EFFECTS OF ANTHROPOGENIC CHANGE ON INTERACTIONS BETWEEN NORTH AMERICAN TEPHRITID FLIES AND THEIR BIOTIC ASSOCIATES

BY

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DISSERTATION

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ABSTRACT

Anthropogenic environmental change is increasingly altering species ranges, community composition, and ecological interactions. Climate change, agriculture, invasive species, and human management of land all affect insect community dynamics, interactions between competitors and natural enemies, and invasive potential. In this thesis, I examine the effects of the following anthropogenic changes on tephritid fruit flies, *Rhagoletis pomonella* (Walsh) and *Zonosemata electa* (Say), and their competitors and natural enemies: climate change (simulated through an experimentally-induced heat effect), novel agricultural host plants, and land/weed management. *R. pomonella* is native to portions of North America and historically utilized hawthorn (*Crataegus* spp. (L.) fruits as its host. After the introduction of apples, a fruit larger than hawthorn berries, to North America by humans, *R. pomonella* made a host shift to apples, which provide a partial escape from natural enemies and competitors. Similarly, *Z. electa* made a host shift from native horsenettle, *Solanum carolinense* (L.)., fruits to introduced crops: peppers and eggplant. The first study employed experimental manipulation of temperature, sunlight, and fruit location to examine the effects of anthropogenic change and competition on parasitism, larval survival rates, and pupal weight in *R. pomonella*. The second study examined the effects of fruit location and trap baits (apples alone, apples with *R. pomonella* larvae, or *R. pomonella* pupae alone) on attraction to ants and also surveyed species composition in an unmanaged apple orchard. The third study surveyed *Z. electa* parasitism rates and infestation rates in *S. carolinense*. The results of the first study indicate that in *R. pomonella* the effects of temperature include lowering parasitism and larval survival rates, with interactions from the effects of competition. The results of the second study indicate that *R. pomonella* larvae are attractive to local ant species and that there are effects of tree location on ant attraction to baits. The results of the third study indicate that infestation rates of *Z. electa* in horsenettle are low compared to infestation rates in peppers and confirmed natural low parasitism rates by *Diachasmimorpha sanguinea* (Ashmead). These results combined provide a more complete overview of the effects of anthropogenic change on North American tephritids and their biotic associates and will inform future pest management strategies.

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Introduction

Rising global temperature affects insect populations in diverse ways, altering even the most basic ecological relationships (e.g., Brennan, Christie & York, 2009). Insect community dynamics change as temperature changes (Nooten *et al*., 2014), with temperature-mediated competitive interactions being important contributors to these dynamics (Rodríguez-Castañeda *et al*., 2017). The number of studies that have examined these interactions by direct experimentation is relatively small, but the emerging picture is of complex patterns which vary by species.

Climate change can alter interactions between intraspecific competitors. In the mountain pine beetle (*Dendroctonus ponderosae* (Hopkins) (Coleoptera: Curculionidae)), for example, models suggest that as winters warm intraspecific competition for resources will limit populations despite an increase in reproduction (Goodsman *et al*., 2018). Chemical communication in two-spot ladybeetle larvae, *Adalia bipunctata* (L.) (Coleoptera: Coccinellidae) is also altered by temperature, changing the oviposition behavior of conspecific females (Sentis *et al*., 2015).

Interactions between interspecific competitors are similarly affected. The dung beetles *Sisyphus rubrus* (Paschalidis) and *Euoniticellus fulvus* (Goeze) (Coleoptera: Scarabaeidae) show differential survival and emigration depending upon temperature, and experimental warming also shifted plant community structure in the presence of the beetles (Holley and Andrew, 2019). Differential larval survival and growth rates were found in multiple species of moth caterpillars in maize exposed to varying temperatures (Ntiri *et al.*, 2016; Sokame *et al*., 2019). The invasive potential of species can also be determined by temperature-mediated interactions with native species. The invasive garden ant, *Lasius neglectus* (Van Loon, Boomsma & Andrásfalvy) (Hymenoptera: Formicidae) has greater competitive success against native ant species at lower temperatures, whereas native species outcompete it in higher temperatures (Frizzi *et al*., 2017). The invasive fruit fly *Bactrocera invadens* (Drew, Tsura & White) outcompetes the indigenous tephritid, *Ceratitis rosa* (Karsch), at lower elevations but not at higher elevations in eastern central Tanzania. Climatic differences seem to be a determining factor in these elevational variations in occurrence (Geurts *et al*., 2010).

The foundation for understanding the effect of climate change on intra- and interspecific competition in phytophagous insect communities is understanding these interactions in the absence of climate change - how patterns of distribution and abundance are altered by competition under a single climate condition (Denno *et al*., 1995; Kaplan and Denno, 2007; Wu et al. 2020). Species with frugivorous larval stages are particularly prone to the effects of competition due to 1) fruit being a temporally limited resource and 2) the confinement of hatching larvae to the individual host fruit where they were deposited as eggs (Denno *et al*., 1995). Interspecific interactions among and within frugivorous species frequently result in competitive displacement, and the mechanisms involved can be specific to each pair of competing species (e.g., Feder, 1995a; Rwomushana *et al*., 2009). Because many frugivorous insects are agricultural pests, understanding how changing climate patterns can affect population dynamics and interactions has the additional dimension of great relevance to crop protection efforts. Among the more important frugivorus fruit pests are tortricid moths such as the Codling Moth (*Cydia pomonella* (L.)), weevils such as the Plum Curculio (*Conotrachelus nenuphar* (Herbst)), and many species of true fruit flies, family Tephritidae (Hendrichs, 1996; Dias *et al*., 2018); the Mediterranean Fruit Fly (*Ceratitis capitata*, (Wiedemann)) is considered by the USDA to be the world's most important agricultural pest (APHIS-USDA, 2020).

