06/2017 08:40:00	03/06/2017 20:40:00
65	i185	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
66	i186	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
67	i187	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
68	i188	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
69	i189	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
70	i190	Cornitermes	1	branca	2017-06-02-LOC-N01	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
71	i191	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
72	i192	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
73	i193	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
74	i194	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
75	i195	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
76	i196	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
77	i197	Cornitermes	1	branca	2017-06-02-LOC-N01	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
78	i198	Cornitermes	1	branca	2017-06-02-LOC-N01	1560	03/06/2017 08:40:00	04/06/2017 10:40:00
79	i199	Cornitermes	1	branca	2017-06-02-LOC-N01	1680	03/06/2017 08:40:00	04/06/2017 12:40:00
80	i200	Cornitermes	1	branca	2017-06-02-LOC-N01	1740	03/06/2017 08:40:00	04/06/2017 13:40:00
81	i201	Cornitermes	1	branca	2017-06-02-LOC-N02	720	03/06/2017 08:40:00	03/06/2017 20:40:00
82	i202	Cornitermes	1	branca	2017-06-02-LOC-N02	720	03/06/2017 08:40:00	03/06/2017 20:40:00
83	i203	Cornitermes	1	branca	2017-06-02-LOC-N02	720	03/06/2017 08:40:00	03/06/2017 20:40:00
84	i204	Cornitermes	1	branca	2017-06-02-LOC-N02	720	03/06/2017 08:40:00	03/06/2017 20:40:00
85	i205	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
86	i206	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
87	i207	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
88	i208	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
89	i209	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
90	i210	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
91	i211	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
92	i212	Cornitermes	1	branca	2017-06-02-LOC-N02	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
93	i213	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
94	i214	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
95	i215	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
96	i216	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
97	i217	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
98	i218	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
99	i219	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
100	i220	Cornitermes	1	branca	2017-06-02-LOC-N02	1260	03/06/2017 08:40:00	04/06/2017 05:40:00
101	i221	Cornitermes	1	branca	2017-06-02-LOC-N03	180	03/06/2017 08:40:00	03/06/2017 11:40:00
102	i222	Cornitermes	1	branca	2017-06-02-LOC-N03	240	03/06/2017 08:40:00	03/06/2017 12:40:00
103	i223	Cornitermes	1	branca	2017-06-02-LOC-N03	300	03/06/2017 08:40:00	03/06/2017 13:40:00
104	i224	Cornitermes	1	branca	2017-06-02-LOC-N03	420	03/06/2017 08:40:00	03/06/2017 15:40:00
105	i225	Cornitermes	1	branca	2017-06-02-LOC-N03	540	03/06/2017 08:40:00	03/06/2017 17:40:00
106	i226	Cornitermes	1	branca	2017-06-02-LOC-N03	600	03/06/2017 08:40:00	03/06/2017 18:40:00
107	i227	Cornitermes	1	branca	2017-06-02-LOC-N03	600	03/06/2017 08:40:00	03/06/2017 18:40:00
108	i228	Cornitermes	1	branca	2017-06-02-LOC-N03	660	03/06/2017 08:40:00	03/06/2017 19:40:00
109	i229	Cornitermes	1	branca	2017-06-02-LOC-N03	720	03/06/2017 08:40:00	03/06/2017 20:40:00
110	i230	Cornitermes	1	branca	2017-06-02-LOC-N03	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
111	i231	Cornitermes	1	branca	2017-06-02-LOC-N03	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
112	i232	Cornitermes	1	branca	2017-06-02-LOC-N03	1200	03/06/2017 08:40:00	04/06/2017 04:40:00
113	i233	Cornitermes	1	branca	2017-06-02-LOC-N03	1200	03/06/2017 08:40:00	04/06/2017 04:40:00

114	i234	Cornitermes	1	branca	2017-06-02-LOC-N03	1260	03/06/2017	08:40:00	04/06/2017 05:40:00
115	i235	Cornitermes	1	branca	2017-06-02-LOC-N03	1260	03/06/2017	08:40:00	04/06/2017 05:40:00
116	i236	Cornitermes	1	branca	2017-06-02-LOC-N03	1260	03/06/2017	08:40:00	04/06/2017 05:40:00
117	i237	Cornitermes	1	branca	2017-06-02-LOC-N03	1260	03/06/2017	08:40:00	04/06/2017 05:40:00
118	i238	Cornitermes	1	branca	2017-06-02-LOC-N03	1260	03/06/2017	08:40:00	04/06/2017 05:40:00
119	i239	Cornitermes	1	branca	2017-06-02-LOC-N03	1440	03/06/2017	08:40:00	04/06/2017 08:40:00
120	i240	Cornitermes	1	branca	2017-06-02-LOC-N03	1740	03/06/2017	08:40:00	04/06/2017 13:40:00
121	i301	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	178	06/06/2017	08:47:00	06/06/2017 11:45:00
122	i302	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	238	06/06/2017	08:47:00	06/06/2017 12:45:00
123	i303	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	418	06/06/2017	08:47:00	06/06/2017 15:45:00
124	i304	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	478	06/06/2017	08:47:00	06/06/2017 16:45:00
125	i305	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	478	06/06/2017	08:47:00	06/06/2017 16:45:00
126	i306	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	538	06/06/2017	08:47:00	06/06/2017 17:45:00
127	i307	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	598	06/06/2017	08:47:00	06/06/2017 18:45:00
128	i308	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	658	06/06/2017	08:47:00	06/06/2017 19:45:00
129	i309	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	658	06/06/2017	08:47:00	06/06/2017 19:45:00
130	i310	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
131	i311	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
132	i312	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
133	i313	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
134	i314	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
135	i315	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
136	i316	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1678	06/06/2017	08:47:00	07/06/2017 12:45:00
137	i317	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1798	06/06/2017	08:47:00	07/06/2017 14:45:00
138	i318	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1798	06/06/2017	08:47:00	07/06/2017 14:45:00
139	i319	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1858	06/06/2017	08:47:00	07/06/2017 15:45:00
140	i320	Cornitermes	1	infravermelha	2017-06-05-YCC-N04	1858	06/06/2017	08:47:00	07/06/2017 15:45:00
141	i321	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	178	06/06/2017	08:47:00	06/06/2017 11:45:00
142	i322	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
143	i323	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
144	i324	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
145	i325	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
146	i326	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
147	i327	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
148	i328	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
149	i329	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
150	i330	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
151	i331	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
152	i332	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
153	i333	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
154	i334	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
155	i335	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1258	06/06/2017	08:47:00	07/06/2017 05:45:00
156	i336	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1258	06/06/2017	08:47:00	07/06/2017 05:45:00
157	i337	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1258	06/06/2017	08:47:00	07/06/2017 05:45:00
158	i338	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1438	06/06/2017	08:47:00	07/06/2017 08:45:00
159	i339	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1558	06/06/2017	08:47:00	07/06/2017 10:45:00
160	i340	Cornitermes	1	infravermelha	2017-06-05-YCC-N05	1738	06/06/2017	08:47:00	07/06/2017 13:45:00
161	i341	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	178	06/06/2017	08:47:00	06/06/2017 11:45:00
162	i342	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	418	06/06/2017	08:47:00	06/06/2017 15:45:00
163	i343	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
164	i344	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
165	i345	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
166	i346	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
167	i347	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
168	i348	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
169	i349	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
170	i350	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00
171	i351	Cornitermes	1	infravermelha	2017-06-05-YCC-N06	1198	06/06/2017	08:47:00	07/06/2017 04:45:00

```
172 i352 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1198 06/06/2017 08:47:00 07/06/2017 04:45:00
173 i353 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1198 06/06/2017 08:47:00 07/06/2017 04:45:00
174 i354 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1198 06/06/2017 08:47:00 07/06/2017 04:45:00
175 i355 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1318 06/06/2017 08:47:00 07/06/2017 06:45:00
176 i356 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1378 06/06/2017 08:47:00 07/06/2017 07:45:00
177 i357 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1438 06/06/2017 08:47:00 07/06/2017 08:45:00
178 i358 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1438 06/06/2017 08:47:00 07/06/2017 08:45:00
179 i359 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1558 06/06/2017 08:47:00 07/06/2017 10:45:00
180 i360 Cornitermes      1 infravermelha 2017-06-05-YCC-N06  1798 06/06/2017 08:47:00 07/06/2017 14:45:00
```

No banco de dados acima, cada linha representa a sobrevivência de um único indivíduo de cupim. As variáveis são:

ind: identificação do indivíduo

genero: gênero do indivíduo

censor: censor da Weibull.

censor(1): Se naquele momento o indivíduo foi realmente observado morto.

censor(0): Se naquele momento o indivíduo foi observado vivo pela última vez.

luz : tipo de luz na qual os cupins estavam expostos.

ninho : identificação do ninho. O código é composto da seguinte forma: YYYY-MM-DD-III-NNN, onde YYYY é o ano em quatro digitos, MM é o mês em dois digitos, DD é o dia em dois digitos, III são as iniciais do coletor e NNN é o número de série do ninho daquele dia.

tempo: tempo em minutos desde o início do experimento até a hora da observação do indivíduo.

tempo_inicio: data e hora que o experimento começou

tempo_morte: data e hora que o indivíduo foi observado pela última vez

2.1 Montando os modelos

Modelo nulo

```
> library(survival)
> m0c<-survreg(Surv(tempo,censor)~1)
```

Modelo completo.

```
> mcc<-survreg(Surv(tempo,censor)~luz,dist="weibull")
```

Contraste

```
> anova(m0c,mcc)
```

```
  Terms Resid. Df    -2*LL Test Df Deviance  Pr(>Chi)
1     1       178 2660.901      NA       NA        NA
2   luz       176 2658.588    =  2 2.313425 0.3145184
```

Não houve diferença significativa entre o modelo nulo e modelo completo, isso já indica que o modelo nulo explica melhor os dados que as variáveis, porém ainda precisamos saber o quanto desse valor é devido as luzes em si.

Contraste

```
> m1c<-survreg(Surv(tempo,censor)~luz,dist="weibull")
> anova(m1c)
```

```
     Df Deviance Resid. Df    -2*LL  Pr(>Chi)
NULL NA       NA       178 2660.901        NA
luz   2 2.313425       176 2658.588 0.3145184
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(m1c))

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:03:14 2018
\begin{table}[ht]
\centering
\begin{tabular}{rrrrrr}
  \hline
 & Df & Deviance & Resid. Df & -2*LL & Pr($>$Chi) \\
  \hline
NULL &  &  & 178.00 & 2660.90 &  \\
  luz & 2.00 & 2.31 & 176.00 & 2658.59 & 0.31 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(m1c))
```

	Df	Deviance	Resid. Df	-2*LL	Pr(>Chi)
NULL			178.00	2660.90	
luz	2.00	2.31	176.00	2658.59	0.31

Para Cornitermes, não houve diferença significativa entre os diferentes tipos de luz. (p=0.314)

2.2 Retirando os valores de alpha e tempos médios para morte

```
> alphac<-1/m1c$scale
> alphac

[1] 3.369157

> muc<-tapply(predict(m1c),luz,mean)
> tpmc<-muc*gamma(1+(1/alphac))
> tpmc

      ausente        branca infravermelha
     1084.973      1065.295      1152.467
```

Convertendo para valores biologicamente informativos. No resultado abaixo, lambda e gama são, respectivamente, os parâmetros de escala e forma.

Para o modelo completo:

```
> library(SurvRegCensCov)
> ConvertWeibull(m1c,conf.level = 0.95)

$vars
                     Estimate           SE
lambda            4.127734e-11 6.444399e-11
gamma             3.369157e+00 2.170796e-01
luzbranca         6.166752e-02 1.825771e-01
luzinfravermelha -2.033275e-01 1.837988e-01

$HR
                         HR        LB       UB
luzbranca        1.0636087 0.7436558 1.521219
luzinfravermelha 0.8160109 0.5691755 1.169892

$ETR
                        ETR        LB       UB
luzbranca        0.9818629 0.8828910 1.091930
luzinfravermelha 1.0622079 0.9550759 1.181357
```

3 Gráfico

Figura 1: Proporção de sobrevivência de *Cornitermes cumulans* sobre o tempo quando expostos a luzes artificiais

Para o modelo nulo:

```
> ConvertWeibull(m0c,conf.level=0.95)

$vars
           Estimate           SE
lambda 5.279996e-11 8.089269e-11
gamma  3.327532e+00 2.123803e-01

> # Lambda and gamma are scale and shape parameters of Weibull distribution.
```

3.1 Gráfico logaritmizado

Para fazer o gráfico logaritmizado preciso do "Scale"do modelo, e dos valores do tempo médio para a morte de cada tratamento. Para obtê-los:

```
> summary(m1c)

Call:
survreg(formula = Surv(tempo, censor) ~ luz, dist = "weibull")
                  Value Std. Error       z        p
(Intercept)       7.0969     0.0386 183.925 0.00e+00
luzbranca        -0.0183     0.0542  -0.338 7.36e-01
luzinfravermelha  0.0603     0.0542   1.113 2.66e-01
Log(scale)       -1.2147     0.0644 -18.852 2.83e-79

Scale= 0.297

Weibull distribution
Loglik(model)= -1329.3   Loglik(intercept only)= -1330.5
        Chisq= 2.31 on 2 degrees of freedom, p= 0.31
Number of Newton-Raphson Iterations: 7
n= 180

> tpmc

      ausente        branca infravermelha
     1084.973      1065.295      1152.467
```

Pontos do gráfico

```
> pontosc<-survfit(Surv(tempo,censor)~luz)
> summary(pontosc)->pontosc
```

```
> data.frame(surv=pontosc$surv,tempo=pontosc$time)->pontosc
> fit<-survfit(Surv(tempo,censor)~luz)
> tenty1<-fit[1]$surv
> tenty2<-fit[2]$surv
> tenty3<-fit[3]$surv
> tentx1<-fit[1]$time
> tentx2<-fit[2]$time
> tentx3<-fit[3]$time
> tentx<-fit$time
> tenty<-fit$surv
>
```

3.2 Gráfico

```
> options(width=75)
> plot((pontosc$surv~pontosc$tempo),log="y",xlab="Time (minutes)",
+      ylab="Survival proportion",col=0)
> curve(exp(-((1084.973^-(1/0.297))*x^(1/0.297))),lty=1,add=T,log="y")
> curve(exp(-((1065.295^-(1/0.297))*x^(1/0.297))),lty=2,add=T,log="y")
> curve(exp(-((1152.467^-(1/0.297))*x^(1/0.297))),lty=3,add=T,log="y")
> points(tenty1~tentx1,pch=1)
> points(tenty2~tentx2,pch=2)
> points(tenty3~tentx3,pch=4)
> legend("topright",legend=c("dark", "white lights", "infrared lights"),
+        bty="n",lty=c(1,2,3),pch=c(1,2,4))
```

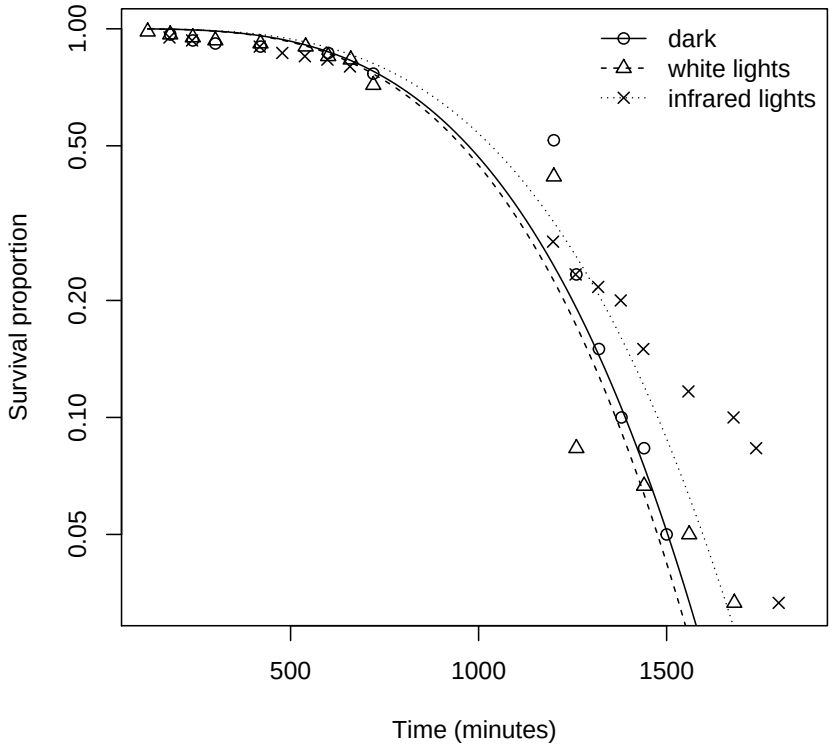

Figura 2: Proporção de sobrevivência logaritmizada de *Cornitermes cumulans* sobre o tempo quando expostos a luzes artificiais

```
> options(width=75)
> plot((pontosc$surv~pontosc$tempo),xlab="Time (minutes)",
+      ylab="Survival proportion",col=0)
> curve(exp(-((1084.973^-(1/0.297))*x^(1/0.297))),lty=1,add=T,log="y")
> curve(exp(-((1065.295^-(1/0.297))*x^(1/0.297))),lty=2,add=T,log="y")
> curve(exp(-((1152.467^-(1/0.297))*x^(1/0.297))),lty=3,add=T,log="y")
> points(tenty1~tentx1,pch=1)
> points(tenty2~tentx2,pch=2)
> points(tenty3~tentx3,pch=4)
> legend("topright",legend=c("dark", "white lights", "infrared lights"),
+        bty="n",lty=c(1,2,3),pch=c(1,2,4))
```

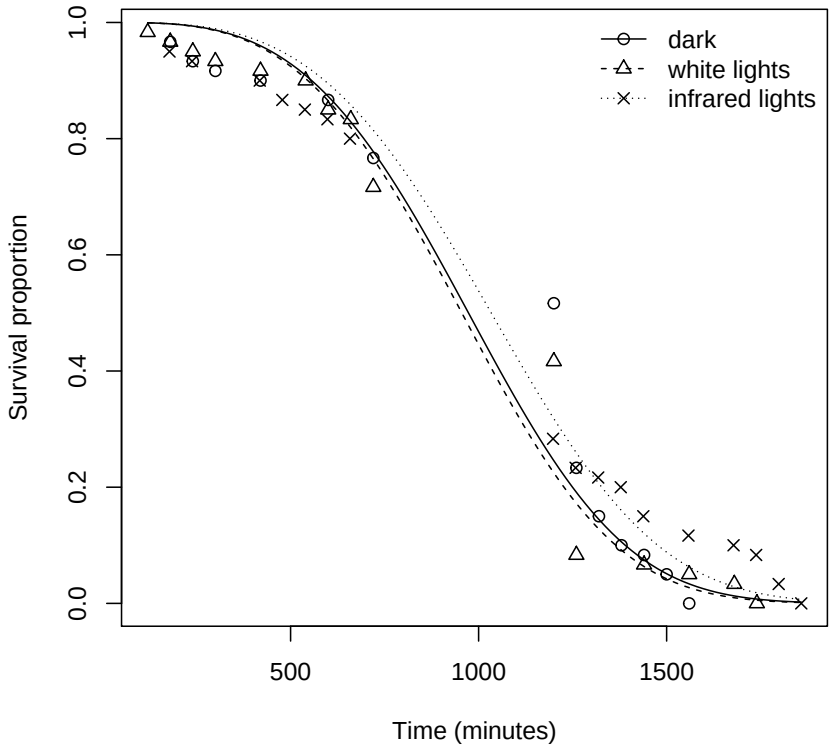

Figura 3: Proporção de sobrevivência de *Cornitermes cumulans* sobre o tempo quando expostos a luzes artificiais

Análises de "Biting the hand that feeds: The interaction between a termitophile and its host"

1 Sobrevivência do termitófilo

1.1 Rationale

Hipótese biológica: *Corotoca* necessitam dos cupins para sobreviver.

Hipótese estatística: *Corotoca* sobrevivem mais quando na presença de cupins do que quando em grupos monoespecíficos (apenas *Corotoca*)

O experimento consiste de duas placas de petri por ninho, onde uma placa continha um grupo monoespecífico de *Corotoca* e a outra um grupo contendo cupins e *Corotoca*. Foram usadas placas de 52mm, forradas com papel filtro e fechadas durante o experimento. A sobrevivência era observada de hora em hora. Foram contados os *Corotoca* vivos e mortos em cada placa.

Cada ninho contribuiu para um único teste (2 placas: uma só com *Corotoca*, outra com cupins e *Corotoca*, veja acima). Em cada teste foram colocados 20 besouros e 10 cupins (8 operários e 2 soldados).

1.2 Carregando os dados

```
> sobr<-read.csv("sobpilot.csv", h=T)
> attach(sobr)
```

```
> sobr
```

	ind	censor	grupo	ninho	tempo	tempo_inicio	tempo_morte
1	i001	1	cor	N08HHS2017	180	24/01/17 09:55 PM	25/01/17 12:55 AM
2	i002	1	cor	N08HHS2017	240	24/01/17 09:55 PM	25/01/17 01:55 AM
3	i003	1	cor	N08HHS2017	240	24/01/17 09:55 PM	25/01/17 01:55 AM
4	i004	1	cor	N08HHS2017	300	24/01/17 09:55 PM	25/01/17 02:55 AM
5	i005	1	cor	N08HHS2017	300	24/01/17 09:55 PM	25/01/17 02:55 AM
6	i006	1	cor	N08HHS2017	360	24/01/17 09:55 PM	25/01/17 03:55 AM
7	i007	1	cor	N08HHS2017	360	24/01/17 09:55 PM	25/01/17 03:55 AM
8	i008	1	cor	N08HHS2017	360	24/01/17 09:55 PM	25/01/17 03:55 AM
9	i009	1	cor	N08HHS2017	360	24/01/17 09:55 PM	25/01/17 03:55 AM
10	i010	1	cor	N08HHS2017	420	24/01/17 09:55 PM	25/01/17 04:55 AM
11	i011	1	cor	N08HHS2017	420	24/01/17 09:55 PM	25/01/17 04:55 AM
12	i012	1	cor	N08HHS2017	420	24/01/17 09:55 PM	25/01/17 04:55 AM
13	i013	1	cor	N08HHS2017	480	24/01/17 09:55 PM	25/01/17 05:55 AM
14	i014	1	cor	N08HHS2017	540	24/01/17 09:55 PM	25/01/17 06:55 AM
15	i015	1	cor	N08HHS2017	540	24/01/17 09:55 PM	25/01/17 06:55 AM

16	i016	1	cor	N08HHS2017	540	24/01/17	09:55	PM	25/01/17 06:55 AM
17	i017	1	cor	N08HHS2017	705	24/01/17	09:55	PM	25/01/17 09:40 AM
18	i018	1	cor	N08HHS2017	805	24/01/17	09:55	PM	25/01/17 11:20 AM
19	i019	1	cor	N08HHS2017	805	24/01/17	09:55	PM	25/01/17 11:20 AM
20	i020	1	cor	N08HHS2017	1165	24/01/17	09:55	PM	25/01/17 05:20 PM
21	i021	1	het	N08HHS2017	420	24/01/17	09:55	PM	25/01/17 04:55 AM
22	i022	1	het	N08HHS2017	420	24/01/17	09:55	PM	25/01/17 04:55 AM
23	i023	1	het	N08HHS2017	480	24/01/17	09:55	PM	25/01/17 05:55 AM
24	i024	1	het	N08HHS2017	480	24/01/17	09:55	PM	25/01/17 05:55 AM
25	i025	1	het	N08HHS2017	480	24/01/17	09:55	PM	25/01/17 05:55 AM
26	i026	1	het	N08HHS2017	540	24/01/17	09:55	PM	25/01/17 06:55 AM
27	i027	1	het	N08HHS2017	540	24/01/17	09:55	PM	25/01/17 06:55 AM
28	i028	1	het	N08HHS2017	540	24/01/17	09:55	PM	25/01/17 06:55 AM
29	i029	1	het	N08HHS2017	540	24/01/17	09:55	PM	25/01/17 06:55 AM
30	i030	1	het	N08HHS2017	600	24/01/17	09:55	PM	25/01/17 07:55 AM
31	i031	1	het	N08HHS2017	600	24/01/17	09:55	PM	25/01/17 07:55 AM
32	i032	1	het	N08HHS2017	600	24/01/17	09:55	PM	25/01/17 07:55 AM
33	i033	1	het	N08HHS2017	615	24/01/17	09:55	PM	25/01/17 08:10 AM
34	i034	1	het	N08HHS2017	615	24/01/17	09:55	PM	25/01/17 08:10 AM
35	i035	1	het	N08HHS2017	615	24/01/17	09:55	PM	25/01/17 08:10 AM
36	i036	1	het	N08HHS2017	645	24/01/17	09:55	PM	25/01/17 08:40 AM
37	i037	1	het	N08HHS2017	765	24/01/17	09:55	PM	25/01/17 10:40 AM
38	i038	1	het	N08HHS2017	765	24/01/17	09:55	PM	25/01/17 10:40 AM
39	i039	1	het	N08HHS2017	1255	24/01/17	09:55	PM	25/01/17 06:50 PM
40	i040	1	het	N08HHS2017	1555	24/01/17	09:55	PM	25/01/17 11:50 PM
41	i041	1	cor	N11HHS2017	60	27/01/17	03:00	PM	27/01/17 04:00 PM
42	i042	1	cor	N11HHS2017	150	27/01/17	03:00	PM	27/01/17 05:30 PM
43	i043	1	cor	N11HHS2017	150	27/01/17	03:00	PM	27/01/17 05:30 PM
44	i044	1	cor	N11HHS2017	150	27/01/17	03:00	PM	27/01/17 05:30 PM
45	i045	1	cor	N11HHS2017	180	27/01/17	03:00	PM	27/01/17 06:00 PM
46	i046	1	cor	N11HHS2017	180	27/01/17	03:00	PM	27/01/17 06:00 PM
47	i047	1	cor	N11HHS2017	240	27/01/17	03:00	PM	27/01/17 07:00 PM
48	i048	1	cor	N11HHS2017	240	27/01/17	03:00	PM	27/01/17 07:00 PM
49	i049	1	cor	N11HHS2017	240	27/01/17	03:00	PM	27/01/17 07:00 PM
50	i050	1	cor	N11HHS2017	300	27/01/17	03:00	PM	27/01/17 08:00 PM
51	i051	1	cor	N11HHS2017	300	27/01/17	03:00	PM	27/01/17 08:00 PM
52	i052	1	cor	N11HHS2017	360	27/01/17	03:00	PM	27/01/17 09:00 PM
53	i053	1	cor	N11HHS2017	360	27/01/17	03:00	PM	27/01/17 09:00 PM
54	i054	1	cor	N11HHS2017	360	27/01/17	03:00	PM	27/01/17 09:00 PM
55	i055	1	cor	N11HHS2017	420	27/01/17	03:00	PM	27/01/17 10:00 PM
56	i056	1	cor	N11HHS2017	420	27/01/17	03:00	PM	27/01/17 10:00 PM
57	i057	1	cor	N11HHS2017	480	27/01/17	03:00	PM	27/01/17 11:00 PM
58	i058	1	cor	N11HHS2017	480	27/01/17	03:00	PM	27/01/17 11:00 PM
59	i059	1	cor	N11HHS2017	600	27/01/17	03:00	PM	28/01/17 01:00 AM
60	i060	1	cor	N11HHS2017	780	27/01/17	03:00	PM	28/01/17 04:00 AM
61	i061	1	het	N11HHS2017	150	27/01/17	03:00	PM	27/01/17 05:30 PM
62	i062	1	het	N11HHS2017	150	27/01/17	03:00	PM	27/01/17 05:30 PM
63	i063	1	het	N11HHS2017	180	27/01/17	03:00	PM	27/01/17 06:00 PM
64	i064	1	het	N11HHS2017	180	27/01/17	03:00	PM	27/01/17 06:00 PM
65	i065	1	het	N11HHS2017	330	27/01/17	03:00	PM	27/01/17 08:30 PM
66	i066	1	het	N11HHS2017	330	27/01/17	03:00	PM	27/01/17 08:30 PM
67	i067	1	het	N11HHS2017	420	27/01/17	03:00	PM	27/01/17 10:00 PM
68	i068	1	het	N11HHS2017	420	27/01/17	03:00	PM	27/01/17 10:00 PM
69	i069	1	het	N11HHS2017	480	27/01/17	03:00	PM	27/01/17 11:00 PM
70	i070	1	het	N11HHS2017	540	27/01/17	03:00	PM	28/01/17 12:00 AM
71	i071	1	het	N11HHS2017	540	27/01/17	03:00	PM	28/01/17 12:00 AM
72	i072	1	het	N11HHS2017	540	27/01/17	03:00	PM	28/01/17 12:00 AM

```
73  i073      1   het N11HHS2017   540 27/01/17 03:00 PM 28/01/17 12:00 AM
74  i074      1   het N11HHS2017   600 27/01/17 03:00 PM 28/01/17 01:00 AM
75  i075      1   het N11HHS2017   600 27/01/17 03:00 PM 28/01/17 01:00 AM
76  i076      1   het N11HHS2017   660 27/01/17 03:00 PM 28/01/17 02:00 AM
77  i077      1   het N11HHS2017   780 27/01/17 03:00 PM 28/01/17 04:00 AM
78  i078      1   het N11HHS2017   780 27/01/17 03:00 PM 28/01/17 04:00 AM
79  i079      1   het N11HHS2017   900 27/01/17 03:00 PM 28/01/17 06:00 AM
80  i080      1   het N11HHS2017  1140 27/01/17 03:00 PM 28/01/17 10:00 AM
81  i081      1   cor N13HHS2017   240 02/02/17 04:58 PM 02/02/17 08:58 PM
82  i082      1   cor N13HHS2017   240 02/02/17 04:58 PM 02/02/17 08:58 PM
83  i083      1   cor N13HHS2017   240 02/02/17 04:58 PM 02/02/17 08:58 PM
84  i084      1   cor N13HHS2017   240 02/02/17 04:58 PM 02/02/17 08:58 PM
85  i085      1   cor N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
86  i086      1   cor N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
87  i087      1   cor N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
88  i088      1   cor N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
89  i089      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
90  i090      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
91  i091      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
92  i092      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
93  i093      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
94  i094      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
95  i095      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
96  i096      1   cor N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
97  i097      1   cor N13HHS2017   540 02/02/17 04:58 PM 03/02/17 01:58 AM
98  i098      1   cor N13HHS2017   600 02/02/17 04:58 PM 03/02/17 02:58 AM
99  i099      1   cor N13HHS2017   660 02/02/17 04:58 PM 03/02/17 03:58 AM
100 i100      1   cor N13HHS2017   840 02/02/17 04:58 PM 03/02/17 06:58 AM
101 i101      1   het N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
102 i102      1   het N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
103 i103      1   het N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
104 i104      1   het N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
105 i105      1   het N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
106 i106      1   het N13HHS2017   420 02/02/17 04:58 PM 02/02/17 11:58 PM
107 i107      1   het N13HHS2017   420 02/02/17 04:58 PM 02/02/17 11:58 PM
108 i108      1   het N13HHS2017   420 02/02/17 04:58 PM 02/02/17 11:58 PM
109 i109      1   het N13HHS2017   480 02/02/17 04:58 PM 03/02/17 12:58 AM
110 i110      1   het N13HHS2017   540 02/02/17 04:58 PM 03/02/17 01:58 AM
111 i111      1   het N13HHS2017   540 02/02/17 04:58 PM 03/02/17 01:58 AM
112 i112      1   het N13HHS2017   600 02/02/17 04:58 PM 03/02/17 02:58 AM
113 i113      1   het N13HHS2017   660 02/02/17 04:58 PM 03/02/17 03:58 AM
114 i114      1   het N13HHS2017   660 02/02/17 04:58 PM 03/02/17 03:58 AM
115 i115      1   het N13HHS2017   660 02/02/17 04:58 PM 03/02/17 03:58 AM
116 i116      1   het N13HHS2017   660 02/02/17 04:58 PM 03/02/17 03:58 AM
117 i117      1   het N13HHS2017   720 02/02/17 04:58 PM 03/02/17 04:58 AM
118 i118      1   het N13HHS2017   780 02/02/17 04:58 PM 03/02/17 05:58 AM
119 i119      1   het N13HHS2017   840 02/02/17 04:58 PM 03/02/17 06:58 AM
120 i120      1   het N13HHS2017  1260 02/02/17 04:58 PM 03/02/17 01:58 PM
```

No banco de dados acima, cada linha representa a sobrevivência de um único indivíduo de cupim. As variáveis são:

ind: identificação do indivíduo

censor: censor da Weibull.

censor(1): Se naquele momento o indivíduo foi observado morto.

censor(0): Se naquele momento o indivíduo foi observado vivo pela última vez.

grupo : tipo de grupo contido naquela placa.

grupo(cor): Grupo monoespecífico (somente *Corotoca*).

grupo(het): Grupo heteroespecífico (cupins e *Corotoca*).

ninho : identificação do ninho(fotos no Isoptera). O código é composto da seguinte forma: NNNIIIYYYY, onde NNN é o número de série daquele ninho, III são as iniciais do coletor e YYYY é o ano em quatro digitos. O coletor nesse caso é Helder Hugo dos Santos.

tempo: tempo em minutos desde o início do experimento até a hora da observação do indivíduo.

tempo_inicio: data e hora que o experimento começou.

tempo_morte: data e hora que o indivíduo foi observado pela última vez.