While some tephritids experience complete competitive exclusion (e.g., the tephritid *C. capitata* is replaced by the confamilial *B. dorsalis* at low elevations in Hawaii, Vargas *et al*., 1995), most experience only partial exclusion. However, survival and reproductive success can be significantly affected by interspecific interactions that fall far short of exclusion. Compounding these effects are biotic and abiotic factors such as temperature, host plant, and oviposition period (Dyuck *et al*., 2004; Rwomushana *et al*., 2009).

In this thesis I examine the potential effects of global warming on the apple maggot fly, *Rhagoletis pomonella*, and its community of natural enemies and competitors. I focus on effects in the American Midwest, which has experienced a nearly 1°C per year temperature rise in the last 100 years (Peterson & Heim Jr., 2013). I used experimental methods to simulate global warming in both controlled laboratory conditions, and, more importantly, in the field. Although this is a well-studied insect, there is no prior experimental work that directly addresses the effects of climate change on this key pest.

R. pomonella background, biology, and evolution

The apple maggot, *R. pomonella,* is an important pest of apple (*Malus domestica* (Borkh.)) orchards in the United States. Historically, this species laid eggs in native hawthorn fruits (*Crataegus* spp. (Gand.)), but in the mid-nineteenth century Walsh (1867) described a shift of *R. pomonella* from hawthorn to introduced domestic apple, citing it as an example of what would later be termed “host race formation” - races that have become partially reproductively isolated populations due to adaptation to different hosts (Jaenike, 1981). In the case of the apple maggot, the adaptations appear to relate to three primary factors: 1) difference in timing between fruiting of the two hosts (Bush 1969a, b), 2) a restriction on mating behavior to locations on or near the host fruit (Prokopy *et al.*, 1971, 1972), and 3) effects of host-associated negative trade-offs (heritable traits that confer a fitness advantage in one habitat but a disadvantage in alternative habitats) on larval survivorship (Feder 1995a). The apple host race emerges between mid-June to mid-July, whereas the hawthorn host race emerges between mid-August to early September (Filchak *et al*., 2000), leading to a difference of approximately 3-4 week in emergence times between host races. Eggs are deposited onto host fruits after flies mate on or near host plants. Finally, larvae develop within the fruit until they are ready to pupate, at which time they emerge from the fruit, dig into the soil, and pupate before entering diapause.

Within both apple and hawthorn host fruits, the primary competitors of apple maggot larvae are tortricid caterpillars (codling moth, *Cydia pomonella*) and plum curculio larvae (*Conotrachelus nenuphar*) (Ressig *et al*., 1998). Both of these competitors cause massive internal fruit damage limiting the resources available to apple maggots (Feder 1995a) and hatch from eggs laid earlier in the season than are apple maggots. As developmental time and growth in insects are often mediated by temperature (e.g., Gibert & Jong, 2001), and fruit ripens and putrefies faster in warmer temperatures, temperature may be an important mediator of these competitive interactions. Early species such as the two apple maggot competitors may outcompete later species due to size and development (e.g., Feder 1995a), and codling moth eggs and larvae are known to develop faster in warmer temperatures (Aghdam *et al*., 2009).

Ambient temperature, sunlight, and tree location may affect larval growth rate and survival. Moosavi *et al*. (2018) reported higher mortality of *Lobesia botrana* (Lepidoptera: Tortricidae) larvae in sun-exposed berries as compared to shaded berries. Apples are relatively large fruits and may offer some protection from sunlight and higher temperatures in parts of the apple (e.g., internal versus external fruit temperatures). Larvae that are pushed to the surface of the apple (via competition) may be unable to escape the potentially warmer outer portion of the fruit. Tree location affects both the amount of sunlight fruit receives and ambient temperatures and humidity, and it may therefore be an important aspect of survivorship and parasitism rates.

In addition to directly affecting survivorship, competitors can force apple maggots toward the surface of the host fruit, where they are more susceptible to attack by parasitoid wasps. Interspecific competition has the greatest effect in this regard, although intraspecific competition in hawthorns can also affect parasitism rates (Feder, 1995b). While many different braconids parasitize *R. pomonella* (Wharton and Marsh 1978), three predominate: *Diachasmimorpha mellea* (Gahan) (also known as *Biosteres melleus*, van Atcherberg and Maeto 1990; *Opius melleus* Gahan 1915; and *Biosteres rhagoletis*, Richmond 1915), *Utetes canaliculatus* (Gahan) (also known as *Opius lectus*, Gahan 1919 and *Opius canaliculatus*, Gahan 1915), and *Diachasma alloeum* (Muesebeck) (Rivard 1967; Dean and Chapman 1973; Maier 1981). All three species have similar biology. The wasp lays its eggs into late-instar apple maggot larvae and the wasp larvae develop after the host has pupated (Lathrop and Newton 1933; Prokopy and Webster 1978; Feder 1995b). The immature wasps then eat the host and overwinter inside the fly puparia. *B. melleus* examine the surfaces of both abscised and attached fruit, while *U. canaliculatus* search primarily on abscised fruits (Feder 1995b). Adult *U. canaliculatus* emergence is asynchronous with the development of apple host race of *R. pomonella* larvae, making them an important parasitoid only on hawthorn host race *R. pomonella*