1.3 Montando os modelos

Modelo nulo

```
> library(survival)
> mc0<-survreg(Surv(tempo,censor)~1)
```

Modelo completo

```
> mc1<-survreg(Surv(tempo,censor)~grupo)
> anova(mc0,mc1)
```

```
  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1       118 1643.731      NA       NA           NA
2 grupo       117 1629.133    =  1 14.59755 0.0001330875
```

```
> anova(mc1)
```

```
      Df Deviance Resid. Df    -2*LL     Pr(>Chi)
NULL  NA       NA       118 1643.731           NA
grupo  1 14.59755       117 1629.133 0.0001330875
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(mc1),digits=c(0,2,2,2,2,4))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:05:30 2018
\begin{table}[ht]
\centering
\begin{tabular}{rrrrrr}
  \hline
 & Df & Deviance & Resid. Df & -2*LL & Pr($>$Chi) \\
  \hline
NULL &  &  & 118.00 & 1643.73 &  \\
  grupo & 1.00 & 14.60 & 117.00 & 1629.13 & 0.0001 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(mc1),digits=c(0,2,2,2,2,4))
```

	Df	Deviance	Resid. Df	-2*LL	Pr(>Chi)
NULL			118.00	1643.73	
grupo	1.00	14.60	117.00	1629.13	0.0001

1.4 Retirando os valores de alpha e tempos médios para mort

```
> library(SurvRegCensCov)
> ConvertWeibull(mc1,conf.level = 0.95)

$vars
              Estimate           SE
lambda    9.488115e-07 9.072399e-07
gamma     2.254527e+00 1.486179e-01
grupohet -7.241403e-01 1.879314e-01

$HR
                HR       LB        UB
grupohet 0.4847411 0.335384 0.7006117

$ETR
              ETR       LB       UB
grupohet 1.378773 1.176389 1.615974

> alpha<-1/mc1$scale
> alpha

[1] 2.254527

> pontos<-survfit(Surv(tempo,censor)~grupo)
> muc1<-tapply(predict(mc1),grupo,mean)
> tpm<-muc1*gamma(1+(1/alpha))
> tpm

     cor      het
415.6637 573.1058

> summary(pontos)->pontoss
> data.frame(surv=pontoss$surv,tempo=pontoss$time)->pontosd
>
```

1.5 Gráficos

Separando os pontos dos dois grupos:

```
> summary(mc1)

Call:
survreg(formula = Surv(tempo, censor) ~ grupo)
             Value Std. Error      z        p
(Intercept)  6.151     0.0591 104.03 0.00e+00
grupohet     0.321     0.0810   3.97 7.32e-05
Log(scale)  -0.813     0.0659 -12.33 6.07e-35

Scale= 0.444

Weibull distribution
Loglik(model)= -814.6   Loglik(intercept only)= -821.9
        Chisq= 14.6 on 1 degrees of freedom, p= 0.00013
Number of Newton-Raphson Iterations: 5
n= 120

> fit<-survfit(Surv(tempo,censor)~grupo)
> yz.1<-fit[1]$surv
> yz.2<-fit[2]$surv
> xz.1<-fit[1]$time
> xz.2<-fit[2]$time

Call:
survreg(formula = Surv(tempo, censor) ~ grupo)
             Value Std. Error      z        p
(Intercept)  6.151     0.0591 104.03 0.00e+00
grupohet     0.321     0.0810   3.97 7.32e-05
Log(scale)  -0.813     0.0659 -12.33 6.07e-35

Scale= 0.444

Weibull distribution
Loglik(model)= -814.6   Loglik(intercept only)= -821.9
        Chisq= 14.6 on 1 degrees of freedom, p= 0.00013
Number of Newton-Raphson Iterations: 5
n= 120
```

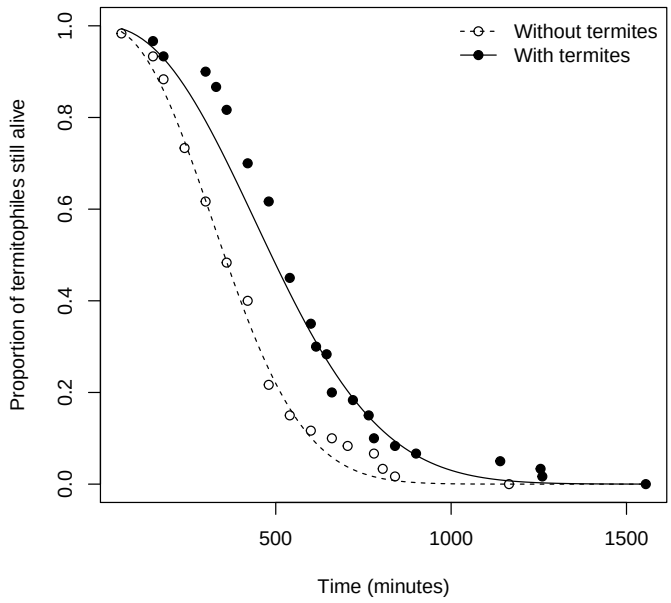

Figura 1: Tempo médio para morte de indivíduos de Corotoca quando na presença e ausência de seus hospedeiros cupins

```
Call:
survreg(formula = Surv(tempo, censor) ~ grupo)
             Value Std. Error      z        p
(Intercept)  6.151     0.0591 104.03 0.00e+00
grupohet     0.321     0.0810   3.97 7.32e-05
Log(scale)  -0.813     0.0659 -12.33 6.07e-35

Scale= 0.444

Weibull distribution
Loglik(model)= -814.6   Loglik(intercept only)= -821.9
        Chisq= 14.6 on 1 degrees of freedom, p= 0.00013
Number of Newton-Raphson Iterations: 5
n= 120
```

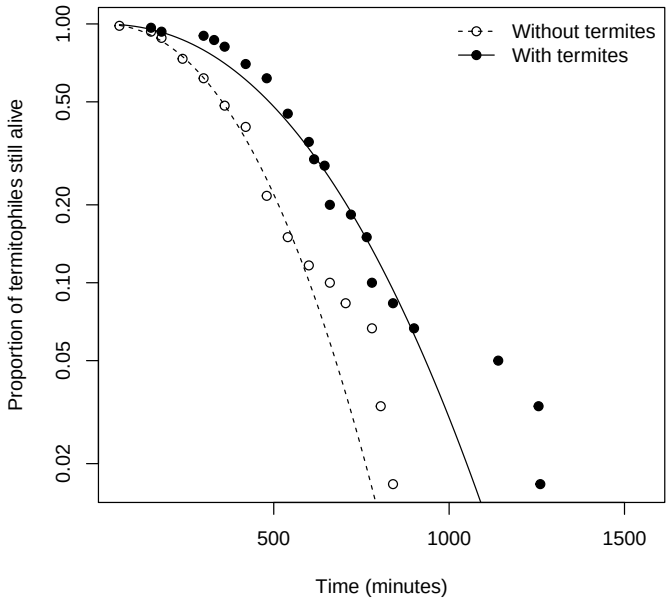

Figura 2: Gráfico logaritmizado do tempo médio para morte de indivíduos de Corotoca quando na presença e ausência de seus hospedeiros cupins

```
> detach(sobr)
```

2 Sobrevivência do cupim

2.1 Carregando os dados

```
> host<-read.csv("hospilot.csv", h=T)
> attach(host)
```

```
> host
```

	ind	id	censor	grupo	ninho	tempo	tempo_inicio	tempo_morte
1	1	ope	1	het	N11HHS2017	360	27/01/17 03:00 PM	27/01/17 09:00 PM
2	2	ope	1	het	N11HHS2017	420	27/01/17 03:00 PM	27/01/17 10:00 PM
3	3	ope	1	het	N11HHS2017	480	27/01/17 03:00 PM	27/01/17 11:00 PM
4	4	ope	1	het	N11HHS2017	540	27/01/17 03:00 PM	28/01/17 12:00 AM
5	5	ope	1	het	N11HHS2017	540	27/01/17 03:00 PM	28/01/17 12:00 AM
6	6	ope	1	het	N11HHS2017	540	27/01/17 03:00 PM	28/01/17 12:00 AM
7	7	ope	1	het	N11HHS2017	660	27/01/17 03:00 PM	28/01/17 02:00 AM
8	8	ope	1	het	N11HHS2017	1200	27/01/17 03:00 PM	28/01/17 11:00 AM

```
9    1 sol      1   het N11HHS2017   300 27/01/17 03:00 PM 27/01/17 08:00 PM
10   2 sol      1   het N11HHS2017   840 27/01/17 03:00 PM 28/01/17 05:00 AM
11   1 ope      1   hos N11HHS2017   540 27/01/17 03:00 PM 28/01/17 12:00 AM
12   2 ope      1   hos N11HHS2017   840 27/01/17 03:00 PM 28/01/17 05:00 AM
13   3 ope      1   hos N11HHS2017  1140 27/01/17 03:00 PM 28/01/17 10:00 AM
14   4 ope      1   hos N11HHS2017  1260 27/01/17 03:00 PM 28/01/17 12:00 PM
15   5 ope      1   hos N11HHS2017  1680 27/01/17 03:00 PM 28/01/17 07:00 PM
16   6 ope      1   hos N11HHS2017  1680 27/01/17 03:00 PM 28/01/17 07:00 PM
17   7 ope      1   hos N11HHS2017  1680 27/01/17 03:00 PM 28/01/17 07:00 PM
18   8 ope      1   hos N11HHS2017  1860 27/01/17 03:00 PM 28/01/17 10:00 PM
19   1 sol      1   hos N11HHS2017   300 27/01/17 03:00 PM 27/01/17 08:00 PM
20   2 sol      1   hos N11HHS2017  1680 27/01/17 03:00 PM 28/01/17 07:00 PM
21   1 ope      1   het N13HHS2017   300 02/02/17 04:58 PM 02/02/17 09:58 PM
22   2 ope      1   het N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
23   3 ope      1   het N13HHS2017   360 02/02/17 04:58 PM 02/02/17 10:58 PM
24   4 ope      1   het N13HHS2017   420 02/02/17 04:58 PM 02/02/17 11:58 PM
25   5 ope      1   het N13HHS2017   540 02/02/17 04:58 PM 03/02/17 01:58 AM
26   6 ope      1   het N13HHS2017   540 02/02/17 04:58 PM 03/02/17 01:58 AM
27   7 ope      1   het N13HHS2017   780 02/02/17 04:58 PM 03/02/17 05:58 AM
28   8 ope      1   het N13HHS2017   840 02/02/17 04:58 PM 03/02/17 06:58 AM
29   1 sol      1   het N13HHS2017   840 02/02/17 04:58 PM 03/02/17 06:58 AM
30   2 sol      1   het N13HHS2017  1080 02/02/17 04:58 PM 03/02/17 10:58 AM
31   1 ope      1   hos N13HHS2017  1860 02/02/17 05:58 PM 04/02/17 12:58 AM
32   2 ope      1   hos N13HHS2017  2280 02/02/17 05:58 PM 04/02/17 07:58 AM
33   3 ope      1   hos N13HHS2017  2580 02/02/17 05:58 PM 04/02/17 12:58 PM
34   4 ope      1   hos N13HHS2017  2640 02/02/17 05:58 PM 04/02/17 01:58 PM
35   5 ope      1   hos N13HHS2017  2700 02/02/17 05:58 PM 04/02/17 02:58 PM
36   6 ope      1   hos N13HHS2017  2700 02/02/17 05:58 PM 04/02/17 02:58 PM
37   7 ope      1   hos N13HHS2017  2700 02/02/17 05:58 PM 04/02/17 02:58 PM
38   8 ope      1   hos N13HHS2017  3240 02/02/17 05:58 PM 04/02/17 11:58 PM
39   1 sol      1   hos N13HHS2017  3060 02/02/17 05:58 PM 04/02/17 08:58 PM
40   2 sol      1   hos N13HHS2017  4800 02/02/17 05:58 PM 06/02/17 01:58 AM
41   1 ope      1   het N08HHS2017    60 24/01/17 09:55 PM 24/01/17 10:55 PM
42   2 ope      1   het N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
43   3 ope      1   het N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
44   4 ope      1   het N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
45   5 ope      1   het N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
46   6 ope      1   het N08HHS2017   360 24/01/17 09:55 PM 25/01/17 03:55 AM
47   7 ope      1   het N08HHS2017   360 24/01/17 09:55 PM 25/01/17 03:55 AM
48   8 ope      1   het N08HHS2017   600 24/01/17 09:55 PM 25/01/17 07:55 AM
49   1 sol      1   het N08HHS2017   840 24/01/17 09:55 PM 25/01/17 11:55 AM
50   2 sol      1   het N08HHS2017   900 24/01/17 09:55 PM 25/01/17 00:55 PM
51   1 ope      1   hos N08HHS2017   120 24/01/17 09:55 PM 24/01/17 11:55 PM
52   2 ope      1   hos N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
53   3 ope      1   hos N08HHS2017   240 24/01/17 09:55 PM 25/01/17 01:55 AM
54   4 ope      1   hos N08HHS2017   600 24/01/17 09:55 PM 25/01/17 07:55 AM
55   5 ope      1   hos N08HHS2017  1080 24/01/17 09:55 PM 25/01/17 03:55 PM
56   6 ope      1   hos N08HHS2017  1140 24/01/17 09:55 PM 25/01/17 04:55 PM
57   7 ope      1   hos N08HHS2017  1680 24/01/17 09:55 PM 26/01/17 01:55 AM
58   8 ope      1   hos N08HHS2017  1800 24/01/17 09:55 PM 26/01/17 03:55 AM
59   1 sol      1   hos N08HHS2017  1140 24/01/17 09:55 PM 25/01/17 04:55 PM
60   2 sol      1   hos N08HHS2017  1920 24/01/17 09:55 PM 26/01/17 05:55 AM
```

No banco de dados acima, cada linha representa a sobrevivência de um único indivíduo de cupim. As variáveis são:

ind: identificação do indivíduo

censor: censor da Weibull.

censor(1): Se naquele momento o indivíduo foi observado morto.

censor(0): Se naquele momento o indivíduo foi observado vivo pela última vez.

grupo : tipo de grupo contido naquela placa.

grupo(cor): Grupo monoespecífico (somente cupins).

grupo(het): Grupo heteroespecífico (cupins e *Corotoca*).

ninho : identificação do ninho(fotos no Isoptera). O código é composto da seguinte forma: NNNIIIYYYY, onde NNN é o número de série daquele ninho, III são as iniciais do coletor e YYYY é o ano em quatro digitos. O coletor nesse caso é Helder Hugo dos Santos.

tempo: tempo em minutos desde o início do experimento até a hora da observação do indivíduo.

tempo_inicio: data e hora que o experimento começou.

tempo_morte: data e hora que o indivíduo foi observado pela última vez.

2.2 Montando os modelos

Modelo nulo

```
> library(survival)
> mh0<-survreg(Surv(tempo,censor)~1)
```

Modelo completo

```
> mh1<-survreg(Surv(tempo,censor)~grupo)
> anova(mh0,mh1)

  Terms Resid. Df    -2*LL Test Df Deviance    Pr(>Chi)
1     1        58 958.5239      NA       NA          NA
2 grupo        57 917.2300    =  1 41.29384 1.30981e-10

> anova(mh1)

      Df Deviance Resid. Df    -2*LL    Pr(>Chi)
NULL  NA       NA        58 958.5239          NA
grupo  1 41.29384        57 917.2300 1.30981e-10
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(mh1),digits=c(0,2,2,2,2,2,10))

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:05:30 2018
\begin{table}[ht]
\centering
\begin{tabular}{rrrrrr}
  \hline
 & Df & Deviance & Resid. Df & -2*LL & Pr($>$Chi) \\
  \hline
NULL &  &  & 58.00 & 958.52 &  \\
  grupo & 1.00 & 41.29 & 57.00 & 917.23 & 0.0000000001 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(mh1),digits=c(0,2,2,2,2,2,10))
```

	Df	Deviance	Resid. Df	-2*LL	Pr(>Chi)
NULL			58.00	958.52	
grupo	1.00	41.29	57.00	917.23	0.0000000001

2.3 Retirando os valores de alpha e tempos médios para morte

```
> library(SurvRegCensCov)
> ConvertWeibull(mh1,conf.level = 0.95)

$vars
              Estimate           SE
lambda    8.825526e-06 1.092261e-05
gamma     1.825172e+00 1.863386e-01
grupohos -2.190695e+00 3.488558e-01

$HR
               HR         LB        UB
grupohos 0.111839 0.05644774 0.2215846

$ETR
              ETR       LB       UB
grupohos 3.321007 2.516206 4.383221

> alpha2<-1/mh1$scale
> alpha2

[1] 1.825172

> pontos2<-survfit(Surv(tempo,censor)~grupo)
> muc2<-tapply(predict(mh1),grupo,mean)
> tpm2<-muc2*gamma(1+(1/alpha2))
> tpm2

      het       hos
 522.3476 1734.7200

>
>
```

2.4 Gráfico

Separando os pontos do gráfico

```
> fit2<-survfit(Surv(tempo,censor)~grupo)
> pontos2<-survfit(Surv(tempo,censor)~grupo)
> summary(pontos2)->pontoss2
> data.frame(surv=pontoss2$surv,tempo=pontoss2$time)->pontosd2
> summary(mh1)

Call:
survreg(formula = Surv(tempo, censor) ~ grupo)
             Value Std. Error     z        p
(Intercept)  6.376      0.102 62.54 0.00e+00
grupohos     1.200      0.142  8.48 2.31e-17
Log(scale)  -0.602      0.102 -5.89 3.78e-09

Scale= 0.548

Weibull distribution
Loglik(model)= -458.6   Loglik(intercept only)= -479.3
        Chisq= 41.29 on 1 degrees of freedom, p= 1.3e-10
Number of Newton-Raphson Iterations: 5
n= 60

> yhz.1<-fit2[1]$surv
> yhz.2<-fit2[2]$surv
> xhz.1<-fit2[1]$time
> xhz.2<-fit2[2]$time
```

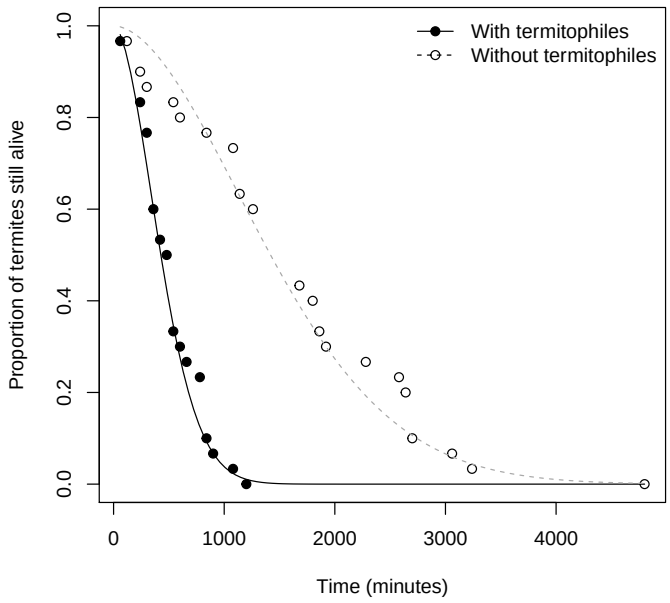

Figura 3: Tempo médio para morte de indivíduos de cupim quando na presença de números crescentes de indivíduos de Corotoca

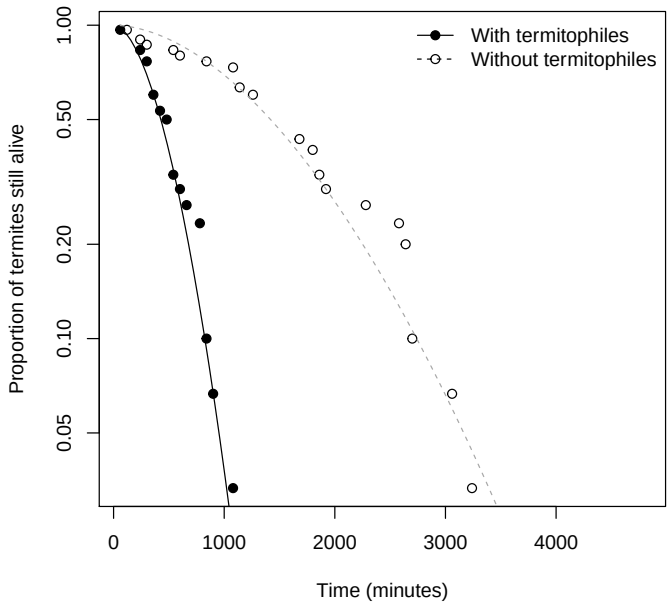

Figura 4: Gráfico logaritmizado do tempo médio para morte de indivíduos de cupim quando na presença de números crescentes de indivíduos de Corotoca

3 Sobrevivência de *Constrictotermes cyphergaster* com diferentes quantidades de *Corotoca melantho*

3.1 Rationale

Hipótese biológica: O efeito de *Corotoca* no seu hospedeiro *Constrictotermes cyphergaster* é menor a medida que sua população diminui.

Hipótese estatística: Se o efeito do termitófilo nos cupins for menor conforme sua população diminui, a sobrevivência de *Constrictotermes cyphergaster* será maior a medida que a quantidade de *Corotoca* diminui em grupos com as duas espécies.

O experimento consiste de duas placas de petri por ninho, onde uma placa continha um grupo monoespecífico de cupins e a outra um grupo de cupins com Corotoca. Foram usadas placas de 85mm, forradas com papel filtro e fechadas durante o experimento. A sobrevivência era observada de hora em hora. Foram contados os cupins vivos e mortos em cada placa.

Os grupos de cupins consistiam de 28 operários e 7 soldados de *Constrictotermes cyphergaster*. Cada ninho contribuiu para um único teste (2 placas: uma só com cupins, outra com cupins mais Corotoca, veja acima). E em cada teste foi colocada uma quantidade diferente de Corotoca, criando um gradiente de 2 até 36 indivíduos do besouro, mantendo-se sempre os 35 cupins, conforme acima.