Temperature and duration of temperature treatments significantly affect survival and fitness of *Diachasmimorpha longicaudata* (a braconid parasitoid commonly mass-reared for use as biological control agents against various tephritid species) (Cai *et al*., 2019). Apple maggots may be more resistant to heat than their parasitoids (Thomas Powell, personal communication, 2019), which would result in reduced parasitism rates as temperatures rise. Such differential heat resistance could have important consequences for apple maggots that are forced to warmer areas of the fruit due to competitors, as parasitoid wasp larvae may experience higher mortality at early developmental stages.

Given the global threat of tephritid flies as invasive pests (e.g., Leblanc *et al*., 2019; Follett *et al*., 2019; Qin *et al*., 2019), understanding how host-parasite dynamics interact with temperature will be increasingly important as climate patterns shift, allowing for species and time-appropriate management measures (including the use of biological control agents).

Hypotheses and predictions

Intraspecific competition can decrease survival and fitness of apple maggot larvae and increase parasitism rates in hawthorns and possibly apples (Feder 1995 a, b) due to interactions between larval location and local temperature. Pupal mass was used as a measure of fitness, independent of survivorship because decreased pupal mass results in slower maturation and lower fecundity for females (Averill and Prokopy, 1987). I varied the temperature experienced by developing larvae under field and laboratory conditions to test two broad hypotheses about the effects of temperature on parasitism and survivorship in *R. pomonella*:

Hypothesis 1: Higher temperatures fundamentally reduce rates of parasitism in *R. pomonella*, with a greater decrease in *R. pomonella* larvae experiencing interspecific competition.

Hypothesis 2: Higher temperatures fundamentally lower *R. pomonella* survival and pupal mass across both competition types (interspecific and intraspecific) but will have a greater negative effect in *R. pomonella larvae* experiencing intraspecific competition.

While direct behavioral changes are not being examined in this study, Hypothesis 2 is complicated due to the known interactions between parasitism rates, type of competition, and host fruit type. As an example, hawthorn race apple maggots have higher rates of parasitism when in fruits with non-conspecific competitors. Higher temperatures are predicted to have a greater effect on apple maggot survival rates in hawthorns, due to their smaller size, than in apples. However, as Hypothesis 1 states that higher temperatures will lower parasitism rates. As parasitoids lower condition and eventually kill their host, it cannot be expected that there is no effect of lowered parasitism rates on survival and pupal mass. Specific predictions for how parasitism rates and *R. pomonella* survival and pupal masses will respond to combinations of heat, competition type, and host fruit are presented in Table 1. Unheated (control) scenarios are expected to correspond with the findings of Feder (1995a,1995b) - lower survival rate and higher parasitism rates only in hawthorns in which *R. pomonella* larvae experience interspecific competition. With the addition of heat, parasitism rates are expected to universally decrease based on unpublished observations from the Feder laboratory (Thomas Powell, personal communication, 2019). In hawthorns, interspecific competition has been shown to increase parasitism rates markedly because competitor larvae force *R. pomonella* larvae toward the surface of the fruit, where they are more susceptible to attack by parasitoids (Feder 1995a). Despite likely higher initial parasitoid egg numbers (not measured in this study), as compared to the control with intraspecific competition, parasitism rates are expected to decrease the most in heated hawthorns containing both *R. pomonella* and interspecific competitor larvae.

Survival rates and pupal weights are predicted to show a more complicated pattern than parasitism rates. Larval survival is expected to be inversely related to parasitism rates; such a relationship is often not met due to interspecific predators, pathogens, and random death from various causes. In general, the death of parasitoid wasp larvae before they can cause lethal damage to their host *R. pomonella* is expected to increase overall fly survival rates. However, as apples are larger fruits and thus provide better buffering of temperature changes, parasitized *R. pomonella* larvae near the center of the apple (their preferred location) may not experience enough heat to kill the wasp larvae. Larvae in interspecific competition apples are known to feed nearer the surface of the apple (Feder 1995b), so wasp larvae parasitizing them are more likely to be affected by the heat, and survivorship of the *R. pomonella* larvae is expected to increase due to decreased parasitism. Survival rates in heated hawthorns are expected to increase in both types of competition (as compared to unheated treatments of the same competition type), as the smaller fruits cannot provide escape from heat at the core, and parasitoid larvae will be preferentially killed by the heat. Heat is expected to lower pupal mass in *R. pomonella* as it does in other taxa (e.g., Markwick *et al.*, 2009; Tanjung *et al*., 2017). Pupal weights are predicted to be affected by both parasitism and competitors in a complicated manner, similarly to the predictions of survival rates. Competitors lower available food resources, while parasitism reduces body condition (Feder 1995b). Even sub-lethal parasitism (e.g., heat killing parasitoid larvae prior to apple maggot pupation) may reduce mass. However, in my study, pupal weights and parasitism rates were not compared. Thus they are only mentioned together as a possible complicating factor. Another possible complicating factor is that of faster decay of fruits at warmer temperatures, which may affect the availability of the fruits as a food source and habitat for the larvae within.