3.2 Carregando os dados

```
> sob<-read.csv("survival.csv", h=T)
> attach(sob)
```

```
> options(width=120)
> sob
```

	ind	caste	censor	ncor	ninho	prescor	tempo	tempo_inicio	tempo_morte
1	1	worker	1	0	2017-04-07-ycc-n04	ausente	180	27/04/2017 14:43:00	27/04/2017 17:43:00
2	2	worker	1	0	2017-04-07-ycc-n04	ausente	448	27/04/2017 14:43:00	27/04/2017 22:11:00
3	3	soldier	1	0	2017-04-07-ycc-n04	ausente	448	27/04/2017 14:43:00	27/04/2017 22:11:00
4	4	worker	1	0	2017-04-07-ycc-n04	ausente	600	27/04/2017 14:43:00	28/04/2017 00:43:00
5	5	soldier	1	0	2017-04-07-ycc-n04	ausente	600	27/04/2017 14:43:00	28/04/2017 00:43:00
6	6	worker	1	0	2017-04-07-ycc-n04	ausente	660	27/04/2017 14:43:00	28/04/2017 01:43:00
7	7	worker	1	0	2017-04-07-ycc-n04	ausente	660	27/04/2017 14:43:00	28/04/2017 01:43:00
8	8	soldier	1	0	2017-04-07-ycc-n04	ausente	786	27/04/2017 14:43:00	28/04/2017 03:49:00
9	9	worker	1	0	2017-04-07-ycc-n04	ausente	840	27/04/2017 14:43:00	28/04/2017 04:43:00
10	10	worker	1	0	2017-04-07-ycc-n04	ausente	917	27/04/2017 14:43:00	28/04/2017 06:00:00
11	11	worker	1	0	2017-04-07-ycc-n04	ausente	917	27/04/2017 14:43:00	28/04/2017 06:00:00
12	12	soldier	1	0	2017-04-07-ycc-n04	ausente	1080	27/04/2017 14:43:00	28/04/2017 08:43:00
13	13	worker	1	0	2017-04-07-ycc-n04	ausente	1147	27/04/2017 14:43:00	28/04/2017 09:50:00
14	14	worker	1	0	2017-04-07-ycc-n04	ausente	1200	27/04/2017 14:43:00	28/04/2017 10:43:00
15	15	worker	1	0	2017-04-07-ycc-n04	ausente	1320	27/04/2017 14:43:00	28/04/2017 12:43:00
16	16	worker	1	0	2017-04-07-ycc-n04	ausente	1320	27/04/2017 14:43:00	28/04/2017 12:43:00
17	17	worker	1	0	2017-04-07-ycc-n04	ausente	1320	27/04/2017 14:43:00	28/04/2017 12:43:00
18	18	worker	1	0	2017-04-07-ycc-n04	ausente	1320	27/04/2017 14:43:00	28/04/2017 12:43:00
19	19	soldier	1	0	2017-04-07-ycc-n04	ausente	1320	27/04/2017 14:43:00	28/04/2017 12:43:00
20	20	soldier	1	0	2017-04-07-ycc-n04	ausente	1380	27/04/2017 14:43:00	28/04/2017 13:43:00
21	21	worker	1	0	2017-04-07-ycc-n04	ausente	1440	27/04/2017 14:43:00	28/04/2017 14:43:00
22	22	worker	1	0	2017-04-07-ycc-n04	ausente	1500	27/04/2017 14:43:00	28/04/2017 15:43:00
23	23	worker	1	0	2017-04-07-ycc-n04	ausente	1620	27/04/2017 14:43:00	28/04/2017 17:43:00
24	24	worker	1	0	2017-04-07-ycc-n04	ausente	1620	27/04/2017 14:43:00	28/04/2017 17:43:00
25	25	worker	1	0	2017-04-07-ycc-n04	ausente	1776	27/04/2017 14:43:00	28/04/2017 20:19:00
26	26	worker	1	0	2017-04-07-ycc-n04	ausente	1776	27/04/2017 14:43:00	28/04/2017 20:19:00
27	27	worker	1	0	2017-04-07-ycc-n04	ausente	1920	27/04/2017 14:43:00	28/04/2017 22:43:00
28	28	worker	1	0	2017-04-07-ycc-n04	ausente	1920	27/04/2017 14:43:00	28/04/2017 22:43:00
29	29	soldier	1	0	2017-04-07-ycc-n04	ausente	1920	27/04/2017 14:43:00	28/04/2017 22:43:00
30	30	worker	1	0	2017-04-07-ycc-n04	ausente	1980	27/04/2017 14:43:00	28/04/2017 23:43:00
31	31	worker	1	0	2017-04-07-ycc-n04	ausente	1980	27/04/2017 14:43:00	28/04/2017 23:43:00
32	32	worker	1	0	2017-04-07-ycc-n04	ausente	2160	27/04/2017 14:43:00	29/04/2017 02:43:00
33	33	worker	1	0	2017-04-07-ycc-n04	ausente	2160	27/04/2017 14:43:00	29/04/2017 02:43:00
34	34	worker	1	0	2017-04-07-ycc-n04	ausente	2160	27/04/2017 14:43:00	29/04/2017 02:43:00
35	35	worker	1	0	2017-04-07-ycc-n04	ausente	2160	27/04/2017 14:43:00	29/04/2017 02:43:00
36	36	worker	1	2	2017-04-07-ycc-n04	presente	180	27/04/2017 14:43:00	27/04/2017 17:43:00
37	37	worker	1	2	2017-04-07-ycc-n04	presente	300	27/04/2017 14:43:00	27/04/2017 19:43:00
38	38	soldier	1	2	2017-04-07-ycc-n04	presente	300	27/04/2017 14:43:00	27/04/2017 19:43:00
39	39	worker	1	2	2017-04-07-ycc-n04	presente	360	27/04/2017 14:43:00	27/04/2017 20:43:00
40	40	worker	1	2	2017-04-07-ycc-n04	presente	448	27/04/2017 14:43:00	27/04/2017 22:11:00
41	41	worker	1	2	2017-04-07-ycc-n04	presente	448	27/04/2017 14:43:00	27/04/2017 22:11:00
42	42	worker	1	2	2017-04-07-ycc-n04	presente	448	27/04/2017 14:43:00	27/04/2017 22:11:00
43	43	soldier	1	2	2017-04-07-ycc-n04	presente	480	27/04/2017 14:43:00	27/04/2017 22:43:00

```
44   44 soldier      1    2 2017-04-07-ycc-n04 presente   480 27/04/2017 14:43:00 27/04/2017 22:43:00
45   45  worker      1    2 2017-04-07-ycc-n04 presente   540 27/04/2017 14:43:00 27/04/2017 23:43:00
46   46 soldier      1    2 2017-04-07-ycc-n04 presente   540 27/04/2017 14:43:00 27/04/2017 23:43:00
47   47  worker      1    2 2017-04-07-ycc-n04 presente   600 27/04/2017 14:43:00 28/04/2017 00:43:00
48   48  worker      1    2 2017-04-07-ycc-n04 presente   660 27/04/2017 14:43:00 28/04/2017 01:43:00
49   49  worker      1    2 2017-04-07-ycc-n04 presente   786 27/04/2017 14:43:00 28/04/2017 03:49:00
50   50  worker      1    2 2017-04-07-ycc-n04 presente   826 27/04/2017 14:43:00 28/04/2017 04:29:00
51   51 soldier      1    2 2017-04-07-ycc-n04 presente   917 27/04/2017 14:43:00 28/04/2017 06:00:00
52   52  worker      1    2 2017-04-07-ycc-n04 presente  1020 27/04/2017 14:43:00 28/04/2017 07:43:00
53   53  worker      1    2 2017-04-07-ycc-n04 presente  1147 27/04/2017 14:43:00 28/04/2017 09:50:00
54   54  worker      1    2 2017-04-07-ycc-n04 presente  1147 27/04/2017 14:43:00 28/04/2017 09:50:00
55   55  worker      1    2 2017-04-07-ycc-n04 presente  1320 27/04/2017 14:43:00 28/04/2017 12:43:00
56   56 soldier      1    2 2017-04-07-ycc-n04 presente  1320 27/04/2017 14:43:00 28/04/2017 12:43:00
57   57  worker      1    2 2017-04-07-ycc-n04 presente  1577 27/04/2017 14:43:00 28/04/2017 17:00:00
58   58  worker      1    2 2017-04-07-ycc-n04 presente  1680 27/04/2017 14:43:00 28/04/2017 18:43:00
59   59  worker      1    2 2017-04-07-ycc-n04 presente  1776 27/04/2017 14:43:00 28/04/2017 20:19:00
60   60  worker      1    2 2017-04-07-ycc-n04 presente  1776 27/04/2017 14:43:00 28/04/2017 20:19:00
61   61 soldier      1    2 2017-04-07-ycc-n04 presente  1776 27/04/2017 14:43:00 28/04/2017 20:19:00
62   62  worker      1    2 2017-04-07-ycc-n04 presente  1920 27/04/2017 14:43:00 28/04/2017 22:43:00
63   63  worker      1    2 2017-04-07-ycc-n04 presente  1980 27/04/2017 14:43:00 28/04/2017 23:43:00
64   64  worker      1    2 2017-04-07-ycc-n04 presente  2160 27/04/2017 14:43:00 29/04/2017 02:43:00
65   65  worker      1    2 2017-04-07-ycc-n04 presente  2160 27/04/2017 14:43:00 29/04/2017 02:43:00
66   66  worker      1    2 2017-04-07-ycc-n04 presente  2160 27/04/2017 14:43:00 29/04/2017 02:43:00
67   67  worker      1    2 2017-04-07-ycc-n04 presente  2280 27/04/2017 14:43:00 29/04/2017 04:43:00
68   68  worker      1    2 2017-04-07-ycc-n04 presente  2400 27/04/2017 14:43:00 29/04/2017 06:43:00
69   69  worker      1    2 2017-04-07-ycc-n04 presente  2760 27/04/2017 14:43:00 29/04/2017 12:43:00
70   70  worker      1    2 2017-04-07-ycc-n04 presente  2948 27/04/2017 14:43:00 29/04/2017 15:51:00
71   71  worker      1    0 2017-04-07-ycc-n05  ausente    61 29/04/2017 16:33:00 29/04/2017 17:34:00
72   72  worker      1    0 2017-04-07-ycc-n05  ausente   862 29/04/2017 16:33:00 30/04/2017 06:55:00
73   73  worker      1    0 2017-04-07-ycc-n05  ausente   910 29/04/2017 16:33:00 30/04/2017 07:43:00
74   74  worker      1    0 2017-04-07-ycc-n05  ausente  1047 29/04/2017 16:33:00 30/04/2017 10:00:00
75   75  worker      1    0 2017-04-07-ycc-n05  ausente  1150 29/04/2017 16:33:00 30/04/2017 11:43:00
76   76  worker      1    0 2017-04-07-ycc-n05  ausente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
77   77  worker      1    0 2017-04-07-ycc-n05  ausente  1270 29/04/2017 16:33:00 30/04/2017 13:43:00
78   78  worker      1    0 2017-04-07-ycc-n05  ausente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
79   79  worker      1    0 2017-04-07-ycc-n05  ausente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
80   80  worker      1    0 2017-04-07-ycc-n05  ausente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
81   81  worker      1    0 2017-04-07-ycc-n05  ausente  1450 29/04/2017 16:33:00 30/04/2017 16:43:00
82   82 soldier      1    0 2017-04-07-ycc-n05  ausente  1450 29/04/2017 16:33:00 30/04/2017 16:43:00
83   83  worker      1    0 2017-04-07-ycc-n05  ausente  1510 29/04/2017 16:33:00 30/04/2017 17:43:00
84   84  worker      1    0 2017-04-07-ycc-n05  ausente  1510 29/04/2017 16:33:00 30/04/2017 17:43:00
85   85  worker      1    0 2017-04-07-ycc-n05  ausente  1570 29/04/2017 16:33:00 30/04/2017 18:43:00
86   86  worker      1    0 2017-04-07-ycc-n05  ausente  1570 29/04/2017 16:33:00 30/04/2017 18:43:00
87   87  worker      1    0 2017-04-07-ycc-n05  ausente  1570 29/04/2017 16:33:00 30/04/2017 18:43:00
88   88 soldier      1    0 2017-04-07-ycc-n05  ausente  1630 29/04/2017 16:33:00 30/04/2017 19:43:00
89   89 soldier      1    0 2017-04-07-ycc-n05  ausente  1630 29/04/2017 16:33:00 30/04/2017 19:43:00
```

```
90   90 soldier      1    0 2017-04-07-ycc-n05  ausente  1630 29/04/2017 16:33:00 30/04/2017 19:43:00
91   91  worker      1    0 2017-04-07-ycc-n05  ausente  1690 29/04/2017 16:33:00 30/04/2017 20:43:00
92   92  worker      1    0 2017-04-07-ycc-n05  ausente  1750 29/04/2017 16:33:00 30/04/2017 21:43:00
93   93  worker      1    0 2017-04-07-ycc-n05  ausente  1750 29/04/2017 16:33:00 30/04/2017 21:43:00
94   94 soldier      1    0 2017-04-07-ycc-n05  ausente  1750 29/04/2017 16:33:00 30/04/2017 21:43:00
95   95  worker      1    0 2017-04-07-ycc-n05  ausente  1930 29/04/2017 16:33:00 01/05/2017 00:43:00
96   96  worker      1    0 2017-04-07-ycc-n05  ausente  1930 29/04/2017 16:33:00 01/05/2017 00:43:00
97   97  worker      1    0 2017-04-07-ycc-n05  ausente  1990 29/04/2017 16:33:00 01/05/2017 01:43:00
98   98  worker      1    0 2017-04-07-ycc-n05  ausente  1990 29/04/2017 16:33:00 01/05/2017 01:43:00
99   99  worker      1    0 2017-04-07-ycc-n05  ausente  1990 29/04/2017 16:33:00 01/05/2017 01:43:00
100 100  worker      1    0 2017-04-07-ycc-n05  ausente  2050 29/04/2017 16:33:00 01/05/2017 02:43:00
101 101  worker      1    0 2017-04-07-ycc-n05  ausente  2050 29/04/2017 16:33:00 01/05/2017 02:43:00
102 102  worker      1    0 2017-04-07-ycc-n05  ausente  2110 29/04/2017 16:33:00 01/05/2017 03:43:00
103 103  worker      1    0 2017-04-07-ycc-n05  ausente  2170 29/04/2017 16:33:00 01/05/2017 04:43:00
104 104 soldier      1    0 2017-04-07-ycc-n05  ausente  2230 29/04/2017 16:33:00 01/05/2017 05:43:00
105 105 soldier      1    0 2017-04-07-ycc-n05  ausente  2347 29/04/2017 16:33:00 01/05/2017 07:40:00
106 106  worker      1    4 2017-04-07-ycc-n05 presente    61 29/04/2017 16:33:00 29/04/2017 17:34:00
107 107  worker      1    4 2017-04-07-ycc-n05 presente   103 29/04/2017 16:33:00 29/04/2017 18:16:00
108 108  worker      1    4 2017-04-07-ycc-n05 presente   223 29/04/2017 16:33:00 29/04/2017 20:16:00
109 109  worker      1    4 2017-04-07-ycc-n05 presente   223 29/04/2017 16:33:00 29/04/2017 20:16:00
110 110  worker      1    4 2017-04-07-ycc-n05 presente   310 29/04/2017 16:33:00 29/04/2017 21:43:00
111 111  worker      1    4 2017-04-07-ycc-n05 presente   730 29/04/2017 16:33:00 30/04/2017 04:43:00
112 112  worker      1    4 2017-04-07-ycc-n05 presente   862 29/04/2017 16:33:00 30/04/2017 06:55:00
113 113  worker      1    4 2017-04-07-ycc-n05 presente   862 29/04/2017 16:33:00 30/04/2017 06:55:00
114 114  worker      1    4 2017-04-07-ycc-n05 presente   910 29/04/2017 16:33:00 30/04/2017 07:43:00
115 115  worker      1    4 2017-04-07-ycc-n05 presente   910 29/04/2017 16:33:00 30/04/2017 07:43:00
116 116  worker      1    4 2017-04-07-ycc-n05 presente  1047 29/04/2017 16:33:00 30/04/2017 10:00:00
117 117  worker      1    4 2017-04-07-ycc-n05 presente  1047 29/04/2017 16:33:00 30/04/2017 10:00:00
118 118  worker      1    4 2017-04-07-ycc-n05 presente  1107 29/04/2017 16:33:00 30/04/2017 11:00:00
119 119  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
120 120  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
121 121  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
122 122  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
123 123  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
124 124  worker      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
125 125 soldier      1    4 2017-04-07-ycc-n05 presente  1210 29/04/2017 16:33:00 30/04/2017 12:43:00
126 126  worker      1    4 2017-04-07-ycc-n05 presente  1270 29/04/2017 16:33:00 30/04/2017 13:43:00
127 127  worker      1    4 2017-04-07-ycc-n05 presente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
128 128  worker      1    4 2017-04-07-ycc-n05 presente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
129 129  worker      1    4 2017-04-07-ycc-n05 presente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
130 130 soldier      1    4 2017-04-07-ycc-n05 presente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
131 131 soldier      1    4 2017-04-07-ycc-n05 presente  1330 29/04/2017 16:33:00 30/04/2017 14:43:00
132 132  worker      1    4 2017-04-07-ycc-n05 presente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
133 133  worker      1    4 2017-04-07-ycc-n05 presente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
134 134  worker      1    4 2017-04-07-ycc-n05 presente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
135 135 soldier      1    4 2017-04-07-ycc-n05 presente  1390 29/04/2017 16:33:00 30/04/2017 15:43:00
```

```
136 136  worker      1    4 2017-04-07-ycc-n05 presente  1450 29/04/2017 16:33:00 30/04/2017 16:43:00
137 137  worker      1    4 2017-04-07-ycc-n05 presente  1450 29/04/2017 16:33:00 30/04/2017 16:43:00
138 138 soldier      1    4 2017-04-07-ycc-n05 presente  1690 29/04/2017 16:33:00 30/04/2017 20:43:00
139 139 soldier      1    4 2017-04-07-ycc-n05 presente  1930 29/04/2017 16:33:00 01/05/2017 00:43:00
140 140 soldier      1    4 2017-04-07-ycc-n05 presente  1990 29/04/2017 16:33:00 01/05/2017 01:43:00
141 141  worker      1    0 2017-04-07-ycc-n08  ausente   120 30/04/2017 04:55:00 30/04/2017 06:55:00
142 142 soldier      1    0 2017-04-07-ycc-n08  ausente   120 30/04/2017 04:55:00 30/04/2017 06:55:00
143 143 soldier      1    0 2017-04-07-ycc-n08  ausente   120 30/04/2017 04:55:00 30/04/2017 06:55:00
144 144  worker      1    0 2017-04-07-ycc-n08  ausente   168 30/04/2017 04:55:00 30/04/2017 07:43:00
145 145  worker      1    0 2017-04-07-ycc-n08  ausente   305 30/04/2017 04:55:00 30/04/2017 10:00:00
146 146  worker      1    0 2017-04-07-ycc-n08  ausente   305 30/04/2017 04:55:00 30/04/2017 10:00:00
147 147 soldier      1    0 2017-04-07-ycc-n08  ausente   305 30/04/2017 04:55:00 30/04/2017 10:00:00
148 148 soldier      1    0 2017-04-07-ycc-n08  ausente   365 30/04/2017 04:55:00 30/04/2017 11:00:00
149 149  worker      1    0 2017-04-07-ycc-n08  ausente   408 30/04/2017 04:55:00 30/04/2017 11:43:00
150 150 soldier      1    0 2017-04-07-ycc-n08  ausente   528 30/04/2017 04:55:00 30/04/2017 13:43:00
151 151  worker      1    0 2017-04-07-ycc-n08  ausente   588 30/04/2017 04:55:00 30/04/2017 14:43:00
152 152  worker      1    0 2017-04-07-ycc-n08  ausente   768 30/04/2017 04:55:00 30/04/2017 17:43:00
153 153  worker      1    0 2017-04-07-ycc-n08  ausente   888 30/04/2017 04:55:00 30/04/2017 19:43:00
154 154  worker      1    0 2017-04-07-ycc-n08  ausente   888 30/04/2017 04:55:00 30/04/2017 19:43:00
155 155  worker      1    0 2017-04-07-ycc-n08  ausente   888 30/04/2017 04:55:00 30/04/2017 19:43:00
156 156  worker      1    0 2017-04-07-ycc-n08  ausente   888 30/04/2017 04:55:00 30/04/2017 19:43:00
157 157 soldier      1    0 2017-04-07-ycc-n08  ausente   948 30/04/2017 04:55:00 30/04/2017 20:43:00
158 158 soldier      1    0 2017-04-07-ycc-n08  ausente   948 30/04/2017 04:55:00 30/04/2017 20:43:00
159 159  worker      1    0 2017-04-07-ycc-n08  ausente  1008 30/04/2017 04:55:00 30/04/2017 21:43:00
160 160  worker      1    0 2017-04-07-ycc-n08  ausente  1008 30/04/2017 04:55:00 30/04/2017 21:43:00
161 161  worker      1    0 2017-04-07-ycc-n08  ausente  1008 30/04/2017 04:55:00 30/04/2017 21:43:00
162 162  worker      1    0 2017-04-07-ycc-n08  ausente  1068 30/04/2017 04:55:00 30/04/2017 22:43:00
163 163  worker      1    0 2017-04-07-ycc-n08  ausente  1068 30/04/2017 04:55:00 30/04/2017 22:43:00
164 164  worker      1    0 2017-04-07-ycc-n08  ausente  1068 30/04/2017 04:55:00 30/04/2017 22:43:00
165 165  worker      1    0 2017-04-07-ycc-n08  ausente  1188 30/04/2017 04:55:00 01/05/2017 00:43:00
166 166  worker      1    0 2017-04-07-ycc-n08  ausente  1188 30/04/2017 04:55:00 01/05/2017 00:43:00
167 167  worker      1    0 2017-04-07-ycc-n08  ausente  1248 30/04/2017 04:55:00 01/05/2017 01:43:00
168 168  worker      1    0 2017-04-07-ycc-n08  ausente  1248 30/04/2017 04:55:00 01/05/2017 01:43:00
169 169  worker      1    0 2017-04-07-ycc-n08  ausente  1308 30/04/2017 04:55:00 01/05/2017 02:43:00
170 170  worker      1    0 2017-04-07-ycc-n08  ausente  1308 30/04/2017 04:55:00 01/05/2017 02:43:00
171 171  worker      1    0 2017-04-07-ycc-n08  ausente  1308 30/04/2017 04:55:00 01/05/2017 02:43:00
172 172  worker      1    0 2017-04-07-ycc-n08  ausente  1368 30/04/2017 04:55:00 01/05/2017 03:43:00
173 173  worker      1    0 2017-04-07-ycc-n08  ausente  1368 30/04/2017 04:55:00 01/05/2017 03:43:00
174 174  worker      1    0 2017-04-07-ycc-n08  ausente  1368 30/04/2017 04:55:00 01/05/2017 03:43:00
175 175  worker      1    0 2017-04-07-ycc-n08  ausente  1788 30/04/2017 04:55:00 01/05/2017 10:43:00
176 176 soldier      1   36 2017-04-07-ycc-n08 presente    60 30/04/2017 04:55:00 30/04/2017 05:55:00
177 177 soldier      1   36 2017-04-07-ycc-n08 presente    60 30/04/2017 04:55:00 30/04/2017 05:55:00
178 178 soldier      1   36 2017-04-07-ycc-n08 presente    60 30/04/2017 04:55:00 30/04/2017 05:55:00
179 179  worker      1   36 2017-04-07-ycc-n08 presente   120 30/04/2017 04:55:00 30/04/2017 06:55:00
180 180  worker      1   36 2017-04-07-ycc-n08 presente   120 30/04/2017 04:55:00 30/04/2017 06:55:00
181 181  worker      1   36 2017-04-07-ycc-n08 presente   168 30/04/2017 04:55:00 30/04/2017 07:43:00
```

182	182	worker	1	36	2017-04-07-ycc-n08	presente	168	30/04/2017 04:55:00	30/04/2017 07:43:00
183	183	soldier	1	36	2017-04-07-ycc-n08	presente	168	30/04/2017 04:55:00	30/04/2017 07:43:00
184	184	worker	1	36	2017-04-07-ycc-n08	presente	228	30/04/2017 04:55:00	30/04/2017 08:43:00
185	185	worker	1	36	2017-04-07-ycc-n08	presente	305	30/04/2017 04:55:00	30/04/2017 10:00:00
186	186	worker	1	36	2017-04-07-ycc-n08	presente	305	30/04/2017 04:55:00	30/04/2017 10:00:00
187	187	soldier	1	36	2017-04-07-ycc-n08	presente	305	30/04/2017 04:55:00	30/04/2017 10:00:00
188	188	worker	1	36	2017-04-07-ycc-n08	presente	365	30/04/2017 04:55:00	30/04/2017 11:00:00
189	189	soldier	1	36	2017-04-07-ycc-n08	presente	365	30/04/2017 04:55:00	30/04/2017 11:00:00
190	190	worker	1	36	2017-04-07-ycc-n08	presente	408	30/04/2017 04:55:00	30/04/2017 11:43:00
191	191	worker	1	36	2017-04-07-ycc-n08	presente	468	30/04/2017 04:55:00	30/04/2017 12:43:00
192	192	worker	1	36	2017-04-07-ycc-n08	presente	468	30/04/2017 04:55:00	30/04/2017 12:43:00
193	193	worker	1	36	2017-04-07-ycc-n08	presente	468	30/04/2017 04:55:00	30/04/2017 12:43:00
194	194	worker	1	36	2017-04-07-ycc-n08	presente	528	30/04/2017 04:55:00	30/04/2017 13:43:00
195	195	worker	1	36	2017-04-07-ycc-n08	presente	528	30/04/2017 04:55:00	30/04/2017 13:43:00
196	196	worker	1	36	2017-04-07-ycc-n08	presente	528	30/04/2017 04:55:00	30/04/2017 13:43:00
197	197	worker	1	36	2017-04-07-ycc-n08	presente	528	30/04/2017 04:55:00	30/04/2017 13:43:00
198	198	worker	1	36	2017-04-07-ycc-n08	presente	588	30/04/2017 04:55:00	30/04/2017 14:43:00
199	199	worker	1	36	2017-04-07-ycc-n08	presente	588	30/04/2017 04:55:00	30/04/2017 14:43:00
200	200	soldier	1	36	2017-04-07-ycc-n08	presente	588	30/04/2017 04:55:00	30/04/2017 14:43:00
201	201	worker	1	36	2017-04-07-ycc-n08	presente	708	30/04/2017 04:55:00	30/04/2017 16:43:00
202	202	worker	1	36	2017-04-07-ycc-n08	presente	768	30/04/2017 04:55:00	30/04/2017 17:43:00
203	203	worker	1	36	2017-04-07-ycc-n08	presente	828	30/04/2017 04:55:00	30/04/2017 18:43:00
204	204	worker	1	36	2017-04-07-ycc-n08	presente	828	30/04/2017 04:55:00	30/04/2017 18:43:00
205	205	worker	1	36	2017-04-07-ycc-n08	presente	828	30/04/2017 04:55:00	30/04/2017 18:43:00
206	206	worker	1	36	2017-04-07-ycc-n08	presente	828	30/04/2017 04:55:00	30/04/2017 18:43:00
207	207	worker	1	36	2017-04-07-ycc-n08	presente	948	30/04/2017 04:55:00	30/04/2017 20:43:00
208	208	worker	1	36	2017-04-07-ycc-n08	presente	1008	30/04/2017 04:55:00	30/04/2017 21:43:00
209	209	worker	1	36	2017-04-07-ycc-n08	presente	1188	30/04/2017 04:55:00	01/05/2017 00:43:00
210	210	worker	1	36	2017-04-07-ycc-n08	presente	1308	30/04/2017 04:55:00	01/05/2017 02:43:00
211	211	soldier	1	0	2017-04-07-ycc-n06	ausente	321	28/04/2017 04:29:00	28/04/2017 09:50:00
212	212	worker	1	0	2017-04-07-ycc-n06	ausente	1094	28/04/2017 04:29:00	28/04/2017 22:43:00
213	213	worker	1	0	2017-04-07-ycc-n06	ausente	1394	28/04/2017 04:29:00	29/04/2017 03:43:00
214	214	worker	1	0	2017-04-07-ycc-n06	ausente	1394	28/04/2017 04:29:00	29/04/2017 03:43:00
215	215	worker	1	0	2017-04-07-ycc-n06	ausente	1574	28/04/2017 04:29:00	29/04/2017 06:43:00
216	216	worker	1	0	2017-04-07-ycc-n06	ausente	1574	28/04/2017 04:29:00	29/04/2017 06:43:00
217	217	worker	1	0	2017-04-07-ycc-n06	ausente	1574	28/04/2017 04:29:00	29/04/2017 06:43:00
218	218	worker	1	0	2017-04-07-ycc-n06	ausente	1634	28/04/2017 04:29:00	29/04/2017 07:43:00
219	219	worker	1	0	2017-04-07-ycc-n06	ausente	1731	28/04/2017 04:29:00	29/04/2017 09:20:00
220	220	worker	1	0	2017-04-07-ycc-n06	ausente	1731	28/04/2017 04:29:00	29/04/2017 09:20:00
221	221	worker	1	0	2017-04-07-ycc-n06	ausente	1731	28/04/2017 04:29:00	29/04/2017 09:20:00
222	222	worker	1	0	2017-04-07-ycc-n06	ausente	1731	28/04/2017 04:29:00	29/04/2017 09:20:00
223	223	worker	1	0	2017-04-07-ycc-n06	ausente	1731	28/04/2017 04:29:00	29/04/2017 09:20:00
224	224	worker	1	0	2017-04-07-ycc-n06	ausente	1754	28/04/2017 04:29:00	29/04/2017 09:43:00
225	225	worker	1	0	2017-04-07-ycc-n06	ausente	1754	28/04/2017 04:29:00	29/04/2017 09:43:00
226	226	worker	1	0	2017-04-07-ycc-n06	ausente	1814	28/04/2017 04:29:00	29/04/2017 10:43:00
227	227	soldier	1	0	2017-04-07-ycc-n06	ausente	1994	28/04/2017 04:29:00	29/04/2017 13:43:00

```
228 228  worker      1    0 2017-04-07-ycc-n06  ausente  2054 28/04/2017 04:29:00 29/04/2017 14:43:00
229 229  worker      1    0 2017-04-07-ycc-n06  ausente  2114 28/04/2017 04:29:00 29/04/2017 15:43:00
230 230  worker      1    0 2017-04-07-ycc-n06  ausente  2114 28/04/2017 04:29:00 29/04/2017 15:43:00
231 231 soldier      1    0 2017-04-07-ycc-n06  ausente  2114 28/04/2017 04:29:00 29/04/2017 15:43:00
232 232  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
233 233  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
234 234  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
235 235  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
236 236  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
237 237  worker      1    0 2017-04-07-ycc-n06  ausente  2225 28/04/2017 04:29:00 29/04/2017 17:34:00
238 238  worker      1    0 2017-04-07-ycc-n06  ausente  2267 28/04/2017 04:29:00 29/04/2017 18:16:00
239 239  worker      1    0 2017-04-07-ycc-n06  ausente  2387 28/04/2017 04:29:00 29/04/2017 20:16:00
240 240 soldier      1    0 2017-04-07-ycc-n06  ausente  2387 28/04/2017 04:29:00 29/04/2017 20:16:00
241 241  worker      1    0 2017-04-07-ycc-n06  ausente  2414 28/04/2017 04:29:00 29/04/2017 20:43:00
242 242  worker      1    0 2017-04-07-ycc-n06  ausente  2474 28/04/2017 04:29:00 29/04/2017 21:43:00
243 243 soldier      1    0 2017-04-07-ycc-n06  ausente  2596 28/04/2017 04:29:00 29/04/2017 23:45:00
244 244 soldier      1    0 2017-04-07-ycc-n06  ausente  2834 28/04/2017 04:29:00 30/04/2017 03:43:00
245 245 soldier      1    0 2017-04-07-ycc-n06  ausente  2894 28/04/2017 04:29:00 30/04/2017 04:43:00
246 246  worker      1   18 2017-04-07-ycc-n06 presente    91 28/04/2017 04:29:00 28/04/2017 06:00:00
247 247 soldier      1   18 2017-04-07-ycc-n06 presente   194 28/04/2017 04:29:00 28/04/2017 07:43:00
248 248  worker      1   18 2017-04-07-ycc-n06 presente   494 28/04/2017 04:29:00 28/04/2017 12:43:00
249 249  worker      1   18 2017-04-07-ycc-n06 presente   614 28/04/2017 04:29:00 28/04/2017 14:43:00
250 250  worker      1   18 2017-04-07-ycc-n06 presente   751 28/04/2017 04:29:00 28/04/2017 17:00:00
251 251  worker      1   18 2017-04-07-ycc-n06 presente   854 28/04/2017 04:29:00 28/04/2017 18:43:00
252 252  worker      1   18 2017-04-07-ycc-n06 presente   950 28/04/2017 04:29:00 28/04/2017 20:19:00
253 253 soldier      1   18 2017-04-07-ycc-n06 presente   950 28/04/2017 04:29:00 28/04/2017 20:19:00
254 254 soldier      1   18 2017-04-07-ycc-n06 presente   950 28/04/2017 04:29:00 28/04/2017 20:19:00
255 255  worker      1   18 2017-04-07-ycc-n06 presente   974 28/04/2017 04:29:00 28/04/2017 20:43:00
256 256  worker      1   18 2017-04-07-ycc-n06 presente   974 28/04/2017 04:29:00 28/04/2017 20:43:00
257 257  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
258 258  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
259 259  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
260 260  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
261 261  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
262 262  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
263 263  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
264 264  worker      1   18 2017-04-07-ycc-n06 presente  1094 28/04/2017 04:29:00 28/04/2017 22:43:00
265 265  worker      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
266 266  worker      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
267 267  worker      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
268 268  worker      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
269 269  worker      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
270 270 soldier      1   18 2017-04-07-ycc-n06 presente  1154 28/04/2017 04:29:00 28/04/2017 23:43:00
271 271  worker      1   18 2017-04-07-ycc-n06 presente  1334 28/04/2017 04:29:00 29/04/2017 02:43:00
272 272  worker      1   18 2017-04-07-ycc-n06 presente  1334 28/04/2017 04:29:00 29/04/2017 02:43:00
273 273  worker      1   18 2017-04-07-ycc-n06 presente  1334 28/04/2017 04:29:00 29/04/2017 02:43:00
```

```
274 274  worker      1   18 2017-04-07-ycc-n06 presente  1334 28/04/2017 04:29:00 29/04/2017 02:43:00
275 275  worker      1   18 2017-04-07-ycc-n06 presente  1394 28/04/2017 04:29:00 29/04/2017 03:43:00
276 276  worker      1   18 2017-04-07-ycc-n06 presente  1394 28/04/2017 04:29:00 29/04/2017 03:43:00
277 277 soldier      1   18 2017-04-07-ycc-n06 presente  1394 28/04/2017 04:29:00 29/04/2017 03:43:00
278 278  worker      1   18 2017-04-07-ycc-n06 presente  1454 28/04/2017 04:29:00 29/04/2017 04:43:00
279 279 soldier      1   18 2017-04-07-ycc-n06 presente  1574 28/04/2017 04:29:00 29/04/2017 06:43:00
280 280 soldier      1   18 2017-04-07-ycc-n06 presente  1994 28/04/2017 04:29:00 29/04/2017 13:43:00
281 281  worker      1    0 2017-04-07-ycc-n07  ausente    60 28/04/2017 19:19:00 28/04/2017 20:19:00
282 282  worker      1    0 2017-04-07-ycc-n07  ausente    84 28/04/2017 19:19:00 28/04/2017 20:43:00
283 283  worker      1    0 2017-04-07-ycc-n07  ausente   204 28/04/2017 19:19:00 28/04/2017 22:43:00
284 284  worker      1    0 2017-04-07-ycc-n07  ausente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
285 285  worker      1    0 2017-04-07-ycc-n07  ausente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
286 286  worker      1    0 2017-04-07-ycc-n07  ausente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
287 287 soldier      1    0 2017-04-07-ycc-n07  ausente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
288 288 soldier      1    0 2017-04-07-ycc-n07  ausente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
289 289 soldier      1    0 2017-04-07-ycc-n07  ausente   506 28/04/2017 19:19:00 29/04/2017 03:45:00
290 290 soldier      1    0 2017-04-07-ycc-n07  ausente   506 28/04/2017 19:19:00 29/04/2017 03:45:00
291 291 soldier      1    0 2017-04-07-ycc-n07  ausente   684 28/04/2017 19:19:00 29/04/2017 06:43:00
292 292  worker      1    0 2017-04-07-ycc-n07  ausente   744 28/04/2017 19:19:00 29/04/2017 07:43:00
293 293  worker      1    0 2017-04-07-ycc-n07  ausente   864 28/04/2017 19:19:00 29/04/2017 09:43:00
294 294 soldier      1    0 2017-04-07-ycc-n07  ausente   924 28/04/2017 19:19:00 29/04/2017 10:43:00
295 295 soldier      1    0 2017-04-07-ycc-n07  ausente   984 28/04/2017 19:19:00 29/04/2017 11:43:00
296 296  worker      1    0 2017-04-07-ycc-n07  ausente  1104 28/04/2017 19:19:00 29/04/2017 13:43:00
297 297  worker      1    0 2017-04-07-ycc-n07  ausente  1104 28/04/2017 19:19:00 29/04/2017 13:43:00
298 298  worker      1    0 2017-04-07-ycc-n07  ausente  1164 28/04/2017 19:19:00 29/04/2017 14:43:00
299 299  worker      1    0 2017-04-07-ycc-n07  ausente  1232 28/04/2017 19:19:00 29/04/2017 15:51:00
300 300  worker      1    0 2017-04-07-ycc-n07  ausente  1232 28/04/2017 19:19:00 29/04/2017 15:51:00
301 301  worker      1    0 2017-04-07-ycc-n07  ausente  1232 28/04/2017 19:19:00 29/04/2017 15:51:00
302 302  worker      1    0 2017-04-07-ycc-n07  ausente  1335 28/04/2017 19:19:00 29/04/2017 17:34:00
303 303  worker      1    0 2017-04-07-ycc-n07  ausente  1335 28/04/2017 19:19:00 29/04/2017 17:34:00
304 304  worker      1    0 2017-04-07-ycc-n07  ausente  1377 28/04/2017 19:19:00 29/04/2017 18:16:00
305 305  worker      1    0 2017-04-07-ycc-n07  ausente  1497 28/04/2017 19:19:00 29/04/2017 20:16:00
306 306  worker      1    0 2017-04-07-ycc-n07  ausente  1497 28/04/2017 19:19:00 29/04/2017 20:16:00
307 307  worker      1    0 2017-04-07-ycc-n07  ausente  1497 28/04/2017 19:19:00 29/04/2017 20:16:00
308 308  worker      1    0 2017-04-07-ycc-n07  ausente  1497 28/04/2017 19:19:00 29/04/2017 20:16:00
309 309  worker      1    0 2017-04-07-ycc-n07  ausente  1497 28/04/2017 19:19:00 29/04/2017 20:16:00
310 310  worker      1    0 2017-04-07-ycc-n07  ausente  1524 28/04/2017 19:19:00 29/04/2017 20:43:00
311 311  worker      1    0 2017-04-07-ycc-n07  ausente  1644 28/04/2017 19:19:00 29/04/2017 22:43:00
312 312  worker      1    0 2017-04-07-ycc-n07  ausente  1644 28/04/2017 19:19:00 29/04/2017 22:43:00
313 313  worker      1    0 2017-04-07-ycc-n07  ausente  1764 28/04/2017 19:19:00 30/04/2017 00:43:00
314 314  worker      1    0 2017-04-07-ycc-n07  ausente  1764 28/04/2017 19:19:00 30/04/2017 00:43:00
315 315  worker      1    0 2017-04-07-ycc-n07  ausente  2321 28/04/2017 19:19:00 30/04/2017 10:00:00
316 316 soldier      1   26 2017-04-07-ycc-n07 presente    60 28/04/2017 19:19:00 28/04/2017 20:19:00
317 317  worker      1   26 2017-04-07-ycc-n07 presente    84 28/04/2017 19:19:00 28/04/2017 20:43:00
318 318  worker      1   26 2017-04-07-ycc-n07 presente   264 28/04/2017 19:19:00 28/04/2017 23:43:00
319 319  worker      1   26 2017-04-07-ycc-n07 presente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
```

```
320 320  worker      1   26 2017-04-07-ycc-n07 presente   446 28/04/2017 19:19:00 29/04/2017 02:45:00
321 321  worker      1   26 2017-04-07-ycc-n07 presente   506 28/04/2017 19:19:00 29/04/2017 03:45:00
322 322  worker      1   26 2017-04-07-ycc-n07 presente   506 28/04/2017 19:19:00 29/04/2017 03:45:00
323 323  worker      1   26 2017-04-07-ycc-n07 presente   506 28/04/2017 19:19:00 29/04/2017 03:45:00
324 324  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
325 325  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
326 326  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
327 327  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
328 328  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
329 329  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
330 330  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
331 331  worker      1   26 2017-04-07-ycc-n07 presente   566 28/04/2017 19:19:00 29/04/2017 04:45:00
332 332  worker      1   26 2017-04-07-ycc-n07 presente   624 28/04/2017 19:19:00 29/04/2017 05:43:00
333 333  worker      1   26 2017-04-07-ycc-n07 presente   624 28/04/2017 19:19:00 29/04/2017 05:43:00
334 334  worker      1   26 2017-04-07-ycc-n07 presente   624 28/04/2017 19:19:00 29/04/2017 05:43:00
335 335  worker      1   26 2017-04-07-ycc-n07 presente   624 28/04/2017 19:19:00 29/04/2017 05:43:00
336 336  worker      1   26 2017-04-07-ycc-n07 presente   624 28/04/2017 19:19:00 29/04/2017 05:43:00
337 337  worker      1   26 2017-04-07-ycc-n07 presente   684 28/04/2017 19:19:00 29/04/2017 06:43:00
338 338  worker      1   26 2017-04-07-ycc-n07 presente   744 28/04/2017 19:19:00 29/04/2017 07:43:00
339 339  worker      1   26 2017-04-07-ycc-n07 presente   744 28/04/2017 19:19:00 29/04/2017 07:43:00
340 340  worker      1   26 2017-04-07-ycc-n07 presente   841 28/04/2017 19:19:00 29/04/2017 09:20:00
341 341  worker      1   26 2017-04-07-ycc-n07 presente   841 28/04/2017 19:19:00 29/04/2017 09:20:00
342 342 soldier      1   26 2017-04-07-ycc-n07 presente   841 28/04/2017 19:19:00 29/04/2017 09:20:00
343 343  worker      1   26 2017-04-07-ycc-n07 presente  1044 28/04/2017 19:19:00 29/04/2017 12:43:00
344 344  worker      1   26 2017-04-07-ycc-n07 presente  1104 28/04/2017 19:19:00 29/04/2017 13:43:00
345 345 soldier      1   26 2017-04-07-ycc-n07 presente  1164 28/04/2017 19:19:00 29/04/2017 14:43:00
346 346  worker      1   26 2017-04-07-ycc-n07 presente  1232 28/04/2017 19:19:00 29/04/2017 15:51:00
347 347 soldier      1   26 2017-04-07-ycc-n07 presente  1377 28/04/2017 19:19:00 29/04/2017 18:16:00
348 348 soldier      1   26 2017-04-07-ycc-n07 presente  1644 28/04/2017 19:19:00 29/04/2017 22:43:00
349 349 soldier      1   26 2017-04-07-ycc-n07 presente  2136 28/04/2017 19:19:00 30/04/2017 06:55:00
350 350 soldier      1   26 2017-04-07-ycc-n07 presente  2321 28/04/2017 19:19:00 30/04/2017 10:00:00
351 351  worker      1    0 2017-04-07-ycc-n10  ausente    60 04/05/2017 21:50:00 04/05/2017 22:50:00
352 352  worker      1    0 2017-04-07-ycc-n10  ausente    60 04/05/2017 21:50:00 04/05/2017 22:50:00
353 353  worker      1    0 2017-04-07-ycc-n10  ausente    60 04/05/2017 21:50:00 04/05/2017 22:50:00
354 354  worker      1    0 2017-04-07-ycc-n10  ausente   120 04/05/2017 21:50:00 04/05/2017 23:50:00
355 355 soldier      1    0 2017-04-07-ycc-n10  ausente   240 04/05/2017 21:50:00 05/05/2017 01:50:00
356 356  worker      1    0 2017-04-07-ycc-n10  ausente   300 04/05/2017 21:50:00 05/05/2017 02:50:00
357 357  worker      1    0 2017-04-07-ycc-n10  ausente   360 04/05/2017 21:50:00 05/05/2017 03:50:00
358 358  worker      1    0 2017-04-07-ycc-n10  ausente   660 04/05/2017 21:50:00 05/05/2017 08:50:00
359 359  worker      1    0 2017-04-07-ycc-n10  ausente   780 04/05/2017 21:50:00 05/05/2017 10:50:00
360 360 soldier      1    0 2017-04-07-ycc-n10  ausente   840 04/05/2017 21:50:00 05/05/2017 11:50:00
361 361  worker      1    0 2017-04-07-ycc-n10  ausente   900 04/05/2017 21:50:00 05/05/2017 12:50:00
362 362  worker      1    0 2017-04-07-ycc-n10  ausente   900 04/05/2017 21:50:00 05/05/2017 12:50:00
363 363 soldier      1    0 2017-04-07-ycc-n10  ausente  1020 04/05/2017 21:50:00 05/05/2017 14:50:00
364 364 soldier      1    0 2017-04-07-ycc-n10  ausente  1020 04/05/2017 21:50:00 05/05/2017 14:50:00
365 365  worker      1    0 2017-04-07-ycc-n10  ausente  1080 04/05/2017 21:50:00 05/05/2017 15:50:00
```

```
366 366  worker      1    0 2017-04-07-ycc-n10  ausente  1200 04/05/2017 21:50:00 05/05/2017 17:50:00
367 367  worker      1    0 2017-04-07-ycc-n10  ausente  1200 04/05/2017 21:50:00 05/05/2017 17:50:00
368 368  worker      1    0 2017-04-07-ycc-n10  ausente  1200 04/05/2017 21:50:00 05/05/2017 17:50:00
369 369  worker      1    0 2017-04-07-ycc-n10  ausente  1330 04/05/2017 21:50:00 05/05/2017 20:00:00
370 370  worker      1    0 2017-04-07-ycc-n10  ausente  1440 04/05/2017 21:50:00 05/05/2017 21:50:00
371 371  worker      1    0 2017-04-07-ycc-n10  ausente  1440 04/05/2017 21:50:00 05/05/2017 21:50:00
372 372 soldier      1    0 2017-04-07-ycc-n10  ausente  1440 04/05/2017 21:50:00 05/05/2017 21:50:00
373 373  worker      1    0 2017-04-07-ycc-n10  ausente  1594 04/05/2017 21:50:00 06/05/2017 00:24:00
374 374  worker      1    0 2017-04-07-ycc-n10  ausente  1594 04/05/2017 21:50:00 06/05/2017 00:24:00
375 375  worker      1    0 2017-04-07-ycc-n10  ausente  1594 04/05/2017 21:50:00 06/05/2017 00:24:00
376 376  worker      1    0 2017-04-07-ycc-n10  ausente  1594 04/05/2017 21:50:00 06/05/2017 00:24:00
377 377  worker      1    0 2017-04-07-ycc-n10  ausente  1642 04/05/2017 21:50:00 06/05/2017 01:12:00
378 378  worker      1    0 2017-04-07-ycc-n10  ausente  1642 04/05/2017 21:50:00 06/05/2017 01:12:00
379 379  worker      1    0 2017-04-07-ycc-n10  ausente  1725 04/05/2017 21:50:00 06/05/2017 02:35:00
380 380  worker      1    0 2017-04-07-ycc-n10  ausente  1860 04/05/2017 21:50:00 06/05/2017 04:50:00
381 381  worker      1    0 2017-04-07-ycc-n10  ausente  1860 04/05/2017 21:50:00 06/05/2017 04:50:00
382 382  worker      1    0 2017-04-07-ycc-n10  ausente  1860 04/05/2017 21:50:00 06/05/2017 04:50:00
383 383 soldier      1    0 2017-04-07-ycc-n10  ausente  1920 04/05/2017 21:50:00 06/05/2017 05:50:00
384 384  worker      1    0 2017-04-07-ycc-n10  ausente  1980 04/05/2017 21:50:00 06/05/2017 06:50:00
385 385 soldier      1    0 2017-04-07-ycc-n10  ausente  2220 04/05/2017 21:50:00 06/05/2017 10:50:00
386 386  worker      1   28 2017-04-07-ycc-n10 presente   120 04/05/2017 21:50:00 04/05/2017 23:50:00
387 387  worker      1   28 2017-04-07-ycc-n10 presente   120 04/05/2017 21:50:00 04/05/2017 23:50:00
388 388  worker      1   28 2017-04-07-ycc-n10 presente   240 04/05/2017 21:50:00 05/05/2017 01:50:00
389 389  worker      1   28 2017-04-07-ycc-n10 presente   240 04/05/2017 21:50:00 05/05/2017 01:50:00
390 390  worker      1   28 2017-04-07-ycc-n10 presente   240 04/05/2017 21:50:00 05/05/2017 01:50:00
391 391  worker      1   28 2017-04-07-ycc-n10 presente   240 04/05/2017 21:50:00 05/05/2017 01:50:00
392 392  worker      1   28 2017-04-07-ycc-n10 presente   360 04/05/2017 21:50:00 05/05/2017 03:50:00
393 393  worker      1   28 2017-04-07-ycc-n10 presente   360 04/05/2017 21:50:00 05/05/2017 03:50:00
394 394  worker      1   28 2017-04-07-ycc-n10 presente   360 04/05/2017 21:50:00 05/05/2017 03:50:00
395 395  worker      1   28 2017-04-07-ycc-n10 presente   360 04/05/2017 21:50:00 05/05/2017 03:50:00
396 396  worker      1   28 2017-04-07-ycc-n10 presente   420 04/05/2017 21:50:00 05/05/2017 04:50:00
397 397  worker      1   28 2017-04-07-ycc-n10 presente   420 04/05/2017 21:50:00 05/05/2017 04:50:00
398 398  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
399 399  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
400 400  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
401 401  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
402 402  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
403 403  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
404 404  worker      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
405 405 soldier      1   28 2017-04-07-ycc-n10 presente   540 04/05/2017 21:50:00 05/05/2017 06:50:00
406 406  worker      1   28 2017-04-07-ycc-n10 presente   595 04/05/2017 21:50:00 05/05/2017 07:45:00
407 407  worker      1   28 2017-04-07-ycc-n10 presente   595 04/05/2017 21:50:00 05/05/2017 07:45:00
408 408  worker      1   28 2017-04-07-ycc-n10 presente   595 04/05/2017 21:50:00 05/05/2017 07:45:00
409 409  worker      1   28 2017-04-07-ycc-n10 presente   595 04/05/2017 21:50:00 05/05/2017 07:45:00
410 410  worker      1   28 2017-04-07-ycc-n10 presente   660 04/05/2017 21:50:00 05/05/2017 08:50:00
411 411  worker      1   28 2017-04-07-ycc-n10 presente   660 04/05/2017 21:50:00 05/05/2017 08:50:00
```

```
412 412  worker      1   28 2017-04-07-ycc-n10 presente   660 04/05/2017 21:50:00 05/05/2017 08:50:00
413 413  worker      1   28 2017-04-07-ycc-n10 presente   660 04/05/2017 21:50:00 05/05/2017 08:50:00
414 414  worker      1   28 2017-04-07-ycc-n10 presente   720 04/05/2017 21:50:00 05/05/2017 09:50:00
415 415 soldier      1   28 2017-04-07-ycc-n10 presente   900 04/05/2017 21:50:00 05/05/2017 12:50:00
416 416 soldier      1   28 2017-04-07-ycc-n10 presente   960 04/05/2017 21:50:00 05/05/2017 13:50:00
417 417 soldier      1   28 2017-04-07-ycc-n10 presente  1020 04/05/2017 21:50:00 05/05/2017 14:50:00
418 418 soldier      1   28 2017-04-07-ycc-n10 presente  1725 04/05/2017 21:50:00 06/05/2017 02:35:00
419 419 soldier      1   28 2017-04-07-ycc-n10 presente  1920 04/05/2017 21:50:00 06/05/2017 05:50:00
420 420 soldier      1   28 2017-04-07-ycc-n10 presente  2460 04/05/2017 21:50:00 06/05/2017 14:50:00
421 421  worker      1    0 2017-04-07-ycc-n12  ausente    80 05/05/2017 00:30:00 05/05/2017 01:50:00
422 422  worker      1    0 2017-04-07-ycc-n12  ausente   125 05/05/2017 00:30:00 05/05/2017 02:35:00
423 423  worker      1    0 2017-04-07-ycc-n12  ausente   125 05/05/2017 00:30:00 05/05/2017 02:35:00
424 424  worker      1    0 2017-04-07-ycc-n12  ausente   125 05/05/2017 00:30:00 05/05/2017 02:35:00
425 425  worker      1    0 2017-04-07-ycc-n12  ausente   320 05/05/2017 00:30:00 05/05/2017 05:50:00
426 426  worker      1    0 2017-04-07-ycc-n12  ausente   320 05/05/2017 00:30:00 05/05/2017 05:50:00
427 427  worker      1    0 2017-04-07-ycc-n12  ausente   620 05/05/2017 00:30:00 05/05/2017 10:50:00
428 428  worker      1    0 2017-04-07-ycc-n12  ausente   680 05/05/2017 00:30:00 05/05/2017 11:50:00
429 429  worker      1    0 2017-04-07-ycc-n12  ausente   860 05/05/2017 00:30:00 05/05/2017 14:50:00
430 430  worker      1    0 2017-04-07-ycc-n12  ausente   920 05/05/2017 00:30:00 05/05/2017 15:50:00
431 431 soldier      1    0 2017-04-07-ycc-n12  ausente   920 05/05/2017 00:30:00 05/05/2017 15:50:00
432 432  worker      1    0 2017-04-07-ycc-n12  ausente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
433 433 soldier      1    0 2017-04-07-ycc-n12  ausente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
434 434 soldier      1    0 2017-04-07-ycc-n12  ausente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
435 435  worker      1    0 2017-04-07-ycc-n12  ausente  1100 05/05/2017 00:30:00 05/05/2017 18:50:00
436 436  worker      1    0 2017-04-07-ycc-n12  ausente  1220 05/05/2017 00:30:00 05/05/2017 20:50:00
437 437  worker      1    0 2017-04-07-ycc-n12  ausente  1220 05/05/2017 00:30:00 05/05/2017 20:50:00
438 438  worker      1    0 2017-04-07-ycc-n12  ausente  1220 05/05/2017 00:30:00 05/05/2017 20:50:00
439 439  worker      1    0 2017-04-07-ycc-n12  ausente  1360 05/05/2017 00:30:00 05/05/2017 23:10:00
440 440  worker      1    0 2017-04-07-ycc-n12  ausente  1400 05/05/2017 00:30:00 05/05/2017 23:50:00
441 441 soldier      1    0 2017-04-07-ycc-n12  ausente  1400 05/05/2017 00:30:00 05/05/2017 23:50:00
442 442  worker      1    0 2017-04-07-ycc-n12  ausente  1460 05/05/2017 00:30:00 06/05/2017 00:50:00
443 443  worker      1    0 2017-04-07-ycc-n12  ausente  1460 05/05/2017 00:30:00 06/05/2017 00:50:00
444 444 soldier      1    0 2017-04-07-ycc-n12  ausente  1460 05/05/2017 00:30:00 06/05/2017 00:50:00
445 445  worker      1    0 2017-04-07-ycc-n12  ausente  1570 05/05/2017 00:30:00 06/05/2017 02:40:00
446 446  worker      1    0 2017-04-07-ycc-n12  ausente  1630 05/05/2017 00:30:00 06/05/2017 03:40:00
447 447  worker      1    0 2017-04-07-ycc-n12  ausente  1630 05/05/2017 00:30:00 06/05/2017 03:40:00
448 448  worker      1    0 2017-04-07-ycc-n12  ausente  1630 05/05/2017 00:30:00 06/05/2017 03:40:00
449 449 soldier      1    0 2017-04-07-ycc-n12  ausente  1630 05/05/2017 00:30:00 06/05/2017 03:40:00
450 450  worker      1    0 2017-04-07-ycc-n12  ausente  1700 05/05/2017 00:30:00 06/05/2017 04:50:00
451 451  worker      1    0 2017-04-07-ycc-n12  ausente  1700 05/05/2017 00:30:00 06/05/2017 04:50:00
452 452  worker      1    0 2017-04-07-ycc-n12  ausente  1760 05/05/2017 00:30:00 06/05/2017 05:50:00
453 453 soldier      1    0 2017-04-07-ycc-n12  ausente  1880 05/05/2017 00:30:00 06/05/2017 07:50:00
454 454  worker      1    0 2017-04-07-ycc-n12  ausente  2000 05/05/2017 00:30:00 06/05/2017 09:50:00
455 455  worker      1    0 2017-04-07-ycc-n12  ausente  2060 05/05/2017 00:30:00 06/05/2017 10:50:00
456 456  worker      1   16 2017-04-07-ycc-n12 presente    80 05/05/2017 00:30:00 05/05/2017 01:50:00
457 457  worker      1   16 2017-04-07-ycc-n12 presente   125 05/05/2017 00:30:00 05/05/2017 02:35:00
```

```
458 458  worker      1   16 2017-04-07-ycc-n12 presente   250 05/05/2017 00:30:00 05/05/2017 04:40:00
459 459  worker      1   16 2017-04-07-ycc-n12 presente   320 05/05/2017 00:30:00 05/05/2017 05:50:00
460 460  worker      1   16 2017-04-07-ycc-n12 presente   320 05/05/2017 00:30:00 05/05/2017 05:50:00
461 461  worker      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
462 462  worker      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
463 463  worker      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
464 464  worker      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
465 465  worker      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
466 466 soldier      1   16 2017-04-07-ycc-n12 presente   380 05/05/2017 00:30:00 05/05/2017 06:50:00
467 467  worker      1   16 2017-04-07-ycc-n12 presente   470 05/05/2017 00:30:00 05/05/2017 08:20:00
468 468  worker      1   16 2017-04-07-ycc-n12 presente   470 05/05/2017 00:30:00 05/05/2017 08:20:00
469 469  worker      1   16 2017-04-07-ycc-n12 presente   470 05/05/2017 00:30:00 05/05/2017 08:20:00
470 470 soldier      1   16 2017-04-07-ycc-n12 presente   470 05/05/2017 00:30:00 05/05/2017 08:20:00
471 471  worker      1   16 2017-04-07-ycc-n12 presente   560 05/05/2017 00:30:00 05/05/2017 09:50:00
472 472  worker      1   16 2017-04-07-ycc-n12 presente   620 05/05/2017 00:30:00 05/05/2017 10:50:00
473 473  worker      1   16 2017-04-07-ycc-n12 presente   620 05/05/2017 00:30:00 05/05/2017 10:50:00
474 474  worker      1   16 2017-04-07-ycc-n12 presente   680 05/05/2017 00:30:00 05/05/2017 11:50:00
475 475  worker      1   16 2017-04-07-ycc-n12 presente   680 05/05/2017 00:30:00 05/05/2017 11:50:00
476 476 soldier      1   16 2017-04-07-ycc-n12 presente   680 05/05/2017 00:30:00 05/05/2017 11:50:00
477 477  worker      1   16 2017-04-07-ycc-n12 presente   740 05/05/2017 00:30:00 05/05/2017 12:50:00
478 478  worker      1   16 2017-04-07-ycc-n12 presente   740 05/05/2017 00:30:00 05/05/2017 12:50:00
479 479  worker      1   16 2017-04-07-ycc-n12 presente   800 05/05/2017 00:30:00 05/05/2017 13:50:00
480 480  worker      1   16 2017-04-07-ycc-n12 presente   800 05/05/2017 00:30:00 05/05/2017 13:50:00
481 481  worker      1   16 2017-04-07-ycc-n12 presente   860 05/05/2017 00:30:00 05/05/2017 14:50:00
482 482  worker      1   16 2017-04-07-ycc-n12 presente   860 05/05/2017 00:30:00 05/05/2017 14:50:00
483 483  worker      1   16 2017-04-07-ycc-n12 presente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
484 484 soldier      1   16 2017-04-07-ycc-n12 presente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
485 485 soldier      1   16 2017-04-07-ycc-n12 presente   980 05/05/2017 00:30:00 05/05/2017 16:50:00
486 486  worker      1   16 2017-04-07-ycc-n12 presente  1040 05/05/2017 00:30:00 05/05/2017 17:50:00
487 487  worker      1   16 2017-04-07-ycc-n12 presente  1040 05/05/2017 00:30:00 05/05/2017 17:50:00
488 488  worker      1   16 2017-04-07-ycc-n12 presente  1040 05/05/2017 00:30:00 05/05/2017 17:50:00
489 489 soldier      1   16 2017-04-07-ycc-n12 presente  1400 05/05/2017 00:30:00 05/05/2017 23:50:00
490 490 soldier      1   16 2017-04-07-ycc-n12 presente  1700 05/05/2017 00:30:00 06/05/2017 04:50:00
491 491 soldier      1    0 2017-04-07-ycc-n13  ausente    60 07/05/2017 03:50:00 07/05/2017 04:50:00
492 492 soldier      1    0 2017-04-07-ycc-n13  ausente   540 07/05/2017 03:50:00 07/05/2017 12:50:00
493 493  worker      1    0 2017-04-07-ycc-n13  ausente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
494 494 soldier      1    0 2017-04-07-ycc-n13  ausente  1000 07/05/2017 03:50:00 07/05/2017 20:30:00
495 495  worker      1    0 2017-04-07-ycc-n13  ausente  1600 07/05/2017 03:50:00 08/05/2017 06:30:00
496 496  worker      1    0 2017-04-07-ycc-n13  ausente  1795 07/05/2017 03:50:00 08/05/2017 09:45:00
497 497  worker      1    0 2017-04-07-ycc-n13  ausente  1795 07/05/2017 03:50:00 08/05/2017 09:45:00
498 498  worker      1    0 2017-04-07-ycc-n13  ausente  1855 07/05/2017 03:50:00 08/05/2017 10:45:00
499 499  worker      1    0 2017-04-07-ycc-n13  ausente  1855 07/05/2017 03:50:00 08/05/2017 10:45:00
500 500  worker      1    0 2017-04-07-ycc-n13  ausente  1855 07/05/2017 03:50:00 08/05/2017 10:45:00
501 501  worker      1    0 2017-04-07-ycc-n13  ausente  1855 07/05/2017 03:50:00 08/05/2017 10:45:00
502 502 soldier      1    0 2017-04-07-ycc-n13  ausente  1855 07/05/2017 03:50:00 08/05/2017 10:45:00
503 503  worker      1    0 2017-04-07-ycc-n13  ausente  1915 07/05/2017 03:50:00 08/05/2017 11:45:00
```

```
504 504  worker      1    0 2017-04-07-ycc-n13  ausente  2220 07/05/2017 03:50:00 08/05/2017 16:50:00
505 505  worker      1    0 2017-04-07-ycc-n13  ausente  2340 07/05/2017 03:50:00 08/05/2017 18:50:00
506 506  worker      1    0 2017-04-07-ycc-n13  ausente  2460 07/05/2017 03:50:00 08/05/2017 20:50:00
507 507  worker      1    0 2017-04-07-ycc-n13  ausente  2580 07/05/2017 03:50:00 08/05/2017 22:50:00
508 508  worker      1    0 2017-04-07-ycc-n13  ausente  2580 07/05/2017 03:50:00 08/05/2017 22:50:00
509 509  worker      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
510 510  worker      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
511 511  worker      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
512 512  worker      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
513 513  worker      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