Materials and Methods

Design, features, and rationale for Experiments 1-4

I performed four experiments to assess the effect of temperature, sunlight, or tree location on interactions between *R. pomonella*, its competitors, and its parasitoids (Table 2). Experiment

1 consisted of placing heating enclosures over the fruiting apple trees and represented the most natural conditions, encompassed nearly the entire development of the larvae, and offered parasitoid wasps unhindered access to the fruits (and the larvae within) during most of the experiment. However, maintaining experimental conditions for the duration of the experiment was difficult. Because the hawthorn trees in the study were in locations with too much human traffic to allow enclosure of the trees, I was able to do this experiment only on apples. Once fruits fell, I collected them within 24 hours, so that after that time wasps were unable to parasitize any larvae.

Experiment 2 consisted of using walk-in environment chambers, which allowed for the most control and could be performed on both fruit types. Conditions in these rooms, however, differed substantially from field conditions; parasitism rates could not be calculated accurately because oviposition opportunities for wasps were temporally limited. Finally, the larvae developed in controlled temperatures only for the last part of the larval stage, as fruits were left in natural conditions on the tree until they abscised and were collected.

In Experiment 3, I examined the natural effects of sunlight on fruit temperature and larval outcome by manipulating shade / sun on the fruits. Parasitoid wasps had the full range of time in which to parasitize larvae. However, parasitoid wasps may have had difficulty finding fruits to parasitize the *R. pomonella* larvae, and this experiment was conducted on apples due to the high risk of disturbance by humans near the available hawthorn trees.

Experiment 4 compared fruits from trees in the interior of the orchard to tree on the edge of the orchard. Conditions were realistic and did not physically hinder access by parasitoids. Apples used in the study were collected within 24 hours of abscising, so wasps may not have had the full range of time available for parasitizing *R. pomonella* larvae. This experiment involved only apples only due to the high risk of disturbance by humans near the available hawthorn trees.

Study Sites

All apple host race data were obtained from an apple orchard owned by the University of Illinois (Figure 1.1). The orchard was originally planted in the early 1980s and included 625 trees (5 trees each from 125 different crosses/accessions). By the early 1990s, the orchard was no longer managed and was used only intermittently as a site for monitoring phenology of insects in the absence of insecticide sprays. It also served as a source for apple pests for research in the current research orchard, which was established in 2006 (R. Weinzierl, personal communication, 2019). The orchard is located at the corner of Race Street and Windsor Avenue, in Urbana, IL (approximate latitude 40.083°, longitude 88.214°). All images of locations were generated using Google Earth (Google, 2019).

Hawthorn host race data were obtained from hawthorn trees located at the Orchard Downs student housing center at 1841 Orchard Place, in Urbana, IL (~ 40.0966162,-88.2156693) (Figure 1.2). This site was selected because all six trees near the North Laundry had a history of high *R. pomonella* infestation rates, high parasitization rates, and high frequency of occurrence of competitor species (McPheron et al, 1988).

Larval rearing procedures used in all experiments

After counting *R. pomonella* oviposition marks as a proxy for number of larvae, as most oviposition punctures contain one egg (Reissig *et al*., 1990, Feder 1995a), I placed each fruit in a Solo® cup with a wire false bottom (apples) or a condiment cup (Crystalware brand, top diameter: 29.7cm, height: 3.3cm, bottom diameter: 3cm) (hawthorns) so that larvae could fall out of the fruit to the bottom of the cup for collection. Cups were placed in climate-controlled environment chambers (apples; ~24°C based on local average July temperatures) or incubators (hawthorn fruits; ~19°C based on local average September temperatures). Fruits were checked daily at approximately 8:00 pm for puparia or larvae that had not exited the apple in preparation to pupate. After one month, fruits were removed from the cups and dissected to record for additional competitor or fly larvae within the fruits. All puparia were weighed at the time of collection. Puparia were maintained for two weeks in moist vermiculite (Figure 1.3) in individual condiment cups and then placed in a cold room (approximately -8°C) for eight weeks to simulate overwintering. At the end of the overwintering period, puparia were dissected to count third instar parasitoids in order to assess parasitism rates.

Scoring of fruit

Fruit were scored as either having the presence of interspecific competitor oviposition scars or exit marks or competitor damage found in fruit during fruit dissection or no apparent presence of non-conspecific competitors. Because tortricid moths (*Cydia pomonella* and *Grapholita packardi*) lay eggs on the surface of leaves or fruit and emerging larvae bore into the fruit (Ohlendorf, 1999), while plum curculio leave a crescent-shaped mark as they oviposit (Antonelli *et al*., 1992), the presence of interspecific or intraspecific competitors can be easily distinguished while they are still in the fruit (Figure 1.4).