514 514 soldier      1    0 2017-04-07-ycc-n13  ausente  2820 07/05/2017 03:50:00 09/05/2017 02:50:00
515 515  worker      1    0 2017-04-07-ycc-n13  ausente  2880 07/05/2017 03:50:00 09/05/2017 03:50:00
516 516  worker      1    0 2017-04-07-ycc-n13  ausente  3000 07/05/2017 03:50:00 09/05/2017 05:50:00
517 517  worker      1    0 2017-04-07-ycc-n13  ausente  3060 07/05/2017 03:50:00 09/05/2017 06:50:00
518 518  worker      1    0 2017-04-07-ycc-n13  ausente  3060 07/05/2017 03:50:00 09/05/2017 06:50:00
519 519  worker      1    0 2017-04-07-ycc-n13  ausente  3060 07/05/2017 03:50:00 09/05/2017 06:50:00
520 520  worker      1    0 2017-04-07-ycc-n13  ausente  3060 07/05/2017 03:50:00 09/05/2017 06:50:00
521 521 soldier      1    0 2017-04-07-ycc-n13  ausente  3060 07/05/2017 03:50:00 09/05/2017 06:50:00
522 522  worker      1    0 2017-04-07-ycc-n13  ausente  3190 07/05/2017 03:50:00 09/05/2017 09:00:00
523 523  worker      1    0 2017-04-07-ycc-n13  ausente  3240 07/05/2017 03:50:00 09/05/2017 09:50:00
524 524  worker      1    0 2017-04-07-ycc-n13  ausente  3300 07/05/2017 03:50:00 09/05/2017 10:50:00
525 525 soldier      1    0 2017-04-07-ycc-n13  ausente  3370 07/05/2017 03:50:00 09/05/2017 12:00:00
526 526  worker      1   32 2017-04-07-ycc-n13 presente   300 07/05/2017 03:50:00 07/05/2017 08:50:00
527 527  worker      1   32 2017-04-07-ycc-n13 presente   360 07/05/2017 03:50:00 07/05/2017 09:50:00
528 528  worker      1   32 2017-04-07-ycc-n13 presente   480 07/05/2017 03:50:00 07/05/2017 11:50:00
529 529  worker      1   32 2017-04-07-ycc-n13 presente   480 07/05/2017 03:50:00 07/05/2017 11:50:00
530 530  worker      1   32 2017-04-07-ycc-n13 presente   540 07/05/2017 03:50:00 07/05/2017 12:50:00
531 531  worker      1   32 2017-04-07-ycc-n13 presente   540 07/05/2017 03:50:00 07/05/2017 12:50:00
532 532  worker      1   32 2017-04-07-ycc-n13 presente   540 07/05/2017 03:50:00 07/05/2017 12:50:00
533 533  worker      1   32 2017-04-07-ycc-n13 presente   540 07/05/2017 03:50:00 07/05/2017 12:50:00
534 534  worker      1   32 2017-04-07-ycc-n13 presente   600 07/05/2017 03:50:00 07/05/2017 13:50:00
535 535  worker      1   32 2017-04-07-ycc-n13 presente   600 07/05/2017 03:50:00 07/05/2017 13:50:00
536 536  worker      1   32 2017-04-07-ycc-n13 presente   600 07/05/2017 03:50:00 07/05/2017 13:50:00
537 537  worker      1   32 2017-04-07-ycc-n13 presente   660 07/05/2017 03:50:00 07/05/2017 14:50:00
538 538  worker      1   32 2017-04-07-ycc-n13 presente   660 07/05/2017 03:50:00 07/05/2017 14:50:00
539 539  worker      1   32 2017-04-07-ycc-n13 presente   660 07/05/2017 03:50:00 07/05/2017 14:50:00
540 540  worker      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
541 541  worker      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
542 542  worker      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
543 543  worker      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
544 544  worker      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
545 545 soldier      1   32 2017-04-07-ycc-n13 presente   720 07/05/2017 03:50:00 07/05/2017 15:50:00
546 546  worker      1   32 2017-04-07-ycc-n13 presente   780 07/05/2017 03:50:00 07/05/2017 16:50:00
547 547  worker      1   32 2017-04-07-ycc-n13 presente   880 07/05/2017 03:50:00 07/05/2017 18:30:00
548 548  worker      1   32 2017-04-07-ycc-n13 presente   880 07/05/2017 03:50:00 07/05/2017 18:30:00
549 549 soldier      1   32 2017-04-07-ycc-n13 presente   880 07/05/2017 03:50:00 07/05/2017 18:30:00
```

```
550 550 soldier      1   32 2017-04-07-ycc-n13 presente   880 07/05/2017 03:50:00 07/05/2017 18:30:00
551 551  worker      1   32 2017-04-07-ycc-n13 presente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
552 552  worker      1   32 2017-04-07-ycc-n13 presente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
553 553  worker      1   32 2017-04-07-ycc-n13 presente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
554 554 soldier      1   32 2017-04-07-ycc-n13 presente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
555 555 soldier      1   32 2017-04-07-ycc-n13 presente   940 07/05/2017 03:50:00 07/05/2017 19:30:00
556 556  worker      1   32 2017-04-07-ycc-n13 presente  1000 07/05/2017 03:50:00 07/05/2017 20:30:00
557 557  worker      1   32 2017-04-07-ycc-n13 presente  1180 07/05/2017 03:50:00 07/05/2017 23:30:00
558 558  worker      1   32 2017-04-07-ycc-n13 presente  1180 07/05/2017 03:50:00 07/05/2017 23:30:00
559 559 soldier      1   32 2017-04-07-ycc-n13 presente  1180 07/05/2017 03:50:00 07/05/2017 23:30:00
560 560 soldier      1   32 2017-04-07-ycc-n13 presente  2040 07/05/2017 03:50:00 08/05/2017 13:50:00
561 561  worker      1    0 2017-04-07-ycc-n14  ausente    60 08/05/2017 01:30:00 08/05/2017 02:30:00
562 562 soldier      1    0 2017-04-07-ycc-n14  ausente    60 08/05/2017 01:30:00 08/05/2017 02:30:00
563 563 soldier      1    0 2017-04-07-ycc-n14  ausente    60 08/05/2017 01:30:00 08/05/2017 02:30:00
564 564 soldier      1    0 2017-04-07-ycc-n14  ausente   180 08/05/2017 01:30:00 08/05/2017 04:30:00
565 565  worker      1    0 2017-04-07-ycc-n14  ausente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
566 566 soldier      1    0 2017-04-07-ycc-n14  ausente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
567 567  worker      1    0 2017-04-07-ycc-n14  ausente   360 08/05/2017 01:30:00 08/05/2017 07:30:00
568 568 soldier      1    0 2017-04-07-ycc-n14  ausente   495 08/05/2017 01:30:00 08/05/2017 09:45:00
569 569  worker      1    0 2017-04-07-ycc-n14  ausente   555 08/05/2017 01:30:00 08/05/2017 10:45:00
570 570  worker      1    0 2017-04-07-ycc-n14  ausente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
571 571  worker      1    0 2017-04-07-ycc-n14  ausente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
572 572  worker      1    0 2017-04-07-ycc-n14  ausente   675 08/05/2017 01:30:00 08/05/2017 12:45:00
573 573  worker      1    0 2017-04-07-ycc-n14  ausente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
574 574  worker      1    0 2017-04-07-ycc-n14  ausente   860 08/05/2017 01:30:00 08/05/2017 15:50:00
575 575  worker      1    0 2017-04-07-ycc-n14  ausente   980 08/05/2017 01:30:00 08/05/2017 17:50:00
576 576  worker      1    0 2017-04-07-ycc-n14  ausente  1040 08/05/2017 01:30:00 08/05/2017 18:50:00
577 577  worker      1    0 2017-04-07-ycc-n14  ausente  1040 08/05/2017 01:30:00 08/05/2017 18:50:00
578 578  worker      1    0 2017-04-07-ycc-n14  ausente  1040 08/05/2017 01:30:00 08/05/2017 18:50:00
579 579  worker      1    0 2017-04-07-ycc-n14  ausente  1100 08/05/2017 01:30:00 08/05/2017 19:50:00
580 580  worker      1    0 2017-04-07-ycc-n14  ausente  1100 08/05/2017 01:30:00 08/05/2017 19:50:00
581 581 soldier      1    0 2017-04-07-ycc-n14  ausente  1160 08/05/2017 01:30:00 08/05/2017 20:50:00
582 582  worker      1    0 2017-04-07-ycc-n14  ausente  1220 08/05/2017 01:30:00 08/05/2017 21:50:00
583 583  worker      1    0 2017-04-07-ycc-n14  ausente  1220 08/05/2017 01:30:00 08/05/2017 21:50:00
584 584  worker      1    0 2017-04-07-ycc-n14  ausente  1280 08/05/2017 01:30:00 08/05/2017 22:50:00
585 585  worker      1    0 2017-04-07-ycc-n14  ausente  1280 08/05/2017 01:30:00 08/05/2017 22:50:00
586 586  worker      1    0 2017-04-07-ycc-n14  ausente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
587 587  worker      1    0 2017-04-07-ycc-n14  ausente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
588 588  worker      1    0 2017-04-07-ycc-n14  ausente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
589 589  worker      1    0 2017-04-07-ycc-n14  ausente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
590 590 soldier      1    0 2017-04-07-ycc-n14  ausente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
591 591  worker      1    0 2017-04-07-ycc-n14  ausente  1640 08/05/2017 01:30:00 09/05/2017 04:50:00
592 592  worker      1    0 2017-04-07-ycc-n14  ausente  1700 08/05/2017 01:30:00 09/05/2017 05:50:00
593 593  worker      1    0 2017-04-07-ycc-n14  ausente  1700 08/05/2017 01:30:00 09/05/2017 05:50:00
594 594  worker      1    0 2017-04-07-ycc-n14  ausente  1890 08/05/2017 01:30:00 09/05/2017 09:00:00
595 595  worker      1    0 2017-04-07-ycc-n14  ausente  1940 08/05/2017 01:30:00 09/05/2017 09:50:00
```

```
596 596  worker      1   20 2017-04-07-ycc-n14 presente   180 08/05/2017 01:30:00 08/05/2017 04:30:00
597 597  worker      1   20 2017-04-07-ycc-n14 presente   180 08/05/2017 01:30:00 08/05/2017 04:30:00
598 598 soldier      1   20 2017-04-07-ycc-n14 presente   180 08/05/2017 01:30:00 08/05/2017 04:30:00
599 599 soldier      1   20 2017-04-07-ycc-n14 presente   240 08/05/2017 01:30:00 08/05/2017 05:30:00
600 600  worker      1   20 2017-04-07-ycc-n14 presente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
601 601  worker      1   20 2017-04-07-ycc-n14 presente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
602 602  worker      1   20 2017-04-07-ycc-n14 presente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
603 603 soldier      1   20 2017-04-07-ycc-n14 presente   300 08/05/2017 01:30:00 08/05/2017 06:30:00
604 604  worker      1   20 2017-04-07-ycc-n14 presente   495 08/05/2017 01:30:00 08/05/2017 09:45:00
605 605  worker      1   20 2017-04-07-ycc-n14 presente   495 08/05/2017 01:30:00 08/05/2017 09:45:00
606 606  worker      1   20 2017-04-07-ycc-n14 presente   555 08/05/2017 01:30:00 08/05/2017 10:45:00
607 607  worker      1   20 2017-04-07-ycc-n14 presente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
608 608  worker      1   20 2017-04-07-ycc-n14 presente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
609 609  worker      1   20 2017-04-07-ycc-n14 presente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
610 610  worker      1   20 2017-04-07-ycc-n14 presente   615 08/05/2017 01:30:00 08/05/2017 11:45:00
611 611  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
612 612  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
613 613  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
614 614  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
615 615  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
616 616  worker      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
617 617 soldier      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
618 618 soldier      1   20 2017-04-07-ycc-n14 presente   740 08/05/2017 01:30:00 08/05/2017 13:50:00
619 619  worker      1   20 2017-04-07-ycc-n14 presente   860 08/05/2017 01:30:00 08/05/2017 15:50:00
620 620  worker      1   20 2017-04-07-ycc-n14 presente   860 08/05/2017 01:30:00 08/05/2017 15:50:00
621 621  worker      1   20 2017-04-07-ycc-n14 presente   920 08/05/2017 01:30:00 08/05/2017 16:50:00
622 622  worker      1   20 2017-04-07-ycc-n14 presente   920 08/05/2017 01:30:00 08/05/2017 16:50:00
623 623  worker      1   20 2017-04-07-ycc-n14 presente   980 08/05/2017 01:30:00 08/05/2017 17:50:00
624 624  worker      1   20 2017-04-07-ycc-n14 presente   980 08/05/2017 01:30:00 08/05/2017 17:50:00
625 625  worker      1   20 2017-04-07-ycc-n14 presente  1100 08/05/2017 01:30:00 08/05/2017 19:50:00
626 626  worker      1   20 2017-04-07-ycc-n14 presente  1160 08/05/2017 01:30:00 08/05/2017 20:50:00
627 627 soldier      1   20 2017-04-07-ycc-n14 presente  1340 08/05/2017 01:30:00 08/05/2017 23:50:00
628 628  worker      1   20 2017-04-07-ycc-n14 presente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
629 629 soldier      1   20 2017-04-07-ycc-n14 presente  1520 08/05/2017 01:30:00 09/05/2017 02:50:00
630 630  worker      1   20 2017-04-07-ycc-n14 presente  1580 08/05/2017 01:30:00 09/05/2017 03:50:00
631 631 soldier      1    0 2017-04-07-ycc-n01  ausente    60 02/05/2017 19:50:00 02/05/2017 20:50:00
632 632  worker      1    0 2017-04-07-ycc-n01  ausente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
633 633  worker      1    0 2017-04-07-ycc-n01  ausente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
634 634 soldier      1    0 2017-04-07-ycc-n01  ausente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
635 635 soldier      1    0 2017-04-07-ycc-n01  ausente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
636 636  worker      1    0 2017-04-07-ycc-n01  ausente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
637 637  worker      1    0 2017-04-07-ycc-n01  ausente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
638 638  worker      1    0 2017-04-07-ycc-n01  ausente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
639 639 soldier      1    0 2017-04-07-ycc-n01  ausente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
640 640 soldier      1    0 2017-04-07-ycc-n01  ausente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
641 641  worker      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
```

```
642 642  worker      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
643 643  worker      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
644 644  worker      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
645 645 soldier      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
646 646 soldier      1    0 2017-04-07-ycc-n01  ausente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
647 647  worker      1    0 2017-04-07-ycc-n01  ausente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
648 648  worker      1    0 2017-04-07-ycc-n01  ausente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
649 649  worker      1    0 2017-04-07-ycc-n01  ausente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
650 650  worker      1    0 2017-04-07-ycc-n01  ausente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
651 651  worker      1    0 2017-04-07-ycc-n01  ausente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
652 652  worker      1    0 2017-04-07-ycc-n01  ausente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
653 653  worker      1    0 2017-04-07-ycc-n01  ausente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
654 654  worker      1    0 2017-04-07-ycc-n01  ausente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
655 655  worker      1    0 2017-04-07-ycc-n01  ausente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
656 656  worker      1    0 2017-04-07-ycc-n01  ausente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
657 657  worker      1    0 2017-04-07-ycc-n01  ausente   540 02/05/2017 19:50:00 03/05/2017 04:50:00
658 658  worker      1    0 2017-04-07-ycc-n01  ausente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
659 659  worker      1    0 2017-04-07-ycc-n01  ausente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
660 660  worker      1    0 2017-04-07-ycc-n01  ausente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
661 661  worker      1    0 2017-04-07-ycc-n01  ausente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
662 662  worker      1    0 2017-04-07-ycc-n01  ausente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
663 663  worker      1    0 2017-04-07-ycc-n01  ausente   780 02/05/2017 19:50:00 03/05/2017 08:50:00
664 664  worker      1    0 2017-04-07-ycc-n01  ausente   780 02/05/2017 19:50:00 03/05/2017 08:50:00
665 665  worker      1    0 2017-04-07-ycc-n01  ausente   960 02/05/2017 19:50:00 03/05/2017 11:50:00
666 666  worker      1    8 2017-04-07-ycc-n01 presente    60 02/05/2017 19:50:00 02/05/2017 20:50:00
667 667 soldier      1    8 2017-04-07-ycc-n01 presente    60 02/05/2017 19:50:00 02/05/2017 20:50:00
668 668  worker      1    8 2017-04-07-ycc-n01 presente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
669 669  worker      1    8 2017-04-07-ycc-n01 presente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
670 670  worker      1    8 2017-04-07-ycc-n01 presente   120 02/05/2017 19:50:00 02/05/2017 21:50:00
671 671  worker      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
672 672  worker      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
673 673  worker      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
674 674  worker      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
675 675 soldier      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
676 676 soldier      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
677 677 soldier      1    8 2017-04-07-ycc-n01 presente   240 02/05/2017 19:50:00 02/05/2017 23:50:00
678 678  worker      1    8 2017-04-07-ycc-n01 presente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
679 679 soldier      1    8 2017-04-07-ycc-n01 presente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
680 680 soldier      1    8 2017-04-07-ycc-n01 presente   300 02/05/2017 19:50:00 03/05/2017 00:50:00
681 681  worker      1    8 2017-04-07-ycc-n01 presente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
682 682  worker      1    8 2017-04-07-ycc-n01 presente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
683 683  worker      1    8 2017-04-07-ycc-n01 presente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
684 684  worker      1    8 2017-04-07-ycc-n01 presente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
685 685  worker      1    8 2017-04-07-ycc-n01 presente   360 02/05/2017 19:50:00 03/05/2017 01:50:00
686 686  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
687 687  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
```

```
688 688  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
689 689  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
690 690  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
691 691  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
692 692  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
693 693  worker      1    8 2017-04-07-ycc-n01 presente   480 02/05/2017 19:50:00 03/05/2017 03:50:00
694 694 soldier      1    8 2017-04-07-ycc-n01 presente   540 02/05/2017 19:50:00 03/05/2017 04:50:00
695 695  worker      1    8 2017-04-07-ycc-n01 presente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
696 696  worker      1    8 2017-04-07-ycc-n01 presente   600 02/05/2017 19:50:00 03/05/2017 05:50:00
697 697  worker      1    8 2017-04-07-ycc-n01 presente   660 02/05/2017 19:50:00 03/05/2017 06:50:00
698 698  worker      1    8 2017-04-07-ycc-n01 presente   660 02/05/2017 19:50:00 03/05/2017 06:50:00
699 699  worker      1    8 2017-04-07-ycc-n01 presente   660 02/05/2017 19:50:00 03/05/2017 06:50:00
700 700  worker      1    8 2017-04-07-ycc-n01 presente   720 02/05/2017 19:50:00 03/05/2017 07:50:00
701 701  worker      1    0 2017-04-07-ycc-n03  ausente   830 09/05/2017 17:00:00 10/05/2017 06:50:00
702 702  worker      1    0 2017-04-07-ycc-n03  ausente  1850 09/05/2017 17:00:00 10/05/2017 23:50:00
703 703  worker      1    0 2017-04-07-ycc-n03  ausente  1910 09/05/2017 17:00:00 11/05/2017 00:50:00
704 704  worker      1    0 2017-04-07-ycc-n03  ausente  1910 09/05/2017 17:00:00 11/05/2017 00:50:00
705 705  worker      1    0 2017-04-07-ycc-n03  ausente  1970 09/05/2017 17:00:00 11/05/2017 01:50:00
706 706  worker      1    0 2017-04-07-ycc-n03  ausente  2270 09/05/2017 17:00:00 11/05/2017 06:50:00
707 707  worker      1    0 2017-04-07-ycc-n03  ausente  2270 09/05/2017 17:00:00 11/05/2017 06:50:00
708 708  worker      1    0 2017-04-07-ycc-n03  ausente  2270 09/05/2017 17:00:00 11/05/2017 06:50:00
709 709  worker      1    0 2017-04-07-ycc-n03  ausente  2330 09/05/2017 17:00:00 11/05/2017 07:50:00
710 710  worker      1    0 2017-04-07-ycc-n03  ausente  2390 09/05/2017 17:00:00 11/05/2017 08:50:00
711 711  worker      1    0 2017-04-07-ycc-n03  ausente  2390 09/05/2017 17:00:00 11/05/2017 08:50:00
712 712  worker      1    0 2017-04-07-ycc-n03  ausente  2390 09/05/2017 17:00:00 11/05/2017 08:50:00
713 713  worker      1    0 2017-04-07-ycc-n03  ausente  2510 09/05/2017 17:00:00 11/05/2017 10:50:00
714 714  worker      1    0 2017-04-07-ycc-n03  ausente  2510 09/05/2017 17:00:00 11/05/2017 10:50:00
715 715  worker      1    0 2017-04-07-ycc-n03  ausente  2510 09/05/2017 17:00:00 11/05/2017 10:50:00
716 716  worker      1    0 2017-04-07-ycc-n03  ausente  2580 09/05/2017 17:00:00 11/05/2017 12:00:00
717 717  worker      1    0 2017-04-07-ycc-n03  ausente  2690 09/05/2017 17:00:00 11/05/2017 13:50:00
718 718  worker      1    0 2017-04-07-ycc-n03  ausente  2840 09/05/2017 17:00:00 11/05/2017 16:20:00
719 719  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
720 720  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
721 721  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
722 722  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
723 723  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
724 724  worker      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
725 725 soldier      1    0 2017-04-07-ycc-n03  ausente  2990 09/05/2017 17:00:00 11/05/2017 18:50:00
726 726  worker      1    0 2017-04-07-ycc-n03  ausente  3230 09/05/2017 17:00:00 11/05/2017 22:50:00
727 727  worker      1    0 2017-04-07-ycc-n03  ausente  3230 09/05/2017 17:00:00 11/05/2017 22:50:00
728 728  worker      1    0 2017-04-07-ycc-n03  ausente  3230 09/05/2017 17:00:00 11/05/2017 22:50:00
729 729 soldier      1    0 2017-04-07-ycc-n03  ausente  3230 09/05/2017 17:00:00 11/05/2017 22:50:00
730 730  worker      1    0 2017-04-07-ycc-n03  ausente  3470 09/05/2017 17:00:00 12/05/2017 02:50:00
731 731 soldier      1    0 2017-04-07-ycc-n03  ausente  3470 09/05/2017 17:00:00 12/05/2017 02:50:00
732 732 soldier      1    0 2017-04-07-ycc-n03  ausente  3470 09/05/2017 17:00:00 12/05/2017 02:50:00
733 733 soldier      1    0 2017-04-07-ycc-n03  ausente  3470 09/05/2017 17:00:00 12/05/2017 02:50:00
```

```
734 734 soldier      1    0 2017-04-07-ycc-n03  ausente  3580 09/05/2017 17:00:00 12/05/2017 04:40:00
735 735 soldier      1    0 2017-04-07-ycc-n03  ausente  3710 09/05/2017 17:00:00 12/05/2017 06:50:00
736 736  worker      1   24 2017-04-07-ycc-n03 presente   110 09/05/2017 17:00:00 09/05/2017 18:50:00
737 737  worker      1   24 2017-04-07-ycc-n03 presente   290 09/05/2017 17:00:00 09/05/2017 21:50:00
738 738  worker      1   24 2017-04-07-ycc-n03 presente   350 09/05/2017 17:00:00 09/05/2017 22:50:00
739 739  worker      1   24 2017-04-07-ycc-n03 presente   470 09/05/2017 17:00:00 10/05/2017 00:50:00
740 740  worker      1   24 2017-04-07-ycc-n03 presente   470 09/05/2017 17:00:00 10/05/2017 00:50:00
741 741  worker      1   24 2017-04-07-ycc-n03 presente   590 09/05/2017 17:00:00 10/05/2017 02:50:00
742 742  worker      1   24 2017-04-07-ycc-n03 presente   590 09/05/2017 17:00:00 10/05/2017 02:50:00
743 743  worker      1   24 2017-04-07-ycc-n03 presente   650 09/05/2017 17:00:00 10/05/2017 03:50:00
744 744  worker      1   24 2017-04-07-ycc-n03 presente   650 09/05/2017 17:00:00 10/05/2017 03:50:00
745 745  worker      1   24 2017-04-07-ycc-n03 presente   650 09/05/2017 17:00:00 10/05/2017 03:50:00
746 746  worker      1   24 2017-04-07-ycc-n03 presente   710 09/05/2017 17:00:00 10/05/2017 04:50:00
747 747  worker      1   24 2017-04-07-ycc-n03 presente   710 09/05/2017 17:00:00 10/05/2017 04:50:00
748 748  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
749 749  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
750 750  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
751 751  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
752 752  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
753 753  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
754 754  worker      1   24 2017-04-07-ycc-n03 presente   890 09/05/2017 17:00:00 10/05/2017 07:50:00
755 755  worker      1   24 2017-04-07-ycc-n03 presente   950 09/05/2017 17:00:00 10/05/2017 08:50:00
756 756  worker      1   24 2017-04-07-ycc-n03 presente  1010 09/05/2017 17:00:00 10/05/2017 09:50:00
757 757  worker      1   24 2017-04-07-ycc-n03 presente  1200 09/05/2017 17:00:00 10/05/2017 13:00:00
758 758  worker      1   24 2017-04-07-ycc-n03 presente  1200 09/05/2017 17:00:00 10/05/2017 13:00:00
759 759  worker      1   24 2017-04-07-ycc-n03 presente  1250 09/05/2017 17:00:00 10/05/2017 13:50:00
760 760  worker      1   24 2017-04-07-ycc-n03 presente  1250 09/05/2017 17:00:00 10/05/2017 13:50:00
761 761  worker      1   24 2017-04-07-ycc-n03 presente  1250 09/05/2017 17:00:00 10/05/2017 13:50:00
762 762 soldier      1   24 2017-04-07-ycc-n03 presente  1250 09/05/2017 17:00:00 10/05/2017 13:50:00
763 763 soldier      1   24 2017-04-07-ycc-n03 presente  1250 09/05/2017 17:00:00 10/05/2017 13:50:00
764 764 soldier      1   24 2017-04-07-ycc-n03 presente  1490 09/05/2017 17:00:00 10/05/2017 17:50:00
765 765 soldier      1   24 2017-04-07-ycc-n03 presente  1490 09/05/2017 17:00:00 10/05/2017 17:50:00
766 766  worker      1   24 2017-04-07-ycc-n03 presente  1550 09/05/2017 17:00:00 10/05/2017 18:50:00
767 767  worker      1   24 2017-04-07-ycc-n03 presente  1550 09/05/2017 17:00:00 10/05/2017 18:50:00
768 768 soldier      1   24 2017-04-07-ycc-n03 presente  1550 09/05/2017 17:00:00 10/05/2017 18:50:00
769 769 soldier      1   24 2017-04-07-ycc-n03 presente  1850 09/05/2017 17:00:00 10/05/2017 23:50:00
770 770 soldier      1   24 2017-04-07-ycc-n03 presente  1850 09/05/2017 17:00:00 10/05/2017 23:50:00
771 771 soldier      1    0 2017-04-07-ycc-n11  ausente   360 08/05/2017 20:50:00 09/05/2017 02:50:00
772 772  worker      1    0 2017-04-07-ycc-n11  ausente   910 08/05/2017 20:50:00 09/05/2017 12:00:00
773 773  worker      1    0 2017-04-07-ycc-n11  ausente   960 08/05/2017 20:50:00 09/05/2017 12:50:00
774 774 soldier      1    0 2017-04-07-ycc-n11  ausente   960 08/05/2017 20:50:00 09/05/2017 12:50:00
775 775  worker      1    0 2017-04-07-ycc-n11  ausente  1080 08/05/2017 20:50:00 09/05/2017 14:50:00
776 776  worker      1    0 2017-04-07-ycc-n11  ausente  1560 08/05/2017 20:50:00 09/05/2017 22:50:00
777 777  worker      1    0 2017-04-07-ycc-n11  ausente  1560 08/05/2017 20:50:00 09/05/2017 22:50:00
778 778  worker      1    0 2017-04-07-ycc-n11  ausente  1560 08/05/2017 20:50:00 09/05/2017 22:50:00
779 779  worker      1    0 2017-04-07-ycc-n11  ausente  1620 08/05/2017 20:50:00 09/05/2017 23:50:00
```

```
780 780  worker      1    0 2017-04-07-ycc-n11  ausente  1680 08/05/2017 20:50:00 10/05/2017 00:50:00
781 781  worker      1    0 2017-04-07-ycc-n11  ausente  1680 08/05/2017 20:50:00 10/05/2017 00:50:00
782 782  worker      1    0 2017-04-07-ycc-n11  ausente  1680 08/05/2017 20:50:00 10/05/2017 00:50:00
783 783  worker      1    0 2017-04-07-ycc-n11  ausente  1680 08/05/2017 20:50:00 10/05/2017 00:50:00
784 784  worker      1    0 2017-04-07-ycc-n11  ausente  1800 08/05/2017 20:50:00 10/05/2017 02:50:00
785 785 soldier      1    0 2017-04-07-ycc-n11  ausente  1800 08/05/2017 20:50:00 10/05/2017 02:50:00
786 786  worker      1    0 2017-04-07-ycc-n11  ausente  1920 08/05/2017 20:50:00 10/05/2017 04:50:00
787 787  worker      1    0 2017-04-07-ycc-n11  ausente  1920 08/05/2017 20:50:00 10/05/2017 04:50:00
788 788  worker      1    0 2017-04-07-ycc-n11  ausente  1920 08/05/2017 20:50:00 10/05/2017 04:50:00
789 789  worker      1    0 2017-04-07-ycc-n11  ausente  1920 08/05/2017 20:50:00 10/05/2017 04:50:00
790 790  worker      1    0 2017-04-07-ycc-n11  ausente  1920 08/05/2017 20:50:00 10/05/2017 04:50:00
791 791  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
792 792  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
793 793  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
794 794  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
795 795  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
796 796  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
797 797  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
798 798  worker      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
799 799 soldier      1    0 2017-04-07-ycc-n11  ausente  1980 08/05/2017 20:50:00 10/05/2017 05:50:00
800 800  worker      1    0 2017-04-07-ycc-n11  ausente  2100 08/05/2017 20:50:00 10/05/2017 07:50:00
801 801  worker      1    0 2017-04-07-ycc-n11  ausente  2160 08/05/2017 20:50:00 10/05/2017 08:50:00
802 802  worker      1    0 2017-04-07-ycc-n11  ausente  2220 08/05/2017 20:50:00 10/05/2017 09:50:00
803 803 soldier      1    0 2017-04-07-ycc-n11  ausente  2280 08/05/2017 20:50:00 10/05/2017 10:50:00
804 804 soldier      1    0 2017-04-07-ycc-n11  ausente  2830 08/05/2017 20:50:00 10/05/2017 20:00:00
805 805 soldier      1    0 2017-04-07-ycc-n11  ausente  3120 08/05/2017 20:50:00 11/05/2017 00:50:00
806 806  worker      1   12 2017-04-07-ycc-n11 presente   540 08/05/2017 20:50:00 09/05/2017 05:50:00
807 807  worker      1   12 2017-04-07-ycc-n11 presente   600 08/05/2017 20:50:00 09/05/2017 06:50:00
808 808  worker      1   12 2017-04-07-ycc-n11 presente   600 08/05/2017 20:50:00 09/05/2017 06:50:00
809 809  worker      1   12 2017-04-07-ycc-n11 presente   600 08/05/2017 20:50:00 09/05/2017 06:50:00
810 810  worker      1   12 2017-04-07-ycc-n11 presente   730 08/05/2017 20:50:00 09/05/2017 09:00:00
811 811  worker      1   12 2017-04-07-ycc-n11 presente   730 08/05/2017 20:50:00 09/05/2017 09:00:00
812 812  worker      1   12 2017-04-07-ycc-n11 presente   780 08/05/2017 20:50:00 09/05/2017 09:50:00
813 813  worker      1   12 2017-04-07-ycc-n11 presente   840 08/05/2017 20:50:00 09/05/2017 10:50:00
814 814  worker      1   12 2017-04-07-ycc-n11 presente   840 08/05/2017 20:50:00 09/05/2017 10:50:00
815 815  worker      1   12 2017-04-07-ycc-n11 presente   840 08/05/2017 20:50:00 09/05/2017 10:50:00
816 816  worker      1   12 2017-04-07-ycc-n11 presente   910 08/05/2017 20:50:00 09/05/2017 12:00:00
817 817  worker      1   12 2017-04-07-ycc-n11 presente   960 08/05/2017 20:50:00 09/05/2017 12:50:00
818 818  worker      1   12 2017-04-07-ycc-n11 presente   960 08/05/2017 20:50:00 09/05/2017 12:50:00
819 819  worker      1   12 2017-04-07-ycc-n11 presente   960 08/05/2017 20:50:00 09/05/2017 12:50:00
820 820  worker      1   12 2017-04-07-ycc-n11 presente  1020 08/05/2017 20:50:00 09/05/2017 13:50:00
821 821  worker      1   12 2017-04-07-ycc-n11 presente  1020 08/05/2017 20:50:00 09/05/2017 13:50:00
822 822  worker      1   12 2017-04-07-ycc-n11 presente  1020 08/05/2017 20:50:00 09/05/2017 13:50:00
823 823  worker      1   12 2017-04-07-ycc-n11 presente  1080 08/05/2017 20:50:00 09/05/2017 14:50:00
824 824  worker      1   12 2017-04-07-ycc-n11 presente  1140 08/05/2017 20:50:00 09/05/2017 15:50:00
825 825  worker      1   12 2017-04-07-ycc-n11 presente  1140 08/05/2017 20:50:00 09/05/2017 15:50:00
```

```
826 826  worker      1   12 2017-04-07-ycc-n11 presente  1140 08/05/2017 20:50:00 09/05/2017 15:50:00
827 827  worker      1   12 2017-04-07-ycc-n11 presente  1200 08/05/2017 20:50:00 09/05/2017 16:50:00
828 828  worker      1   12 2017-04-07-ycc-n11 presente  1270 08/05/2017 20:50:00 09/05/2017 18:00:00
829 829  worker      1   12 2017-04-07-ycc-n11 presente  1270 08/05/2017 20:50:00 09/05/2017 18:00:00
830 830  worker      1   12 2017-04-07-ycc-n11 presente  1270 08/05/2017 20:50:00 09/05/2017 18:00:00
831 831 soldier      1   12 2017-04-07-ycc-n11 presente  1270 08/05/2017 20:50:00 09/05/2017 18:00:00
832 832 soldier      1   12 2017-04-07-ycc-n11 presente  1270 08/05/2017 20:50:00 09/05/2017 18:00:00
833 833  worker      1   12 2017-04-07-ycc-n11 presente  1320 08/05/2017 20:50:00 09/05/2017 18:50:00
834 834  worker      1   12 2017-04-07-ycc-n11 presente  1320 08/05/2017 20:50:00 09/05/2017 18:50:00
835 835 soldier      1   12 2017-04-07-ycc-n11 presente  1320 08/05/2017 20:50:00 09/05/2017 18:50:00
836 836  worker      1   12 2017-04-07-ycc-n11 presente  1380 08/05/2017 20:50:00 09/05/2017 19:50:00
837 837 soldier      1   12 2017-04-07-ycc-n11 presente  1620 08/05/2017 20:50:00 09/05/2017 23:50:00
838 838 soldier      1   12 2017-04-07-ycc-n11 presente  1800 08/05/2017 20:50:00 10/05/2017 02:50:00
839 839 soldier      1   12 2017-04-07-ycc-n11 presente  1800 08/05/2017 20:50:00 10/05/2017 02:50:00
840 840 soldier      1   12 2017-04-07-ycc-n11 presente  1860 08/05/2017 20:50:00 10/05/2017 03:50:00
```