R. pomonella survivorship and pupal mass

Survivorship was calculated as the number of *R. pomonella* maggots emerged from a fruit divided by the number of *R. pomonella* oviposition marks in the same fruit. Pupae were not dissected out of puparia, so pupal mass was a measure of both pupa and puparia. Puparia were weighed using a balance accurate to four decimal places of a gram. The balance used was of an enclosed design to prevent disturbance by airflow, which could affect minute measurements.

Data loggers

The data loggers (Lascar EasyLog EL-USB-2-LCD) have a capacity of 16,000 readings and a temperature range -35 to +80°C. The loggers are weather-resistant, but to ensure no damage occurred all loggers were placed inside red plastic Solo cups ® (top diameter: 8.89 cm, bottom diameter: 5.72 cm, height: 10.8 cm) hung upside-down to act as a shield from rain. Wire was threaded into a small hole at the bottom of the cup and formed a loop for the logger clip to hang from, and another loop external to the cup was used to hang the logger and shield from the tree.

Experiment 1 (heating enclosures): temperature effects on apple host race in field conditions

Experiment 1 was a field experiment to examine effects of temperature and competition type on *R. pomonella* larval survival and parasitism rate. I used a block design using passive heating enclosures for Experiment 1. Small passive heating structures have previously been used to study the effects of climate warming on plant and terrestrial insect communities (Barton *et al*., 2009), but as this experiment enclosed entire apple trees (divided into two compartments) with their fruits, extensive modifications were needed. In 2018 (June 15 to July 30), three trees (n = 3) were surrounded by PVC structures divided into two equal heating and control treatments, measuring 2.4 m wide (1.2 m width per treatment), by 2.4 m deep, by 3.7 m high. Each length of pipe was joined with standard PVC three-way joints. Placement of the structure was such that each treatment side received approximately equal amounts of sun and shade and contained approximately equal total numbers of apples (Figure 1.5a). One-half of each target tree was surrounded by greenhouse plastic with an open top system and openable panels (Figure 1.5b-c) at the bottom to allow airflow as needed by day to maintain a 3-5°C temperature increase. This temperature range was chosen based on the results of Shen *et al*. (2014), which showed that a difference as slight as 3°C can have a significantly negative effect on survival rates and puparial mass in *Bactrocera cucurbitae* (Coquillett) and *B. tau* (Walker) in competition with one another (as compared to either species when competing only with conspecifics). The panels at the bottom were added after an initial test in 2017 showed the enclosures could increase temperature to up to 10°C above ambient during peak daytime temperatures without being vented, which could potentially kill *R. pomonella* larvae (data not shown). The other half of the tree was surrounded by Loboo Idea® fiberglass screen mesh to replicate the visual and physical barrier while still allowing airflow to maintain ambient temperatures. Two additional trees were used as a control with one side surrounded by mesh and one side left open to compare temperature, parasitism rates, and fly infestation rates to ensure that apples on branches enclosed in the mesh did not differ from unenclosed apples.

Trees (Figure 1.6) were selected based on previous year infestation rates as measured by yellow panel and red sphere sticky traps hung in trees to trap adult flies (data not shown). Temperatures were recorded using data loggers as described in Section 1 of Methods. Temperatures of all heating enclosures were taken both inside and outside and compared to Willard Airport air temperatures (Midwestern Regional Climate Center, 2018) to ensure accuracy of data loggers (Appendix A). Abscised apples were collected each morning at approximately 8:00 am and brought into a temperature-controlled room (approximately -8°C) to rear out larvae.

Experiment 2 (environment chambers): temperature effects on both host races in laboratory conditions

Experiment 2 was a laboratory experiment to examine effects of temperature and competition type on *R. pomonella* larval survival rate and pupal mass. In 2018, fruits were collected from either the orchard (apples: July 18) or Orchard Downs (hawthorn: September 6) to be scored for competition type. Each fruit was placed in a cup (see Larval rearing in Methods). Fruits were placed in either control or heated (5°C higher than respective control) conditions. Two hundred of each fruit species were used (n=50 per treatment per competition type). All data were recorded in order of exit of larvae, based on Feder (1995a), who documented a significant difference in the competitive effect of other *R. pomonella* larvae between hawthorns and apples.

Experiment 3: effects of sunlight versus shade

Experiment 3 was a field experiment to examine effects of sunlight and competition type on *R. pomonella* larval survival and parasitism rate. On July 18, apples from each target tree were collected. After oviposition marks were scored, apples were divided into fruit with either 'apple maggot larvae only' or 'apple maggot plus non-conspecifics' categories based on oviposition/entrance marks, and all were dissected after the conclusion of the experiment to ensure there were no signs of competitor larval damage in the fruit. Only fruits with at least medium levels of competition (as per Scoring section of Methods) were used for the apple maggot larvae only treatment. For each treatment (n=50 apples of each competition category per treatment), individual apples were placed in red Solo cups with the cup bottom replaced with screen to allow drainage while preventing larvae from falling through. Cups were then placed in clear plastic bins to prevent them from falling over, and the bins were placed next to an apple tree in the orchard. Shade treatment bins were placed in the shade of the tree, while sun treatment bins were placed next to the tree in full sun. Pupae were collected each morning at approximately 8:30 am and then reared as per larval rearing methods.

Additional apples were measured with a temperature probe (Traceable® Digital Dial Thermometer °C) at depths of 1 cm, 2 cm, and at the core to assess differences of temperature at varying depths within the fruit. Measurements were not taken on experimental fruits, because punctures to the apple might affect rotting time and larval survival within.

Experiment 4: effects of internal versus edge trees

Experiment 4 was a field experiment to examine effects of tree location on *R. pomonella* larval survival and parasitism rates. Temperatures of trees at the edge of the overgrown orchard (n=6) and trees at least 5 meters from the edge (n=6) were taken at hourly intervals using the data loggers described. Only July 18, the area below and around each tree was cleared of all abscised apples to ensure that only apples that abscised after the start of the experiment were collected. Apples from each tree were allowed to abscise and remain on the ground for 24 hours before collecting to ensure all parasitoid wasps had time to oviposit. Each apple was scored by competition type, and oviposition marks were counted. Fifty each of apples with only apple maggot larvae or apples with apple maggot larvae plus conspecifics were collected (first 8-9 apples encountered after per tree) and then taken into the laboratory for larvae to be reared as per larval rearing methods

Statistical analyses for all 4 experiments

A pilot analysis of *R. pomonella* survival rate and parasitism rate data revealed that they were sufficiently normally distributed that standard analysis of variance methods could be used for the analysis. While the raw data were not always perfectly parametric (e.g, ,parasitism rates, due to zero rates in some fruits), all model residuals passed tests for normality and homoscedasticity by visual inspection of residual plots, Shapiro-Wilk tests for normality, and Levene tests of homogeneity of group variances. A paired, 2-tailed ANOVA was carried out for Experiment 1 to test whether individual trees were a source of significant variation, as each tree contained both the control and the heated apples. Because individual trees did not significantly contribute to variation, data were pooled across trees for subsequent experiment 1 standard two-tailed ANOVAs. Two-way ANOVAs were also the standard carried out for experiments 2-4.

Experiment 1: paired two-way analyses of variance were conducted with parasitism rates and *R. pomonella* survival rates as the dependent variables and temperature treatment as the independent variable. Experiment 2: two-way analyses of variance were conducted with parasitism rates and *R. pomonella* survival rates as the dependent variables and temperature treatment as the independent variable. Experiment 3: two-way analyses of variance were conducted with parasitism rates and *R. pomonella* survival rates as the dependent variables and sun treatment as the independent variable Experiment 4: two-way analyses of variance were conducted for parasitism rates and *R. pomonella* survival rates (respectively) as the dependent variable and tree location as the independent variable. All analysis of variance and post-hoc tests were conducted in R (R Core Team, 2016) using tidyverse (Wickman 2016), lmerTest (Kuznetsova 2017), emmeans (Lenth, 2018), visreg (Burchett 2017), and car (Fox and Weisberg 2019) packages.

Results

Experiment 1 (heating enclosures): temperature effects on apple host race in field conditions

Efficacy of the partial enclosures for increasing temperature

The temperatures within the enclosures were consistently higher than external temperatures (overall internal means: 25.9C, σ = 5.3°C; overall external means: 24.0°C, σ = 4.4°C). The paired temperature records for two digital loggers in Tree 1 (n = 1752 readings per location; internal mean: 26°C, σ = 5.4°C; external mean: 24.1°C, σ = 4.4°C), one external to the enclosure and one internal to the enclosure, are plotted against time/dates for the summer of 2018 (Figure 1.7, Figure 1.8). The internal and external temperatures are very similar at night, but the internal temperatures are consistently higher in midday. Thus, enclosures heat the space they enclose in daily pulses.

Temperature effects on apple host race in field conditions

Total mean survival rate per apple (n=1115 apples) averaged 10% (σ = 19%). In the paired ANOVA, parasitism rate was significantly lowered by the effects of both interspecific competition ($p = 2\times10^{-4}$, F = 43.7, df = 1) and heat treatment ($p = 1.9\times10^{-3}$, F = 20.5, df = 1), while interactions between effects of competition type and treatment were not significant (p = 0.051, F = 5.3, df = 1). When the data are pooled (pairs ignored) both effects of interspecific competition (p = <0.001, F = 21.8, df = 1) and heat (p = <0.001, F = 58.1, df = 1) significantly lowered parasitism, but in this case the interaction is also significant (p = 0.005, F = 7.9, df = 1) (Figure 1.9a). Total mean survival rate per apple (n=1115 apples) averaged 39% (σ = 19%). For larval survival with the paired data, the effects of competition type (p = 0.946, F = 0.0, df = 1), heat treatment (p = 0.797, F = 0.1 , df = 1), and the interaction between treatment and competition type (p = 0.409, F = 0.8, df = 1) were all not significant. When the data were pooled, none of the tests were close to significant, either (type of competition: p = 0.299, F = 1.1, df = 1; treatment: p = 0.205, F = 1.6, df = 1; interaction: p = 0.299, F = 1.1, df = 1) (Figure 1.9b). Means for survival rate and parasitism rate for Experiment 1 pooled data are shown in Table 3.