No banco de dados acima, cada linha representa a sobrevivência de um único indivíduo de cupim. As variáveis são:

ind: identificação do indivíduo

casta: casta do indivíduo

censor: censor da Weibull.

censor(1): Se naquele momento o indivíduo foi observado morto.

censor(0): Se naquele momento o indivíduo foi observado vivo pela última vez.

ncor : número de indivíduos de Corotoca naquela placa.

ninho : identificação do ninho(fotos no Isoptera). O código é composto da seguinte forma: YYYY-MM-DD-III-NNN, onde YYYY é o ano em quatro digitos, MM é o mês em dois digitos, DD é o dia em dois digitos, III são as iniciais do coletor e NNN é o número de série do ninho daquele dia. O coletor nesse caso é Yuri Carvalho de Carvalho.

prescor: se indivíduos de *Corotoca* estavam presentes ou ausentes naquela placa.

tempo: tempo em minutos desde o início do experimento até a hora da observação do indivíduo.

tempo_inicio: data e hora que o experimento começou

tempo_morte: data e hora que o indivíduo foi observado pela última vez

3.3 montando os modelos

Modelo nulo

```
> library(survival)
> m0<-survreg(Surv(tempo,censor)~1)
```

Modelo completo

```
> m1<-survreg(Surv(tempo,censor)~ncor)
```

Contraste m0xm1

```
> anova(m0,m1)
```

```
  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1       838 13311.73      NA       NA           NA
2  ncor       837 13140.00    =  1 171.7358 3.090669e-39
```

```
> detach(sob)
```

3.4 Criando subsets

Criando subsets de cada ninho para a obter os tempos médios para morte de cada teste.

```
> sob02<-subset(sob, ninho=="2017-04-07-ycc-n04")
> sob04<-subset(sob, ninho=="2017-04-07-ycc-n05")
> sob08<-subset(sob, ninho=="2017-04-07-ycc-n01")
> sob12<-subset(sob, ninho=="2017-04-07-ycc-n11")
> sob16<-subset(sob, ninho=="2017-04-07-ycc-n12")
> sob18<-subset(sob, ninho=="2017-04-07-ycc-n06")
> sob20<-subset(sob, ninho=="2017-04-07-ycc-n14")
> sob24<-subset(sob, ninho=="2017-04-07-ycc-n03")
> sob26<-subset(sob, ninho=="2017-04-07-ycc-n07")
> sob28<-subset(sob, ninho=="2017-04-07-ycc-n10")
> sob32<-subset(sob, ninho=="2017-04-07-ycc-n13")
> sob36<-subset(sob, ninho=="2017-04-07-ycc-n08")
```

3.5 Funções

Função para o teste de sobrevivência em cada ninho

```
> survi<-function(){
+   library(survival)
+   m0<-survreg(Surv(tempo,censor)~1)
+   m1<-survreg(Surv(tempo,censor)~ncor)
+    anova(m0,m1)
+  }
```

Função para obter o valor de cada tempo médio para morte

```
> sobre<-function(){
+    m1<-survreg(Surv(tempo,censor)~ncor)
+    anova(m1)
+    summary(m1)
+    alpha<-1/m1$scale
+    alpha
+    mu<-tapply(predict(m1),ncor,mean)
+    tpm<-mu*gamma(1+(1/alpha))
+    tpm
+  }
```

Função para obter o alpha

```
> alfa<-function(){
+    m1<-survreg(Surv(tempo,censor)~ncor)
+    anova(m1)
+    summary(m1)
+    alpha<-1/m1$scale
+    alpha
+ }
```

Função para obter o gráfico

```
> funplot<-function(){
+ m1<-survreg(Surv(tempo,censor)~ncor)
+ anova(m1)
+    summary(m1)
+    alpha<-1/m1$scale
+ pontos<-survfit(Surv(tempo,censor)~ncor)
+ summary(pontos)->pontoss
+ data.frame(surv=pontoss$surv,tempo=pontoss$time)->pontosd
+ fit<-survfit(Surv(tempo,censor)~ncor)
+ y.1<-fit[1]$surv
+ y.2<-fit[2]$surv
+ x.1<-fit[1]$time
+ x.2<-fit[2]$time
+ mc1<-tapply(predict(m1),ncor,mean)[1]
+ mc2<-tapply(predict(m1),ncor,mean)[2]
+ plot((pontosd$surv~pontosd$tempo),xlab="Time (minutes)",
+      ylab="Survival proportion",
+      col=0)
+ curve(exp((-mc1^(-alpha))*(x^alpha)),col="black",lty=1,add=T)
+ curve(exp((-mc2^(-alpha))*(x^alpha)),col="black",lty=2,add=T)
+ points(y.1~x.1,pch=1)
+ points(y.2~x.2,pch=2)
+ }
```

Função para um gráfico alternativo

```
> altplot<-function(){
+ m1<-survreg(Surv(tempo,censor)~ncor)
+ anova(m1)
+    summary(m1)
+    alpha<-1/m1$scale
+ pontos<-survfit(Surv(tempo,censor)~ncor)
+ summary(pontos)->pontoss
+ data.frame(surv=pontoss$surv,tempo=pontoss$time)->pontosd
+ fit<-survfit(Surv(tempo,censor)~ncor)
+ plot(fit,lty=1:2,xlab="Time (minutes)",ylab="Survival proportion")
+ legend("topright",legend=c("no termitophile", "with termitophile"),
+        bty="n",lty=c(1,3))
+
+ }
```

3.6 Tempo médio para a morte

3.6.1 02 Corotocas

```
> attach(sob02)
> survi02<-survi()
```

```
> tpm02<-sobre()
> alfa02<-alfa()
> plot02<-funplot()
> legend("topright",legend=c("no Corotoca", "2 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot02<-altplot()
> #plot02
> detach(sob02)
> survi02

  Terms Resid. Df    -2*LL Test Df   Deviance  Pr(>Chi)
1     1        68 1105.699      NA         NA        NA
2  ncor        67 1105.680    =  1 0.01920432 0.8897823

> tpm02

       0        2
1278.414 1300.149

> alfa02

[1] 1.978964

> #plot02
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi02)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1105.70 &  &  &  &  \\
  2 & ncor &  67 & 1105.68 & = &  1 & 0.02 & 0.89 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi02)
```

A presença de 2 Corotoca não afetou a sobrevivência dos cupins.

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1105.70				
2	ncor	67	1105.68	=	1	0.02	0.89

3.6.2 04 Corotocas

```
> attach(sob04)
> survi04<-survi()
> tpm04<-sobre()
> alfa04<-alfa()
> plot04<-funplot()
> legend("topright",legend=c("no Corotoca", "4 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot04<-altplot()
> detach(sob04)
> survi04

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1085.567      NA       NA           NA
2  ncor        67 1072.749    =  1 12.81793 0.0003433141

> tpm04

       0        4
1521.784 1124.927

> alfa04

[1] 3.012232
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi04)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1085.57 &  &  &  &  \\
  2 & ncor &  67 & 1072.75 & = &  1 & 12.82 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi04)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1085.57				
2	ncor	67	1072.75	=	1	12.82	0.00

3.6.3 08 Corotocas

```
> attach(sob08)
> survi08<-survi()
> tpm08<-sobre()
> alfa08<-alfa()
> plot08<-funplot()
> legend("topright",legend=c("no Corotoca", "8 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot08<-altplot()
> detach(sob08)
> survi08

  Terms Resid. Df    -2*LL Test Df  Deviance  Pr(>Chi)
1     1        68 929.6338      NA        NA        NA
2  ncor        67 929.2634    =  1 0.3703746 0.5428001

> tpm08

       0        8
398.2861 371.5992

> alfa08

[1] 2.108284
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi08)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
```

```
1 & 1 &  68 & 929.63 &  &  &  \\
  2 & ncor &  67 & 929.26 & = &   1 & 0.37 & 0.54 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi08)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	929.63				
2	ncor	67	929.26	=	1	0.37	0.54

3.6.4 12 Corotocas

```
> attach(sob12)
> survi12<-survi()
> tpm12<-sobre()
> alfa12<-alfa()
> plot12<-funplot()
> legend("topright",legend=c("no Corotoca", "12 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot12<-altplot()
> detach(sob12)
> survi12

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1080.476      NA       NA           NA
2  ncor        67 1043.013    =  1 37.46357 9.313662e-10

> tpm12

       0       12
1773.172 1109.184

> alfa12

[1] 3.69806
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi12)
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1080.48 &  &  &  &  \\
  2 & ncor &  67 & 1043.01 & = &  1 & 37.46 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi12)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1080.48				
2	ncor	67	1043.01	=	1	37.46	0.00

3.6.5 16 Corotocas

```
> attach(sob16)
> survi16<-survi()
> tpm16<-sobre()
> alfa16<-alfa()
> plot16<-funplot()
> legend("topright",legend=c("no Corotoca", "16 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot16<-altplot()
> detach(sob16)
> survi16

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1068.827      NA       NA           NA
2  ncor        67 1051.111    =  1 17.71656 2.563848e-05

> tpm16

       0        16
1140.8866  658.7541

> alfa16

[1] 1.999809
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi16)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1068.83 &  &  &  &  \\
  2 & ncor &  67 & 1051.11 & = &  1 & 17.72 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi16)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1068.83				
2	ncor	67	1051.11	=	1	17.72	0.00

3.6.6 18 Corotocas

```
> attach(sob18)
> survi18<-survi()
> tpm18<-sobre()
> alfa18<-alfa()
> plot18<-funplot()
> legend("topright",legend=c("no Corotoca", "18 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot18<-altplot()
> detach(sob18)
> survi18

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1098.808      NA       NA           NA
2  ncor        67 1050.720    =  1 48.08824 4.074632e-12

> tpm18
```

```
       0       18
1900.559 1098.217

> alfa18

[1] 3.82565
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi18)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:46 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1098.81 &  &  &  &  \\
  2 & ncor &  67 & 1050.72 & = &  1 & 48.09 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi18)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1098.81				
2	ncor	67	1050.72	=	1	48.09	0.00

3.6.7 20 Corotocas

```
> attach(sob20)
> survi20<-survi()
> tpm20<-sobre()
> alfa20<-alfa()
> plot20<-funplot()
> legend("topright",legend=c("no Corotoca", "20 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot20<-altplot()
> detach(sob20)
> survi20
```

```
  Terms Resid. Df    -2*LL Test Df Deviance   Pr(>Chi)
1     1        68 1059.653      NA       NA         NA
2  ncor        67 1053.773    =  1 5.879817 0.01531542
```

```
> tpm20
```

```
       0       20
994.3107 722.3643
```

```
> alfa20
```

```
[1] 1.878466
```

Código LaTeXpara a tabela

```
> xtable(survi20)
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1059.65 &  &  &  &  \\
  2 & ncor &  67 & 1053.77 & = &  1 & 5.88 & 0.02 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi20)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1059.65				
2	ncor	67	1053.77	=	1	5.88	0.02

3.6.8 24 Corotocas

```
> attach(sob24)
> survi24<-survi()
> tpm24<-sobre()
> alfa24<-alfa()
> plot24<-funplot()
```

```
> legend("topright",legend=c("no Corotoca", "24 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot24<-altplot()
> detach(sob24)
> survi24

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1161.708      NA       NA           NA
2  ncor        67 1085.559    =  1 76.14931 2.630077e-18

> tpm24

       0       24
2566.418 1042.704

> alfa24

[1] 3.256339
```

Código LaTeXpara a tabela

```
> xtable(survi24)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1161.71 &  &  &  &  \\
  2 & ncor &  67 & 1085.56 & = &  1 & 76.15 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi24)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1161.71				
2	ncor	67	1085.56	=	1	76.15	0.00

3.6.9 26 Corotocas

```
> attach(sob26)
> survi26<-survi()
> tpm26<-sobre()
> alfa26<-alfa()
> plot26<-funplot()
> legend("topright",legend=c("no Corotoca", "26 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot26<-altplot()
> detach(sob26)
> survi26

  Terms Resid. Df    -2*LL Test Df Deviance  Pr(>Chi)
1     1        68 1067.766      NA       NA        NA
2  ncor        67 1063.534    =  1 4.231383 0.0396831

> tpm26

        0        26
1037.6624  786.7508

> alfa26

[1] 1.797965

>
>
```

Código LaTeXpara a tabela

```
> xtable(survi26)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1067.77 &  &  &  &  \\
  2 & ncor &  67 & 1063.53 & = &  1 & 4.23 & 0.04 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi26)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1067.77				
2	ncor	67	1063.53	=	1	4.23	0.04

3.6.10 28 Corotocas

```
> attach(sob28)
> survi28<-survi()
> tpm28<-sobre()
> alfa28<-alfa()
> plot28<-funplot()
> legend("topright",legend=c("no Corotoca", "28 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot28<-altplot()
> detach(sob28)
> survi28

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1079.587      NA       NA           NA
2  ncor        67 1067.595    =  1 11.99275 0.0005340797

> tpm28

        0        28
1133.8431  656.6225

> alfa28

[1] 1.575919
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi28)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1079.59 &  &  &  &  \\
  2 & ncor &  67 & 1067.59 & = &  1 & 11.99 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi28)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1079.59				
2	ncor	67	1067.59	=	1	11.99	0.00

3.6.11 32 Corotocas

```
> attach(sob32)
> survi32<-survi()
> tpm32<-sobre()
> alfa32<-alfa()
> plot32<-funplot()
> legend("topright",legend=c("no Corotoca", "32 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot32<-altplot()
> detach(sob32)
> survi32

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1149.457      NA       NA           NA
2  ncor        67 1074.322    =  1 75.13519 4.395627e-18

> tpm32

        0        32
2275.5021  794.0491

> alfa32

[1] 2.749299
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi32)

% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
```

```
1 & 1 &  68 & 1149.46 &  &  &  &  \\
  2 & ncor &  67 & 1074.32 & = &   1 & 75.14 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi32)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1149.46				
2	ncor	67	1074.32	=	1	75.14	0.00

3.6.12 36 Corotocas

```
> attach(sob36)
> survi36<-survi()
> tpm36<-sobre()
> alfa36<-alfa()
> plot36<-funplot()
> legend("topright",legend=c("no Corotoca", "36 Corotoca"),bty="n",lty=c(1,3),
+        pch=c(1,2))
> aplot36<-altplot()
> detach(sob36)
> survi36

  Terms Resid. Df    -2*LL Test Df Deviance     Pr(>Chi)
1     1        68 1036.163      NA       NA           NA
2  ncor        67 1024.108    =  1 12.05527 0.0005164623

> tpm36

       0       36
848.1531 515.3634

> alfa36

[1] 1.75632
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(survi36)
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rlrrlrrr}
  \hline
 & Terms & Resid. Df & -2*LL & Test & Df & Deviance & Pr($>$Chi) \\
  \hline
1 & 1 &  68 & 1036.16 &  &  &  &  \\
  2 & ncor &  67 & 1024.11 & = &  1 & 12.06 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(survi36)
```

	Terms	Resid. Df	-2*LL	Test	Df	Deviance	Pr(>Chi)
1	1	68	1036.16				
2	ncor	67	1024.11	=	1	12.06	0.00

3.7 Montando os gráficos

3.7.1 Variáveis

```
> options(width=75)
> tmp<-as.array(c(tpm02[-1],tpm04[-1],tpm08[-1],tpm12[-1],tpm16[-1],tpm18[-1],
+                 tpm20[-1],tpm24[-1],tpm26[-1],tpm28[-1],tpm32[-1],tpm36[-1]))
> tmp

       2         4         8        12        16        18        20
1300.1485 1124.9268  371.5992 1109.1844  658.7541 1098.2172  722.3643
      24        26        28        32        36
1042.7039  786.7508  656.6225  794.0491  515.3634

> #Tempo médio para morte de cupins com Corotoca/tempo médio para morte de cupins
> #sem Corotoca (y):
> tmp2<-as.array(c(tpm02[2]/tpm02[1],tpm04[2]/tpm04[1],tpm08[2]/tpm08[1],
+                  tpm12[2]/tpm12[1],tpm16[2]/tpm16[1],tpm18[2]/tpm18[1],
+                  tpm20[2]/tpm20[1],tpm24[2]/tpm24[1],tpm26[2]/tpm26[1],
+                  tpm28[2]/tpm28[1],tpm32[2]/tpm32[1],tpm36[2]/tpm36[1]))
> tmp2

       2         4         8        12        16        18        20
1.0170010 0.7392158 0.9329956 0.6255367 0.5774054 0.5778389 0.7264975
```

```
       24        26        28        32        36
0.4062877 0.7581953 0.5791123 0.3489556 0.6076302

> #Quantidade de Corotoca(x1):
> rownames(tmp)

 [1] "2"  "4"  "8"  "12" "16" "18" "20" "24" "26" "28" "32" "36"

> cor<-as.numeric(rownames(tmp))
> cor

 [1]  2  4  8 12 16 18 20 24 26 28 32 36

> # n de Corotoca/n de cupim(x2):
> cor2<-as.numeric(rownames(tmp))/35
> cor2

 [1] 0.05714286 0.11428571 0.22857143 0.34285714 0.45714286 0.51428571
 [7] 0.57142857 0.68571429 0.74285714 0.80000000 0.91428571 1.02857143

> rownames(cor2)

NULL

> # n de Corotoca/n de Corotoca+ n de cupim(x3):
> cor3<-as.numeric(rownames(tmp))/(as.numeric(rownames(tmp))+35)
> cor3

 [1] 0.05405405 0.10256410 0.18604651 0.25531915 0.31372549 0.33962264
 [7] 0.36363636 0.40677966 0.42622951 0.44444444 0.47761194 0.50704225

>
```

3.7.2 Gráfico 1

```
Analysis of Variance Table

Response: tmp2
          Df  Sum Sq  Mean Sq F value  Pr(>F)
cor        1 0.19259 0.192587  8.9639 0.01348 *
Residuals 10 0.21485 0.021485
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Call:
lm(formula = tmp2 ~ cor)

Residuals:
     Min       1Q   Median       3Q      Max
```

```
-0.18907 -0.11514 -0.02901  0.14627  0.18711

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.886612   0.087281  10.158 1.38e-06 ***
cor         -0.012136   0.004053  -2.994   0.0135 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1466 on 10 degrees of freedom
Multiple R-squared:  0.4727,        Adjusted R-squared:   0.42
F-statistic: 8.964 on 1 and 10 DF,  p-value: 0.01348
```

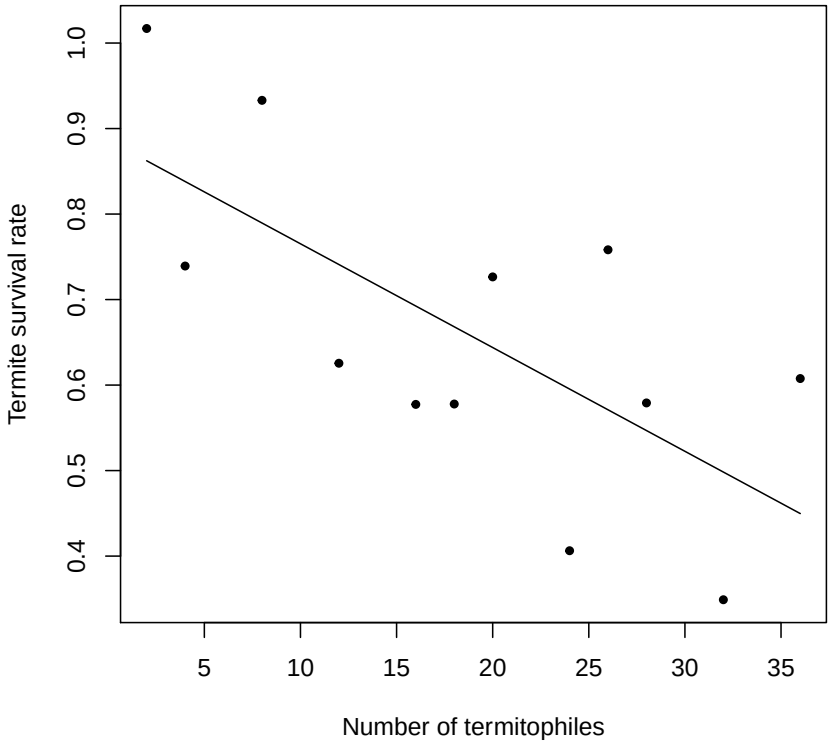

Figura 1: Tempo médio para morte de indivíduos de cupim em grupos com Corotoca sobre o tempo médio para morte de cupins em grupos monoespecíficos quando na presença de números crescentes de indivíduos de Corotoca

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(mg))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{lrrrrr}
  \hline
 & Df & Sum Sq & Mean Sq & F value & Pr($>$F) \\
  \hline
cor & 1 & 0.19 & 0.19 & 8.96 & 0.0135 \\
  Residuals & 10 & 0.21 & 0.02 &  &  \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(mg))
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
cor	1	0.19	0.19	8.96	0.0135
Residuals	10	0.21	0.02		

3.7.3 Gráfico 2

```
Analysis of Variance Table

Response: tmp2
          Df  Sum Sq  Mean Sq F value  Pr(>F)
cor2       1 0.19259 0.192587  8.9639 0.01348 *
Residuals 10 0.21485 0.021485
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Call:
lm(formula = tmp2 ~ cor2)

Residuals:
     Min       1Q   Median       3Q      Max
-0.18907 -0.11514 -0.02901  0.14627  0.18711

Coefficients:
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.88661    0.08728  10.158 1.38e-06 ***
cor2        -0.42475    0.14187  -2.994   0.0135 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1466 on 10 degrees of freedom
Multiple R-squared:  0.4727,        Adjusted R-squared:   0.42
F-statistic: 8.964 on 1 and 10 DF,  p-value: 0.01348
```