Experiment 2 (environment chambers): temperature effects on both host races in laboratory conditions

In the apple host race, total mean larval weight per apple (n=200 apples) averaged 0.009 g (σ = 0.005 g). In the apple host race pupal weight is affected significantly only by the effects of competition type (p < 0.001, F = 36.4, df = 1), with an increase in survival in fruits with both conspecifics and non-conspecifics, although the effects of treatment are nearly significant (p =

0.062, F = 3.5, df = 1). The effects of treatment (p = 0.062) and interactions between competition type and treatment had no effect (p = 0.546, F = 0.4, df = 1) on pupal weight (Figure 1.10a). Total mean larval survival rate per apple (n=200 apples) averaged 41.7% (σ = 17.4%). The effects of heat (p = 0.008, F = 7.2, df = 1) and the interaction between heat and interspecific competition (p = 0.031, F = 4.7, df = 1) increased *R. pomonella* survival rates. Effects of type of competition were not significant (p = 0.922) on survival rates (Figure 1.10b).

In the hawthorn host race, total mean larval weight per hawthorn fruit (n=200 hawthorn fruits) averaged 0.0083 g (σ = 0.007 g). The effects of interspecific competition lowered survival rate (p = 0.003, F = 8.8, df = 1) and the effects of heat increased it (p = 0.011, F = 606, df = 1). There was no effect of interaction between treatment and type of competition (p = 0.084, F = 3.0, df = 1) (Figure 1.11a). The effects of interspecific competition significantly lowered survival rate (p = 0.003, F = 8.9, df = 1), and there was a significant interaction between the effects of treatment and type of competition (p = 0.037, F = 4.4, df = 1), resulting in the lowest survival rate in *intraspecific fruits* in the control treatment. Treatment alone had no significant main effect (p = 0.165, F = 1.9, df = 1) on survival rate (Figure 1.11b). Summaries of means for both host races are found in Table 4. Mean survival rates ranged from 40% in *interspecific hawthorn fruits* under controlled conditions to 57% in *intraspecific hawthorn fruits* under controlled conditions, while mean pupal weights ranged from 0.0080 g in interspecific hawthorn fruits under heated conditions to 0.0089 g in interspecific apple fruits in controlled conditions (Table 4).

Experiment 3: effects of sun versus shade

Total mean larval survival rate per apple (n=100 apples) averaged 44.1% (σ = 16.5%). Survival rates were lower in shade treatments (p < 0.001, F = 21.0, df = 1) and when competing against interspecific larvae (p = 0.038, F = 4.3, df = 1). There was also an interaction between the effects of treatment type and competition type which lowered survival rate the most in *interspecific apples* in the shade treatment (p = 0.047, F = 3.9, df = 1). (Figure 1.12a). Total mean parasitism rate per apple (n=100 apples) averaged 12.2%. Parasitism rates were lower in sunlight treatments (p = 0.007, F = 7.4, df = 1) and when *R. pomonella* larvae were competing against interspecific larvae (p = 0.002, F = 10.4, df = 1). There was also a significant interaction between the effects of treatment type and competition type resulting in lowest parasitism rates in intraspecific larvae in sunlight treatments (p = 0.028, F = 4.9, df = 1) (Figure 1.12b) (Table 5).

Experiment 4: effects of internal versus edge trees

Total mean larval survival rate per apple (n=100 apples) averaged 43.1% (σ = 17.3%). Survival rates were higher in larvae from edge trees (p = 0.049, F = 4.0, df = 1). Type of competition (p = 0.079, F = 3.2, df = 1) and the interaction between tree location and type of competition (p = 0.315, F = 1.0, df = 1) had no effect on survival rates (Figure 1.13a). Total mean parasitism rate per apple (n=100 apples) averaged 13.8% (σ = 18.3%). The effect of treatment (p = 0.054, F = 1.1, df = 1), type of competition (p = 0.303, F = 3.8, df = 1), the interaction between the two factors (p = 0.653, F = 0.2, df = 1) had no effect on parasitism rates (Figure 1.13b) (Table 6).

Discussion

While climate change is understood to affect insects, few studies have experimentally examined the effects of temperature on population dynamics among phytophagous insects and their natural enemies (*e.g.*, Geurts *et al.*, 2010; Sentis *et al.*, 2015; Ntiri *et al.* 2016; Frizzi *et al.*, 2017; Goodsman *et al.*, 2018; Holley and Andrew, 2019; Sokame *et al*. 2019). This study provides the first experimental data on the effects of temperature on interactions between tephritid fruit flies, their competitors, and their natural enemies in both field and laboratory conditions.

Experiment 1 was unique, as the partial enclosures designed to heat one half of each of the 3 experimental trees were previously untested in *Rhagoletis* research, or any other research that I am aware of, necessitating that effectiveness and accuracy of the enclosures be assessed. This experiment provides new methods for experimentally manipulating temperature of fruits in the field. The passive heating enclosures were effective in realistically heating a portion of each target tree without killing the apple maggot larvae within. This experiment was also the first to examine in *R. pomonella*, and possibly all insects, the interactions between increased heat, type of competition, larval survival and pupa mass (proxies for fitness), and parasitism — under field conditions as well as in the laboratory. *Experiment 2* examined only the effects of increased heat on interactions between *R. pomonella* and its competitors in laboratory conditions. *Experiments 3* and *4* examined anthropogenic changes from different approaches, with *Experiment 3* focusing on the effects of sunlight and *Experiment 4* examining edge effects. The results of final two experiments are important as humans continue to alter natural ecosystems and create patchy fragments of natural and managed plant communities.