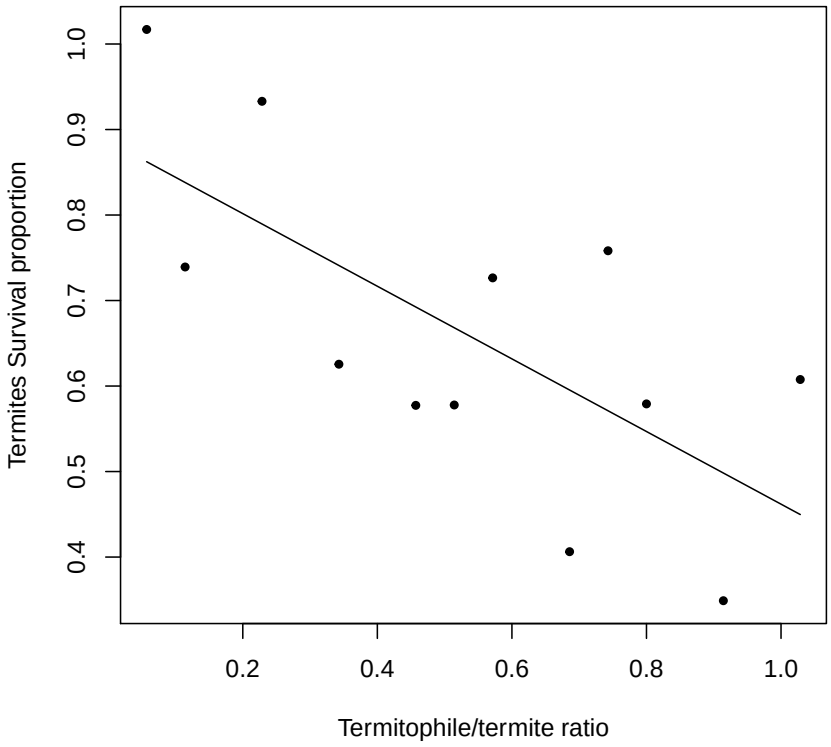

Figura 2: Tempo médio para morte de indivíduos de cupim em grupos com Corotoca sobre o tempo médio para morte de cupins em grupos monoespecíficos quando na presença de proporções crescentes de indivíduos de Corotoca

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(mg2))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{lrrrrr}
  \hline
 & Df & Sum Sq & Mean Sq & F value & Pr($>$F) \\
  \hline
cor2 & 1 & 0.19 & 0.19 & 8.96 & 0.0135 \\
  Residuals & 10 & 0.21 & 0.02 &  &  \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(mg2))
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
cor2	1	0.19	0.19	8.96	0.0135
Residuals	10	0.21	0.02		

3.7.4 Gráfico 3

```
Analysis of Variance Table

Response: tmp2
          Df  Sum Sq  Mean Sq F value   Pr(>F)
cor3       1 0.21427 0.214270  11.093 0.007611 **
Residuals 10 0.19317 0.019316
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Call:
lm(formula = tmp2 ~ cor3)

Residuals:
     Min       1Q   Median       3Q      Max
-0.17210 -0.10496 -0.01395  0.11145  0.19832

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.9656     0.1007   9.591 2.33e-06 ***
```

```
cor3         -0.9519     0.2858  -3.331  0.00761 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.139 on 10 degrees of freedom
Multiple R-squared:  0.5259,        Adjusted R-squared:  0.4785
F-statistic: 11.09 on 1 and 10 DF,  p-value: 0.007611
```

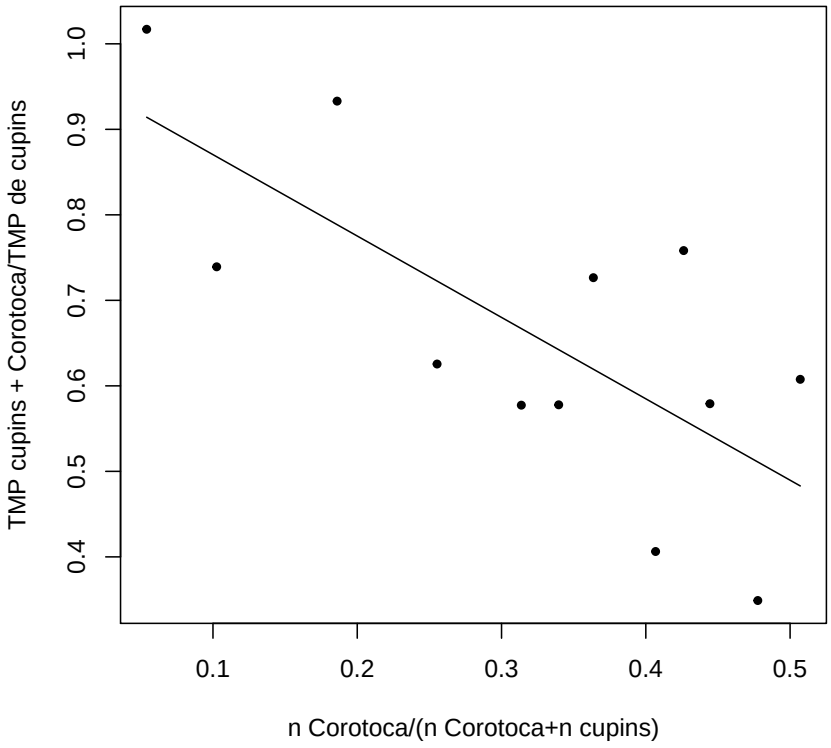

Figura 3: Tempo médio para morte de indivíduos de cupim em grupos com Corotoca sobre o tempo médio para morte de cupins em grupos monoespecíficos quando na presença de proporções crescentes de indivíduos de Corotoca na população da placa

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(anova(mg3))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:06:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{lrrrrr}
  \hline
 & Df & Sum Sq & Mean Sq & F value & Pr($>$F) \\
  \hline
cor3 & 1 & 0.21 & 0.21 & 11.09 & 0.0076 \\
  Residuals & 10 & 0.19 & 0.02 &  &  \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(mg3))
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
cor3	1	0.21	0.21	11.09	0.0076
Residuals	10	0.19	0.02		

4 Efeito da quantidade de *Corotoca* na sobrevivência de *Corotoca*

4.1 Rationale

Hipótese biológica: A sobrevivência de *Corotoca* pode ser afetada pela quantidade de sua população na placa, devido à competição por recurso.

Hipótese estatística: Se a sobrevivência de *Corotoca* for afetada pela quantidade de besouros presentes nas placas, à medida que o número de *Corotoca* aumenta, seu tempo médio para para morte diminui.

O experimento consiste de uma placa com um grupo de cupins com *Corotoca*. Foram usadas placas de 85mm, forradas com papel filtro e fechadas durante o experimento. A sobrevivência era observada de hora em hora. Foram contados os termitófilos vivos e mortos em cada placa. Os grupos de cupins consistiam de 28 operários e 7 soldados de *Constrictotermes cyphergaster*. E em cada teste foi colocada uma quantidade diferente de Corotoca, criando um gradiente de 2 até 36 indivíduos do besouro, mantendo-se sempre os 35 cupins, conforme acima.

4.2 Carregando os dados

```
> sobc<-read.csv("survivalcorotoca.csv", h=T)
> attach(sobc)
```

```
> options(width=120)
> sobc
```

	ind	censor	ncor	ninho	tempo	tempo_inicio	tempo_morte
1	n01.01	1	8	2017-04-07-ycc-n01	120	02/05/2017 19:50:00	02/05/2017 21:50:00
2	n01.02	1	8	2017-04-07-ycc-n01	240	02/05/2017 19:50:00	02/05/2017 23:50:00
3	n01.03	1	8	2017-04-07-ycc-n01	240	02/05/2017 19:50:00	02/05/2017 23:50:00
4	n01.04	1	8	2017-04-07-ycc-n01	240	02/05/2017 19:50:00	02/05/2017 23:50:00
5	n01.05	1	8	2017-04-07-ycc-n01	300	02/05/2017 19:50:00	03/05/2017 00:50:00
6	n01.06	1	8	2017-04-07-ycc-n01	300	02/05/2017 19:50:00	03/05/2017 00:50:00
7	n01.07	1	8	2017-04-07-ycc-n01	600	02/05/2017 19:50:00	03/05/2017 05:50:00
8	n01.08	1	8	2017-04-07-ycc-n01	660	02/05/2017 19:50:00	03/05/2017 06:50:00
9	n03.01	1	24	2017-04-07-ycc-n03	60	09/05/2017 17:00:00	09/05/2017 18:00:00
10	n03.02	1	24	2017-04-07-ycc-n03	170	09/05/2017 17:00:00	09/05/2017 19:50:00
11	n03.03	1	24	2017-04-07-ycc-n03	170	09/05/2017 17:00:00	09/05/2017 19:50:00
12	n03.04	1	24	2017-04-07-ycc-n03	230	09/05/2017 17:00:00	09/05/2017 20:50:00
13	n03.05	1	24	2017-04-07-ycc-n03	230	09/05/2017 17:00:00	09/05/2017 20:50:00
14	n03.06	1	24	2017-04-07-ycc-n03	230	09/05/2017 17:00:00	09/05/2017 20:50:00
15	n03.07	1	24	2017-04-07-ycc-n03	230	09/05/2017 17:00:00	09/05/2017 20:50:00
16	n03.08	1	24	2017-04-07-ycc-n03	230	09/05/2017 17:00:00	09/05/2017 20:50:00
17	n03.09	1	24	2017-04-07-ycc-n03	290	09/05/2017 17:00:00	09/05/2017 21:50:00
18	n03.10	1	24	2017-04-07-ycc-n03	290	09/05/2017 17:00:00	09/05/2017 21:50:00
19	n03.11	1	24	2017-04-07-ycc-n03	290	09/05/2017 17:00:00	09/05/2017 21:50:00
20	n03.12	1	24	2017-04-07-ycc-n03	290	09/05/2017 17:00:00	09/05/2017 21:50:00
21	n03.13	1	24	2017-04-07-ycc-n03	290	09/05/2017 17:00:00	09/05/2017 21:50:00
22	n03.14	1	24	2017-04-07-ycc-n03	350	09/05/2017 17:00:00	09/05/2017 22:50:00
23	n03.15	1	24	2017-04-07-ycc-n03	410	09/05/2017 17:00:00	09/05/2017 23:50:00
24	n03.16	1	24	2017-04-07-ycc-n03	470	09/05/2017 17:00:00	10/05/2017 00:50:00
25	n03.17	1	24	2017-04-07-ycc-n03	470	09/05/2017 17:00:00	10/05/2017 00:50:00
26	n03.18	1	24	2017-04-07-ycc-n03	470	09/05/2017 17:00:00	10/05/2017 00:50:00
27	n03.19	1	24	2017-04-07-ycc-n03	470	09/05/2017 17:00:00	10/05/2017 00:50:00
28	n03.20	1	24	2017-04-07-ycc-n03	470	09/05/2017 17:00:00	10/05/2017 00:50:00
29	n03.21	1	24	2017-04-07-ycc-n03	590	09/05/2017 17:00:00	10/05/2017 02:50:00
30	n03.22	1	24	2017-04-07-ycc-n03	830	09/05/2017 17:00:00	10/05/2017 06:50:00
31	n03.23	1	24	2017-04-07-ycc-n03	1010	09/05/2017 17:00:00	10/05/2017 09:50:00
32	n03.24	1	24	2017-04-07-ycc-n03	1070	09/05/2017 17:00:00	10/05/2017 10:50:00
33	n04.01	1	2	2017-04-07-ycc-n04	240	27/04/2017 14:43:00	27/04/2017 18:43:00
34	n04.02	1	2	2017-04-07-ycc-n04	600	27/04/2017 14:43:00	28/04/2017 00:43:00
35	n05.01	1	4	2017-04-07-ycc-n05	103	29/04/2017 16:33:00	29/04/2017 18:16:00
36	n05.02	1	4	2017-04-07-ycc-n05	310	29/04/2017 16:33:00	29/04/2017 21:43:00
37	n05.03	1	4	2017-04-07-ycc-n05	310	29/04/2017 16:33:00	29/04/2017 21:43:00
38	n05.04	1	4	2017-04-07-ycc-n05	1210	29/04/2017 16:33:00	30/04/2017 12:43:00
39	n06.01	1	18	2017-04-07-ycc-n06	91	28/04/2017 04:29:00	28/04/2017 06:00:00
40	n06.02	1	18	2017-04-07-ycc-n06	91	28/04/2017 04:29:00	28/04/2017 06:00:00
41	n06.03	1	18	2017-04-07-ycc-n06	91	28/04/2017 04:29:00	28/04/2017 06:00:00
42	n06.04	1	18	2017-04-07-ycc-n06	134	28/04/2017 04:29:00	28/04/2017 06:43:00
43	n06.05	1	18	2017-04-07-ycc-n06	134	28/04/2017 04:29:00	28/04/2017 06:43:00
44	n06.06	1	18	2017-04-07-ycc-n06	194	28/04/2017 04:29:00	28/04/2017 07:43:00
45	n06.07	1	18	2017-04-07-ycc-n06	194	28/04/2017 04:29:00	28/04/2017 07:43:00
46	n06.08	1	18	2017-04-07-ycc-n06	254	28/04/2017 04:29:00	28/04/2017 08:43:00
47	n06.09	1	18	2017-04-07-ycc-n06	254	28/04/2017 04:29:00	28/04/2017 08:43:00
48	n06.10	1	18	2017-04-07-ycc-n06	321	28/04/2017 04:29:00	28/04/2017 09:50:00
49	n06.11	1	18	2017-04-07-ycc-n06	321	28/04/2017 04:29:00	28/04/2017 09:50:00
50	n06.12	1	18	2017-04-07-ycc-n06	444	28/04/2017 04:29:00	28/04/2017 11:53:00
51	n06.13	1	18	2017-04-07-ycc-n06	494	28/04/2017 04:29:00	28/04/2017 12:43:00
52	n06.14	1	18	2017-04-07-ycc-n06	494	28/04/2017 04:29:00	28/04/2017 12:43:00
53	n06.15	1	18	2017-04-07-ycc-n06	554	28/04/2017 04:29:00	28/04/2017 13:43:00
54	n06.16	1	18	2017-04-07-ycc-n06	614	28/04/2017 04:29:00	28/04/2017 14:43:00
55	n06.17	1	18	2017-04-07-ycc-n06	751	28/04/2017 04:29:00	28/04/2017 17:00:00

```
56  n06.18      1   18 2017-04-07-ycc-n06   950 28/04/2017 04:29:00 28/04/2017 20:19:00
57  n07.01      1   26 2017-04-07-ycc-n07    60 28/04/2017 19:19:00 28/04/2017 20:19:00
58  n07.02      1   26 2017-04-07-ycc-n07    84 28/04/2017 19:19:00 28/04/2017 20:43:00
59  n07.03      1   26 2017-04-07-ycc-n07   204 28/04/2017 19:19:00 28/04/2017 22:43:00
60  n07.04      1   26 2017-04-07-ycc-n07   204 28/04/2017 19:19:00 28/04/2017 22:43:00
61  n07.05      1   26 2017-04-07-ycc-n07   264 28/04/2017 19:19:00 28/04/2017 23:43:00
62  n07.06      1   26 2017-04-07-ycc-n07   264 28/04/2017 19:19:00 28/04/2017 23:43:00
63  n07.07      1   26 2017-04-07-ycc-n07   264 28/04/2017 19:19:00 28/04/2017 23:43:00
64  n07.08      1   26 2017-04-07-ycc-n07   446 28/04/2017 19:19:00 29/04/2017 02:45:00
65  n07.09      1   26 2017-04-07-ycc-n07   446 28/04/2017 19:19:00 29/04/2017 02:45:00
66  n07.10      1   26 2017-04-07-ycc-n07   446 28/04/2017 19:19:00 29/04/2017 02:45:00
67  n07.11      1   26 2017-04-07-ycc-n07   446 28/04/2017 19:19:00 29/04/2017 02:45:00
68  n07.12      1   26 2017-04-07-ycc-n07   506 28/04/2017 19:19:00 29/04/2017 03:45:00
69  n07.13      1   26 2017-04-07-ycc-n07   506 28/04/2017 19:19:00 29/04/2017 03:45:00
70  n07.14      1   26 2017-04-07-ycc-n07   506 28/04/2017 19:19:00 29/04/2017 03:45:00
71  n07.15      1   26 2017-04-07-ycc-n07   506 28/04/2017 19:19:00 29/04/2017 03:45:00
72  n07.16      1   26 2017-04-07-ycc-n07   506 28/04/2017 19:19:00 29/04/2017 03:45:00
73  n07.17      1   26 2017-04-07-ycc-n07   566 28/04/2017 19:19:00 29/04/2017 04:45:00
74  n07.18      1   26 2017-04-07-ycc-n07   566 28/04/2017 19:19:00 29/04/2017 04:45:00
75  n07.19      1   26 2017-04-07-ycc-n07   624 28/04/2017 19:19:00 29/04/2017 05:43:00
76  n07.20      1   26 2017-04-07-ycc-n07   624 28/04/2017 19:19:00 29/04/2017 05:43:00
77  n07.21      1   26 2017-04-07-ycc-n07   744 28/04/2017 19:19:00 29/04/2017 07:43:00
78  n07.22      1   26 2017-04-07-ycc-n07   744 28/04/2017 19:19:00 29/04/2017 07:43:00
79  n07.23      1   26 2017-04-07-ycc-n07   744 28/04/2017 19:19:00 29/04/2017 07:43:00
80  n07.24      1   26 2017-04-07-ycc-n07   744 28/04/2017 19:19:00 29/04/2017 07:43:00
81  n07.25      1   26 2017-04-07-ycc-n07   864 28/04/2017 19:19:00 29/04/2017 09:43:00
82  n07.26      1   26 2017-04-07-ycc-n07  1164 28/04/2017 19:19:00 29/04/2017 14:43:00
83  n08.01      1   36 2017-04-07-ycc-n08    60 30/04/2017 04:55:00 30/04/2017 05:55:00
84  n08.02      1   36 2017-04-07-ycc-n08    60 30/04/2017 04:55:00 30/04/2017 05:55:00
85  n08.03      1   36 2017-04-07-ycc-n08   120 30/04/2017 04:55:00 30/04/2017 06:55:00
86  n08.04      1   36 2017-04-07-ycc-n08   120 30/04/2017 04:55:00 30/04/2017 06:55:00
87  n08.05      1   36 2017-04-07-ycc-n08   168 30/04/2017 04:55:00 30/04/2017 07:43:00
88  n08.06      1   36 2017-04-07-ycc-n08   168 30/04/2017 04:55:00 30/04/2017 07:43:00
89  n08.07      1   36 2017-04-07-ycc-n08   168 30/04/2017 04:55:00 30/04/2017 07:43:00
90  n08.08      1   36 2017-04-07-ycc-n08   168 30/04/2017 04:55:00 30/04/2017 07:43:00
91  n08.09      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
92  n08.10      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
93  n08.11      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
94  n08.12      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
95  n08.13      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
96  n08.14      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
97  n08.15      1   36 2017-04-07-ycc-n08   228 30/04/2017 04:55:00 30/04/2017 08:43:00
98  n08.16      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
99  n08.17      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
100 n08.18      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
101 n08.19      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
102 n08.20      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
103 n08.21      1   36 2017-04-07-ycc-n08   305 30/04/2017 04:55:00 30/04/2017 10:00:00
104 n08.22      1   36 2017-04-07-ycc-n08   365 30/04/2017 04:55:00 30/04/2017 11:00:00
105 n08.23      1   36 2017-04-07-ycc-n08   365 30/04/2017 04:55:00 30/04/2017 11:00:00
106 n08.24      1   36 2017-04-07-ycc-n08   365 30/04/2017 04:55:00 30/04/2017 11:00:00
107 n08.25      1   36 2017-04-07-ycc-n08   408 30/04/2017 04:55:00 30/04/2017 11:43:00
108 n08.26      1   36 2017-04-07-ycc-n08   408 30/04/2017 04:55:00 30/04/2017 11:43:00
109 n08.27      1   36 2017-04-07-ycc-n08   408 30/04/2017 04:55:00 30/04/2017 11:43:00
110 n08.28      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
111 n08.29      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
112 n08.30      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
113 n08.31      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
```

```
114 n08.32      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
115 n08.33      1   36 2017-04-07-ycc-n08   468 30/04/2017 04:55:00 30/04/2017 12:43:00
116 n08.34      1   36 2017-04-07-ycc-n08   768 30/04/2017 04:55:00 30/04/2017 17:43:00
117 n08.35      1   36 2017-04-07-ycc-n08   768 30/04/2017 04:55:00 30/04/2017 17:43:00
118 n08.36      1   36 2017-04-07-ycc-n08   768 30/04/2017 04:55:00 30/04/2017 17:43:00
119 n10.01      1   28 2017-04-07-ycc-n10    60 04/05/2017 21:50:00 04/05/2017 22:50:00
120 n10.02      1   28 2017-04-07-ycc-n10   120 04/05/2017 21:50:00 04/05/2017 23:50:00
121 n10.03      1   28 2017-04-07-ycc-n10   120 04/05/2017 21:50:00 04/05/2017 23:50:00
122 n10.04      1   28 2017-04-07-ycc-n10   120 04/05/2017 21:50:00 04/05/2017 23:50:00
123 n10.05      1   28 2017-04-07-ycc-n10   240 04/05/2017 21:50:00 05/05/2017 01:50:00
124 n10.06      1   28 2017-04-07-ycc-n10   240 04/05/2017 21:50:00 05/05/2017 01:50:00
125 n10.07      1   28 2017-04-07-ycc-n10   240 04/05/2017 21:50:00 05/05/2017 01:50:00
126 n10.08      1   28 2017-04-07-ycc-n10   240 04/05/2017 21:50:00 05/05/2017 01:50:00
127 n10.09      1   28 2017-04-07-ycc-n10   300 04/05/2017 21:50:00 05/05/2017 02:50:00
128 n10.10      1   28 2017-04-07-ycc-n10   300 04/05/2017 21:50:00 05/05/2017 02:50:00
129 n10.11      1   28 2017-04-07-ycc-n10   300 04/05/2017 21:50:00 05/05/2017 02:50:00
130 n10.12      1   28 2017-04-07-ycc-n10   300 04/05/2017 21:50:00 05/05/2017 02:50:00
131 n10.13      1   28 2017-04-07-ycc-n10   300 04/05/2017 21:50:00 05/05/2017 02:50:00
132 n10.14      1   28 2017-04-07-ycc-n10   360 04/05/2017 21:50:00 05/05/2017 03:50:00
133 n10.15      1   28 2017-04-07-ycc-n10   360 04/05/2017 21:50:00 05/05/2017 03:50:00
134 n10.16      1   28 2017-04-07-ycc-n10   360 04/05/2017 21:50:00 05/05/2017 03:50:00
135 n10.17      1   28 2017-04-07-ycc-n10   420 04/05/2017 21:50:00 05/05/2017 04:50:00
136 n10.18      1   28 2017-04-07-ycc-n10   540 04/05/2017 21:50:00 05/05/2017 06:50:00
137 n10.19      1   28 2017-04-07-ycc-n10   540 04/05/2017 21:50:00 05/05/2017 06:50:00
138 n10.20      1   28 2017-04-07-ycc-n10   540 04/05/2017 21:50:00 05/05/2017 06:50:00
139 n10.21      1   28 2017-04-07-ycc-n10   540 04/05/2017 21:50:00 05/05/2017 06:50:00
140 n10.22      1   28 2017-04-07-ycc-n10   540 04/05/2017 21:50:00 05/05/2017 06:50:00
141 n10.23      1   28 2017-04-07-ycc-n10   660 04/05/2017 21:50:00 05/05/2017 08:50:00
142 n10.24      1   28 2017-04-07-ycc-n10   660 04/05/2017 21:50:00 05/05/2017 08:50:00
143 n10.25      1   28 2017-04-07-ycc-n10   720 04/05/2017 21:50:00 05/05/2017 09:50:00
144 n10.26      1   28 2017-04-07-ycc-n10   720 04/05/2017 21:50:00 05/05/2017 09:50:00
145 n10.27      1   28 2017-04-07-ycc-n10   720 04/05/2017 21:50:00 05/05/2017 09:50:00
146 n10.28      1   28 2017-04-07-ycc-n10   780 04/05/2017 21:50:00 05/05/2017 10:50:00
147 n11.01      1   12 2017-04-07-ycc-n11   120 08/05/2017 20:50:00 08/05/2017 22:50:00
148 n11.02      1   12 2017-04-07-ycc-n11   180 08/05/2017 20:50:00 08/05/2017 23:50:00
149 n11.03      1   12 2017-04-07-ycc-n11   360 08/05/2017 20:50:00 09/05/2017 02:50:00
150 n11.04      1   12 2017-04-07-ycc-n11   360 08/05/2017 20:50:00 09/05/2017 02:50:00
151 n11.05      1   12 2017-04-07-ycc-n11   360 08/05/2017 20:50:00 09/05/2017 02:50:00
152 n11.06      1   12 2017-04-07-ycc-n11   360 08/05/2017 20:50:00 09/05/2017 02:50:00
153 n11.07      1   12 2017-04-07-ycc-n11   360 08/05/2017 20:50:00 09/05/2017 02:50:00
154 n11.08      1   12 2017-04-07-ycc-n11   420 08/05/2017 20:50:00 09/05/2017 03:50:00
155 n11.09      1   12 2017-04-07-ycc-n11   480 08/05/2017 20:50:00 09/05/2017 04:50:00
156 n11.10      1   12 2017-04-07-ycc-n11   540 08/05/2017 20:50:00 09/05/2017 05:50:00
157 n11.11      1   12 2017-04-07-ycc-n11   600 08/05/2017 20:50:00 09/05/2017 06:50:00
158 n11.12      1   12 2017-04-07-ycc-n11   730 08/05/2017 20:50:00 09/05/2017 09:00:00
159 n12.01      1   16 2017-04-07-ycc-n12   250 05/05/2017 00:30:00 05/05/2017 04:40:00
160 n12.02      1   16 2017-04-07-ycc-n12   250 05/05/2017 00:30:00 05/05/2017 04:40:00
161 n12.03      1   16 2017-04-07-ycc-n12   250 05/05/2017 00:30:00 05/05/2017 04:40:00
162 n12.04      1   16 2017-04-07-ycc-n12   320 05/05/2017 00:30:00 05/05/2017 05:50:00
163 n12.05      1   16 2017-04-07-ycc-n12   320 05/05/2017 00:30:00 05/05/2017 05:50:00
164 n12.06      1   16 2017-04-07-ycc-n12   380 05/05/2017 00:30:00 05/05/2017 06:50:00
165 n12.07      1   16 2017-04-07-ycc-n12   380 05/05/2017 00:30:00 05/05/2017 06:50:00
166 n12.08      1   16 2017-04-07-ycc-n12   500 05/05/2017 00:30:00 05/05/2017 08:50:00
167 n12.09      1   16 2017-04-07-ycc-n12   500 05/05/2017 00:30:00 05/05/2017 08:50:00
168 n12.10      1   16 2017-04-07-ycc-n12   560 05/05/2017 00:30:00 05/05/2017 09:50:00
169 n12.11      1   16 2017-04-07-ycc-n12   620 05/05/2017 00:30:00 05/05/2017 10:50:00
170 n12.12      1   16 2017-04-07-ycc-n12   680 05/05/2017 00:30:00 05/05/2017 11:50:00
171 n12.13      1   16 2017-04-07-ycc-n12   680 05/05/2017 00:30:00 05/05/2017 11:50:00
```

```
172 n12.14      1   16 2017-04-07-ycc-n12   740 05/05/2017 00:30:00 05/05/2017 12:50:00
173 n12.15      1   16 2017-04-07-ycc-n12   920 05/05/2017 00:30:00 05/05/2017 15:50:00
174 n12.16      1   16 2017-04-07-ycc-n12  1100 05/05/2017 00:30:00 05/05/2017 18:50:00
175 n13.01      1   32 2017-04-07-ycc-n13    60 07/05/2017 03:50:00 07/05/2017 04:50:00
176 n13.02      1   32 2017-04-07-ycc-n13   240 07/05/2017 03:50:00 07/05/2017 07:50:00
177 n13.03      1   32 2017-04-07-ycc-n13   240 07/05/2017 03:50:00 07/05/2017 07:50:00
178 n13.04      1   32 2017-04-07-ycc-n13   240 07/05/2017 03:50:00 07/05/2017 07:50:00
179 n13.05      1   32 2017-04-07-ycc-n13   300 07/05/2017 03:50:00 07/05/2017 08:50:00
180 n13.06      1   32 2017-04-07-ycc-n13   300 07/05/2017 03:50:00 07/05/2017 08:50:00
181 n13.07      1   32 2017-04-07-ycc-n13   360 07/05/2017 03:50:00 07/05/2017 09:50:00
182 n13.08      1   32 2017-04-07-ycc-n13   360 07/05/2017 03:50:00 07/05/2017 09:50:00
183 n13.09      1   32 2017-04-07-ycc-n13   420 07/05/2017 03:50:00 07/05/2017 10:50:00
184 n13.10      1   32 2017-04-07-ycc-n13   420 07/05/2017 03:50:00 07/05/2017 10:50:00
185 n13.11      1   32 2017-04-07-ycc-n13   420 07/05/2017 03:50:00 07/05/2017 10:50:00
186 n13.12      1   32 2017-04-07-ycc-n13   420 07/05/2017 03:50:00 07/05/2017 10:50:00
187 n13.13      1   32 2017-04-07-ycc-n13   480 07/05/2017 03:50:00 07/05/2017 11:50:00
188 n13.14      1   32 2017-04-07-ycc-n13   540 07/05/2017 03:50:00 07/05/2017 12:50:00
189 n13.15      1   32 2017-04-07-ycc-n13   540 07/05/2017 03:50:00 07/05/2017 12:50:00
190 n13.16      1   32 2017-04-07-ycc-n13   540 07/05/2017 03:50:00 07/05/2017 12:50:00
191 n13.17      1   32 2017-04-07-ycc-n13   600 07/05/2017 03:50:00 07/05/2017 13:50:00
192 n13.18      1   32 2017-04-07-ycc-n13   600 07/05/2017 03:50:00 07/05/2017 13:50:00
193 n13.19      1   32 2017-04-07-ycc-n13   600 07/05/2017 03:50:00 07/05/2017 13:50:00
194 n13.20      1   32 2017-04-07-ycc-n13   600 07/05/2017 03:50:00 07/05/2017 13:50:00
195 n13.21      1   32 2017-04-07-ycc-n13   660 07/05/2017 03:50:00 07/05/2017 14:50:00
196 n13.22      1   32 2017-04-07-ycc-n13   660 07/05/2017 03:50:00 07/05/2017 14:50:00
197 n13.23      1   32 2017-04-07-ycc-n13   660 07/05/2017 03:50:00 07/05/2017 14:50:00
198 n13.24      1   32 2017-04-07-ycc-n13   660 07/05/2017 03:50:00 07/05/2017 14:50:00
199 n13.25      1   32 2017-04-07-ycc-n13   780 07/05/2017 03:50:00 07/05/2017 16:50:00
200 n13.26      1   32 2017-04-07-ycc-n13   780 07/05/2017 03:50:00 07/05/2017 16:50:00
201 n13.27      1   32 2017-04-07-ycc-n13   880 07/05/2017 03:50:00 07/05/2017 18:30:00
202 n13.28      1   32 2017-04-07-ycc-n13   880 07/05/2017 03:50:00 07/05/2017 18:30:00
203 n13.29      1   32 2017-04-07-ycc-n13  1000 07/05/2017 03:50:00 07/05/2017 20:30:00
204 n13.30      1   32 2017-04-07-ycc-n13  1080 07/05/2017 03:50:00 07/05/2017 21:50:00
205 n13.31      1   32 2017-04-07-ycc-n13  1080 07/05/2017 03:50:00 07/05/2017 21:50:00
206 n13.32      1   32 2017-04-07-ycc-n13  1240 07/05/2017 03:50:00 08/05/2017 00:30:00
207 n13.01      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
208 n13.02      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
209 n13.03      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
210 n13.04      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
211 n13.05      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
212 n13.06      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
213 n13.07      1   20 2017-04-07-ycc-n14   180 08/05/2017 01:30:00 08/05/2017 04:30:00
214 n13.08      1   20 2017-04-07-ycc-n14   240 08/05/2017 01:30:00 08/05/2017 05:30:00
215 n13.09      1   20 2017-04-07-ycc-n14   240 08/05/2017 01:30:00 08/05/2017 05:30:00
216 n13.10      1   20 2017-04-07-ycc-n14   240 08/05/2017 01:30:00 08/05/2017 05:30:00
217 n13.11      1   20 2017-04-07-ycc-n14   300 08/05/2017 01:30:00 08/05/2017 06:30:00
218 n13.12      1   20 2017-04-07-ycc-n14   360 08/05/2017 01:30:00 08/05/2017 07:30:00
219 n13.13      1   20 2017-04-07-ycc-n14   495 08/05/2017 01:30:00 08/05/2017 09:45:00
220 n13.14      1   20 2017-04-07-ycc-n14   495 08/05/2017 01:30:00 08/05/2017 09:45:00
221 n13.15      1   20 2017-04-07-ycc-n14   495 08/05/2017 01:30:00 08/05/2017 09:45:00
222 n13.16      1   20 2017-04-07-ycc-n14   495 08/05/2017 01:30:00 08/05/2017 09:45:00
223 n13.17      1   20 2017-04-07-ycc-n14   555 08/05/2017 01:30:00 08/05/2017 10:45:00
224 n13.18      1   20 2017-04-07-ycc-n14   555 08/05/2017 01:30:00 08/05/2017 10:45:00
225 n13.19      1   20 2017-04-07-ycc-n14   615 08/05/2017 01:30:00 08/05/2017 11:45:00
226 n13.20      1   20 2017-04-07-ycc-n14   980 08/05/2017 01:30:00 08/05/2017 17:50:00
```

No banco de dados acima, cada linha representa a sobrevivência de um único indivíduo de *Corotoca*. As variáveis são:

ind: identificação do indivíduo

censor: censor da Weibull.

censor(1): Se naquele momento o indivíduo foi observado morto.

censor(0): Se naquele momento o indivíduo foi observado vivo pela última vez.

ncor : número de indivíduos de Corotoca naquela placa.

ninho : identificação do ninho(fotos no Isoptera). O código é composto da seguinte forma: YYYY-MM-DD-III-NNN, onde YYYY é o ano em quatro digitos, MM é o mês em dois digitos, DD é o dia em dois digitos, III são as iniciais do coletor e NNN é o número de série do ninho daquele dia. O coletor nesse caso é Yuri Carvalho de Carvalho.

tempo: tempo em minutos desde o início do experimento até a hora da observação do indivíduo.

4.3 Montando os modelos

A quantidade de *Corotoca* afeta sua sobrevivência? Modelo nulo:

```
> library(survival)
> m0<-survreg(Surv(tempo,censor)~1)
>
```

Modelo completo

```
> mc<-survreg(Surv(tempo,censor)~ncor)
```

Contraste dos modelos

```
> anova(m0,mc)

  Terms Resid. Df    -2*LL Test Df   Deviance  Pr(>Chi)
1     1       224 3086.061      NA         NA        NA
2  ncor       223 3086.019    =  1 0.04238336 0.8368907

> anova(mc)

     Df   Deviance Resid. Df    -2*LL  Pr(>Chi)
NULL NA         NA       224 3086.061        NA
ncor  1 0.04238336       223 3086.019 0.8368907
```

O resultado não foi significativo, então nossa hipótese não foi confirmada.

4.4 Tempo médio para morte de cada grupo

```
> options(width=75)
> mcx<-survreg(Surv(tempo,censor)~ninho)
> alpha<-1/mcx$scale
> alpha
```

```
[1] 1.969789
```

```
> pontos<-survfit(Surv(tempo,censor)~ninho)
> muc<-tapply(predict(mcx),ncor,mean)
> tpm<-muc*gamma(1+(1/alpha))
> tpm
```

```
       2        4        8       12       16       18       20       24
404.1861 568.3193 336.8220 386.1799 513.9864 378.1234 372.2066 416.3413
      26       28       32       36
493.8577 401.7780 568.8089 330.9905
```

```
>
```

4.5 Gráfico

4.5.1 Variáveis do gráfico

```
> options(width=75)
> #y
> tpmx<-as.array(c(tpm))
> tpmx
```

```
       2        4        8       12       16       18       20       24
404.1861 568.3193 336.8220 386.1799 513.9864 378.1234 372.2066 416.3413
      26       28       32       36
493.8577 401.7780 568.8089 330.9905
```

```
> #x1
> cor<-as.numeric(rownames(tpm))
> cor
```

```
 [1]  2  4  8 12 16 18 20 24 26 28 32 36
```

```
> #x2
> cor2<-as.numeric(rownames(tpm))/35
> cor2
```

```
 [1] 0.05714286 0.11428571 0.22857143 0.34285714 0.45714286 0.51428571
 [7] 0.57142857 0.68571429 0.74285714 0.80000000 0.91428571 1.02857143
```

4.5.2 Gráfico

```
Analysis of Variance Table

Response: tpmx
          Df Sum Sq Mean Sq F value Pr(>F)
cor        1     75    75.5  0.0097 0.9234
Residuals 10  77531  7753.1
```

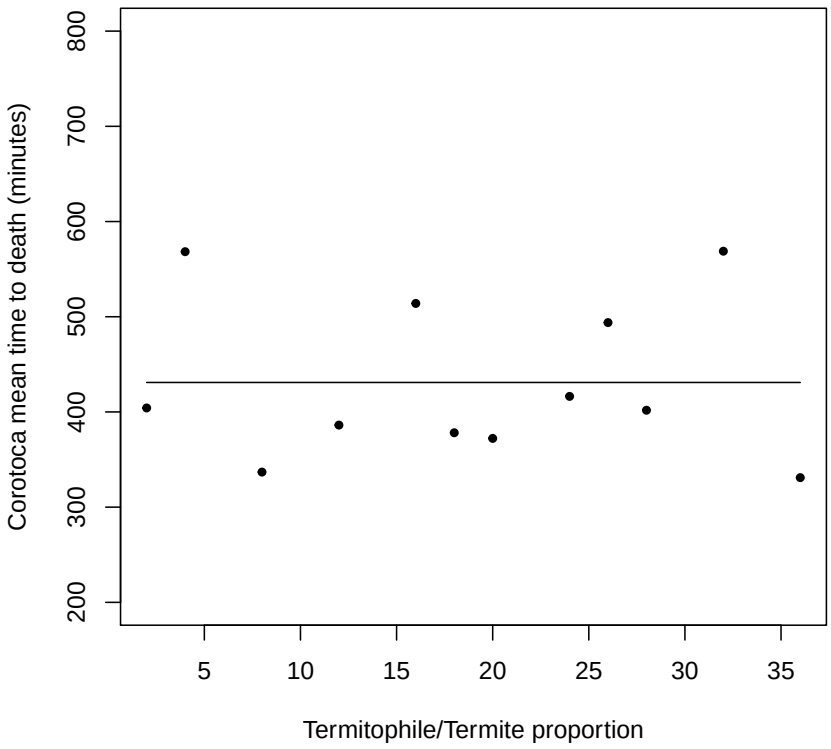

Figura 1: Tempo médio para morte de indivíduos de *Corotoca* confinados em placas de Petri com seus hospedeiros *Constrictotermes cyphergaster* e com números crescentes de indivíduos de *Corotoca*

```
Analysis of Variance Table

Response: tpmx
          Df Sum Sq Mean Sq F value Pr(>F)
cor2       1     75    75.5  0.0097 0.9234
Residuals 10  77531  7753.1
```

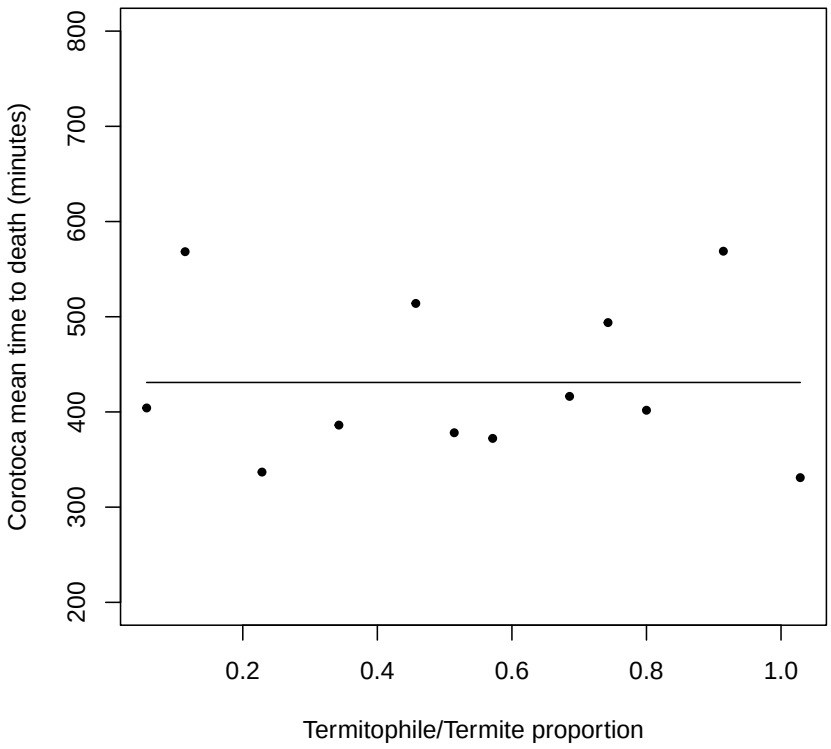

Figura 2: Tempo médio para morte de indivíduos de *Corotoca* confinados em placas de Petri com seus hospedeiros *Constrictotermes cyphergaster* e com números crescentes de indivíduos de *Corotoca*

5 Comportamento de Corotoca explica o efeito na sobrevivência dos cupins?

5.1 Rationale

Hipótese biológica: A sobrevivência dos cupins é reduzida devido às interações dos termitófilos com ele. Hipótese estatística: Se determinada interação do termitófilo com o hospedeiro causou a redução na sobrevivência dos cupins, esta interação aumentará a medida que a sobrevivência de *Corotoca* diminui.

O experimento consiste de uma placa de petri por ninho, contendo um grupo de cupins com *Corotoca*. Foram usadas placas de 85mm de diâmetro interno, forradas com papel filtro e expostas à luz branca (LED). As placas foram filmadas durante 58 minutos, no início do teste de sobrevivência. Os grupos de cupins consistiam de 28 operários e 7 soldados de *Constrictotermes cypherster*. E em cada teste foi colocada uma quantidade diferente de Corotoca, criando um gradiente de 2 até 36 indivíduos do besouro, mantendo-se sempre os 35 cupins, conforme acima. A cada 2 minutos do vídeo, os comportamentos realizados em cada placa eram observados e anotados.

5.2 Carregando os dados

```
> comport<-read.csv("comport2.csv", h=T)
> attach(comport)
```

```
> comport
```

```
                nest ncor mtmcor mtmint mtmhos mtacor mtaint dd ogc cgh cgc pe
1  2017-04-07-ycc-n01    8      1      2      3     40     12  0   1   1   3  1
2  2017-04-07-ycc-n03   24     17     15      7    116     15  3   3   1   1  0
3  2017-04-07-ycc-n04    2      0      1      4      8      3  0   0   0   0  0
4  2017-04-07-ycc-n05    4      0      2      7      6      7  0   3   1   0  0
5  2017-04-07-ycc-n06   18      6      9      6    118     16  7  11   1   0  0
6  2017-04-07-ycc-n07   26     11     19      8    139     22  0   5   0   2  3
7  2017-04-07-ycc-n08   36     34      6      0    175     13  0   1   0   4  0
8  2017-04-07-ycc-n10   28     14     12      1    149     51  2   2   1   1  0
9  2017-04-07-ycc-n11   12     10     29     28     59     19  1   2   1   0  0
10 2017-04-07-ycc-n12   16     12     19      6     69     24  0   3   3   0  1
11 2017-04-07-ycc-n13   32     25     30      2    136     43  0   4   1   0  4
12 2017-04-07-ycc-n14   20     38      7      2    105     17  0   2   1   1  1
         hsr   corsob    hossob       den
1  0.9329956 336.8220  371.5992 0.1422918
2  0.4062877 416.3413 1042.7039 0.1702627
3  1.0170010 404.1861 1300.1485 0.1318028
4  0.7392158 568.3193 1124.9270 0.1352991
5  0.5778389 378.1234 1098.2172 0.1597736
6  0.7581953 493.8577  786.7508 0.1737590
7  0.6076302 330.9905  515.3634 0.1912408
8  0.5791123 401.7780  656.6225 0.1772554
9  0.6255367 386.1799 1109.1844 0.1492846
10 0.5774054 513.9864  658.7541 0.1562773
11 0.3489556 568.8089  794.0491 0.1842481
12 0.7264975 372.2066  722.3643 0.1632700
```

No banco de dados acima, cada linha representa uma placa com um grupo de *Constrictotermes cyphergaster* acompanhados de indivíduos de *Corotoca melantho* e suas interações registradas. As variáveis são:

nest: identificação do ninho

ncor: número de indivíduos de Corotoca naquela placa

mtmcor: número de interações boca-a-boca entre Corotoca

mtmint: número de interações boca-a-boca entre Corotoca e cupins

mtmhos: número de interações boca-a-boca entre cupins

mtacor: número de mordidas entre Corotoca

mtaint: número de mordidas de Corotoca nos cupins

dd: extensão do abdomen, provavelmente depositando gotícula

cgh: *Corotoca* realizando grooming nos cupins

cgc: *Corotoca* realizando grooming em outros *Corotoca*

pe: eversão de pênis em *Corotoca*

hsr: taxa de sobrevivência de *Constrictotermes cyphergaster* quando na presença de *Corotoca*

corsob: tempo médio para morte de *Corotoca melantho*

hossob: tempo médio para morte de *Constrictotermes cyphergaster*

5.3 AIC

Criando o modelo com as covariáveis a serem analisadas:

```
> modelo<-glm(hsr~mtmint*mtaint*den,na.action = "na.fail")
```

Seleção de modelo pela AIC:

```
> library(MuMIn)
> dredge(modelo,rank="AIC")

Global model call: glm(formula = hsr ~ mtmint * mtaint * den, na.action = "na.fail")
---
Model selection table
     (Int)    den        mtn       mtm den:mtn   den:mtm    mtn:mtm den:mtn:mtm
6   1.5790 -5.031            -0.008697
8   1.5570 -4.848 -5.663e-04 -0.008388
22  1.5610 -4.915            -0.006648         -0.012750
2   1.7770 -6.942
5   0.8177                   -0.012690
4   1.5880 -5.305 -3.683e-03
```

```
16  1.6350 -5.299 -8.296e-03 -0.008072 0.04313
40  1.5560 -4.864 -3.539e-04 -0.008067                   -1.506e-05
24  1.5520 -4.818 -5.444e-04 -0.007753         -0.004024
7   0.8603        -4.231e-03 -0.009290
12  1.8860 -6.990 -3.326e-02           0.16760
3   0.8215        -8.104e-03
48  1.8630 -6.920 -2.884e-02 -0.002404 0.17510           -2.204e-04
32  1.6790 -5.489 -2.605e-02  0.011580 0.14580 -0.119800
56  1.5820 -5.070 -5.718e-05 -0.011120          0.023400 -4.515e-05
39  0.8742        -5.132e-03 -0.010720                    6.791e-05
64  1.8340 -6.672 -3.167e-02  0.004122 0.18890 -0.046630 -1.766e-04
128 2.1840 -8.475 -5.337e-02 -0.195300 0.29010  1.065000  9.456e-03    -0.05257
1   0.6581
    df logLik   AIC delta weight
6    4  9.439 -10.9  0.00  0.301
8    5  9.453  -8.9  1.97  0.112
22   5  9.442  -8.9  2.00  0.111
2    3  7.109  -8.2  2.66  0.080
5    3  6.720  -7.4  3.44  0.054
4    4  7.640  -7.3  3.60  0.050
16   6  9.477  -7.0  3.92  0.042
40   6  9.455  -6.9  3.97  0.041
24   6  9.453  -6.9  3.97  0.041
7    4  7.424  -6.8  4.03  0.040
12   5  7.945  -5.9  4.99  0.025
3    3  5.796  -5.6  5.29  0.021
48   7  9.572  -5.1  5.73  0.017
32   7  9.540  -5.1  5.80  0.017
56   7  9.456  -4.9  5.97  0.015
39   5  7.445  -4.9  5.99  0.015
64   8  9.578  -3.2  7.72  0.006
128  9 10.320  -2.6  8.24  0.005
1    2  3.269  -2.5  8.34  0.005
Models ranked by AIC(x)
```

```
> model<-dredge(modelo,rank="AIC")
> model

Global model call: glm(formula = hsr ~ mtmint * mtaint * den, na.action = "na.fail")
---
Model selection table
     (Int)    den        mtn       mtm den:mtn   den:mtm    mtn:mtm den:mtn:mtm
6   1.5790 -5.031           -0.008697
8   1.5570 -4.848 -5.663e-04 -0.008388
22  1.5610 -4.915           -0.006648         -0.012750
2   1.7770 -6.942
5   0.8177                  -0.012690
```

```
4   1.5880 -5.305 -3.683e-03
16  1.6350 -5.299 -8.296e-03 -0.008072 0.04313
40  1.5560 -4.864 -3.539e-04 -0.008067                  -1.506e-05
24  1.5520 -4.818 -5.444e-04 -0.007753         -0.004024
7   0.8603        -4.231e-03 -0.009290
12  1.8860 -6.990 -3.326e-02           0.16760
3   0.8215        -8.104e-03
48  1.8630 -6.920 -2.884e-02 -0.002404 0.17510           -2.204e-04
32  1.6790 -5.489 -2.605e-02  0.011580 0.14580 -0.119800
56  1.5820 -5.070 -5.718e-05 -0.011120          0.023400 -4.515e-05
39  0.8742        -5.132e-03 -0.010720                    6.791e-05
64  1.8340 -6.672 -3.167e-02  0.004122 0.18890 -0.046630 -1.766e-04
128 2.1840 -8.475 -5.337e-02 -0.195300 0.29010  1.065000  9.456e-03    -0.05257
1   0.6581
    df logLik   AIC delta weight
6    4  9.439 -10.9  0.00  0.301
8    5  9.453  -8.9  1.97  0.112
22   5  9.442  -8.9  2.00  0.111
2    3  7.109  -8.2  2.66  0.080
5    3  6.720  -7.4  3.44  0.054
4    4  7.640  -7.3  3.60  0.050
16   6  9.477  -7.0  3.92  0.042
40   6  9.455  -6.9  3.97  0.041
24   6  9.453  -6.9  3.97  0.041
7    4  7.424  -6.8  4.03  0.040
12   5  7.945  -5.9  4.99  0.025
3    3  5.796  -5.6  5.29  0.021
48   7  9.572  -5.1  5.73  0.017
32   7  9.540  -5.1  5.80  0.017
56   7  9.456  -4.9  5.97  0.015
39   5  7.445  -4.9  5.99  0.015
64   8  9.578  -3.2  7.72  0.006
128  9 10.320  -2.6  8.24  0.005
1    2  3.269  -2.5  8.34  0.005
Models ranked by AIC(x)

>
```

Código LaTeXpara a tabela

```
> library(xtable)
> xtable(dredge(modelo,rank="AIC"))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:08:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{rrrrrrrrrrrrrr}
  \hline
 & (Intercept) & den & mtaint & mtmint & den:mtaint & den:mtmint & mtaint:mtmint & den:mtaint:mtmint & df & logLik & AIC & delta & weight \\
  \hline
6 & 1.58 & -5.03 &  & -0.01 &  &  &  & 4 & 9.4 & -10.9 & 0.0 & 0.30 \\
  8 & 1.56 & -4.85 & -0.00 & -0.01 &  &  &  & 5 & 9.5 & -8.9 & 2.0 & 0.11 \\
  22 & 1.56 & -4.91 &  & -0.01 &  & -0.01 &  &  & 5 & 9.4 & -8.9 & 2.0 & 0.11 \\
  2 & 1.78 & -6.94 &  &  &  &  &  &  & 3 & 7.1 & -8.2 & 2.7 & 0.08 \\
  5 & 0.82 &  &  & -0.01 &  &  &  &  & 3 & 6.7 & -7.4 & 3.4 & 0.05 \\
  4 & 1.59 & -5.30 & -0.00 &  &  &  &  &  & 4 & 7.6 & -7.3 & 3.6 & 0.05 \\
  16 & 1.63 & -5.30 & -0.01 & -0.01 & 0.04 &  &  &  & 6 & 9.5 & -7.0 & 3.9 & 0.04 \\
  40 & 1.56 & -4.86 & -0.00 & -0.01 &  &  & -0.00 &  & 6 & 9.5 & -6.9 & 4.0 & 0.04 \\
  24 & 1.55 & -4.82 & -0.00 & -0.01 &  & -0.00 &  &  & 6 & 9.5 & -6.9 & 4.0 & 0.04 \\
  7 & 0.86 &  & -0.00 & -0.01 &  &  &  &  & 4 & 7.4 & -6.8 & 4.0 & 0.04 \\
  12 & 1.89 & -6.99 & -0.03 &  & 0.17 &  &  &  & 5 & 7.9 & -5.9 & 5.0 & 0.02 \\
  3 & 0.82 &  & -0.01 &  &  &  &  &  & 3 & 5.8 & -5.6 & 5.3 & 0.02 \\
  48 & 1.86 & -6.92 & -0.03 & -0.00 & 0.18 &  & -0.00 &  & 7 & 9.6 & -5.1 & 5.7 & 0.02 \\
  32 & 1.68 & -5.49 & -0.03 & 0.01 & 0.15 & -0.12 &  &  & 7 & 9.5 & -5.1 & 5.8 & 0.02 \\
  56 & 1.58 & -5.07 & -0.00 & -0.01 &  & 0.02 & -0.00 &  & 7 & 9.5 & -4.9 & 6.0 & 0.02 \\
  39 & 0.87 &  & -0.01 & -0.01 &  &  & 0.00 &  & 5 & 7.4 & -4.9 & 6.0 & 0.02 \\
  64 & 1.83 & -6.67 & -0.03 & 0.00 & 0.19 & -0.05 & -0.00 &  & 8 & 9.6 & -3.2 & 7.7 & 0.01 \\
  128 & 2.18 & -8.48 & -0.05 & -0.20 & 0.29 & 1.07 & 0.01 & -0.05 & 9 & 10.3 & -2.6 & 8.2 & 0.00 \\
  1 & 0.66 &  &  &  &  &  &  &  & 2 & 3.3 & -2.5 & 8.3 & 0.00 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(dredge(modelo,rank="AIC"))
```

	(Intercept)	den	mtaint	mtmint	den:mtaint	den:mtmint	mtaint:mtmint	den:mtaint:mtmint	df	logLik	AIC	delta	weight
6	1.58	-5.03		-0.01					4	9.4	-10.9	0.0	0.30
8	1.56	-4.85	-0.00	-0.01					5	9.5	-8.9	2.0	0.11
22	1.56	-4.91		-0.01		-0.01			5	9.4	-8.9	2.0	0.11
2	1.78	-6.94							3	7.1	-8.2	2.7	0.08
5	0.82			-0.01					3	6.7	-7.4	3.4	0.05
4	1.59	-5.30	-0.00						4	7.6	-7.3	3.6	0.05
16	1.63	-5.30	-0.01	-0.01	0.04				6	9.5	-7.0	3.9	0.04
40	1.56	-4.86	-0.00	-0.01			-0.00		6	9.5	-6.9	4.0	0.04
24	1.55	-4.82	-0.00	-0.01		-0.00			6	9.5	-6.9	4.0	0.04
7	0.86		-0.00	-0.01					4	7.4	-6.8	4.0	0.04
12	1.89	-6.99	-0.03		0.17				5	7.9	-5.9	5.0	0.02
3	0.82		-0.01						3	5.8	-5.6	5.3	0.02
48	1.86	-6.92	-0.03	-0.00	0.18		-0.00		7	9.6	-5.1	5.7	0.02
32	1.68	-5.49	-0.03	0.01	0.15	-0.12			7	9.5	-5.1	5.8	0.02
56	1.58	-5.07	-0.00	-0.01		0.02	-0.00		7	9.5	-4.9	6.0	0.02
39	0.87		-0.01	-0.01			0.00		5	7.4	-4.9	6.0	0.02
64	1.83	-6.67	-0.03	0.00	0.19	-0.05	-0.00		8	9.6	-3.2	7.7	0.01
128	2.18	-8.48	-0.05	-0.20	0.29	1.07	0.01	-0.05	9	10.3	-2.6	8.2	0.00
1	0.66								2	3.3	-2.5	8.3	0.00

De acordo com o menor delta, e maior peso, o melhor modelo seria o que contém densidade e as interações boca-a-boca.

```
> modaic<-glm(hsr~mtmint+den)
> anova(modaic,test="F")

Analysis of Deviance Table

Model: gaussian, link: identity

Response: hsr

Terms added sequentially (first to last)


       Df Deviance Resid. Df Resid. Dev       F   Pr(>F)
NULL                      11    0.40743
mtmint  1 0.178181        10    0.22925 11.0058 0.008976 **
den     1 0.083546         9    0.14571  5.1604 0.049230 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> summary(modaic)

Call:
glm(formula = hsr ~ mtmint + den)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-0.18530  -0.06700   0.01338   0.05952   0.21898

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.578719   0.340431   4.637  0.00122 **
mtmint      -0.008697   0.004209  -2.067  0.06875 .
den         -5.031464   2.214893  -2.272  0.04923 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.01618976)

    Null deviance: 0.40743  on 11  degrees of freedom
Residual deviance: 0.14571  on  9  degrees of freedom
AIC: -10.878

Number of Fisher Scoring iterations: 2

>
```

```
> library(xtable)
> xtable(anova(modaic,test="F"))
```

```
% latex table generated in R 3.2.3 by xtable 1.8-2 package
% Tue Jul 17 02:08:47 2018
\begin{table}[ht]
\centering
\begin{tabular}{lrrrrrr}
  \hline
 & Df & Deviance & Resid. Df & Resid. Dev & F & Pr($>$F) \\
  \hline
NULL &  &  & 11 & 0.41 &  &  \\
  mtmint & 1 & 0.18 & 10 & 0.23 & 11.01 & 0.0090 \\
  den & 1 & 0.08 & 9 & 0.15 & 5.16 & 0.0492 \\
   \hline
\end{tabular}
\end{table}
```

Tabela

```
> xtable(anova(modaic,test="F"))
```

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
NULL			11	0.41		
mtmint	1	0.18	10	0.23	11.01	0.0090
den	1	0.08	9	0.15	5.16	0.0492

Modelo em LaTeX desenvolvido por Rodrigues, V. B. (2017).

Rodrigues, V. B. 2007. Modelo de Tese e Disertação da Universidade Federal de Viçosa, para LaTeX. Disponível em: http://bit.ly/teseufvlatex. DOI: 10.5281/zenodo.905784