Parasitism rates were affected by temperature and parasitism, with a decrease in the number of parasitized larvae in heated fruits and an increase in parasitism in fruits with interspecific competition (e.g., larvae of more than one species present), as predicted. Survival rates did not vary with temperature or competition, consistent with previous results (Feder 1995a, 1995b). While humidity and temperature were controlled as best as possible within chambers, both fluctuated with daily and hourly weather, which could have affected the outcome. Higher humidity rates in the heated chambers could have increased rot of the apples or otherwise made them less suitable, thereby reducing survival and lessening the effects of higher survival in the heated (experimental) group seen in the other experiments in this study.

Feder (1995a) found a significant effect of competition type on both survival rate and pupal weight in hawthorns but not in apples. While I found that type of competition had an effect on pupal weight and survival rate in hawthorns, in apples I found an effect of competition on pupal weight but not on survival rate (as predicted). These results would seem to be contradictory, given that pupal weight is a proxy for fitness. However, parasitism rates, which can influence survival rate and pupal weight, were not measured in this experiment. Moreover, larvae experienced the same uncontrolled natural conditions until the apples were abscised and therefore were already well into their development. Furthermore, this experiment was the least natural of the four conducted, as fruits were brought into a controlled laboratory environment. Many environmental stressors that would be found under natural conditions (e.g., parasitoids or fluctuating temperatures and humidity levels) were not present in this experiment and may account for these results. Despite these limitations, significant interactions were found in hawthorn race larvae. Hawthorns, as a much smaller fruit than apple, provide less of a buffer against temperature differences, less space to avoid competitors, and easier access to larvae by parasitoid wasps. These results support my predictions as well as support the conclusions that larger apples offer an escape from natural enemies and competitors (Feder, 1995b). Further studies on the effect of fluctuating climactic conditions versus steady differences in heat and humidity are warranted.

Higher rates of survival in intraspecific apples and apples placed in the sun, as well as the interaction between the two factors, suggests that both factors are important in moderating the survival rate of the apple host race of *R. pomonella*. While the effect of competition type was not significant on survival rate of *R. pomonella* larvae in apples previously (Feder, 1995a), my study has both temporal (~25 years) and geographical (Michigan versus Illinois) differences. It is likely that the populations of flies, competitor species, and parasitoids, along with multiple environmental factors, differ between the two studies. Additionally, the methodology between the two studies is not identical, which may further complicate attempts at direct comparisons between the two. Parasitism rates were lower in intraspecific apples and apples in the sun, with an interaction between type of competition and treatment. My results also suggest that apples that fall in sunny, warmer locations provide a better host until the larvae emerges to pupate. This study cannot offer a mechanistic explanation, but I speculate that they are many possible factors, including an increase of visibility to female parasitoid wasps in the open (reducing numbers of parasitoids) and warmer temperatures (selectively reducing rates of parasitoid larvae survival). Because apples are large fruits, an increased rate of decay may not make apples less suitable, as proposed in Feder (1995a). I did not test hawthorn fruits in this study as the available hawthorn trees with medium to high rates of infestation by *R. pomonella* were in a location subject to high levels of disturbance by people. As rate of emergence affects pupal weight in hawthorn race *R. pomonella*, future studies should test the effect of rot rates on pupal weight and survival rate in both host fruits.

Higher rates of survival along edge trees support the results from Experiment 3 (sun vs shade), as edge trees experience more sunlight. While neither type of competition nor the interaction had significant effects, the general trend of treatment being the most significant effect was consistent across experiments. Neither main effects nor interactions were significant for parasitism rates in this experiment, although treatment effect was near significance. There are likely additional factors that were unaccounted for in this experiment (e.g., specific tree location, tree height, underbrush species surrounding each tree) whereas in Experiment 3, the same trees were used for both treatments. Additionally, although only a small number of sampling of readings was taken, mean internal humidity and temperature in the orchard were both higher than at the edge, which could confound results. Finally, the sample size of this experiment was half that of *Experiment 3*, and a larger sample size may yield more robust evidence of the effects of type of competition and interaction. Even so, the results are not unexpected as compared to Feder's (1995a) findings.

Across all four experiments, a general pattern of the effect of temperature on apple parasitism rates emerges, consistent with my hypothesis 1. Effects on survival rate are less clear, but overall, this study shows that heat alone decreases survival rate, consistent with hypothesis 2, but interactions with interspecific competitor larvae and host fruit generally complicate this pattern such that survival cannot be easily predicted in heat treated larvae. These results are likely related, as previous work (Feder 1995a, 1995b) suggests that parasitism rates are a primary driver behind lower survival rates in *interspecific hawthorn fruits*. As compared with apples, a stronger pattern the effects of temperature emerges from smaller hawthorn fruits, which may offer less buffering from temperature, easier access to larvae by parasitoid wasps (especially when larger interspecific competitors push them toward the surface of the fruit, as in Feder 1995b), and fewer overall resources. Edge effects appear to be a less important factor on both survival and parasitism rates. Treatment (edge vs interior) effects were significant only for survival rates but approached significance for parasitism rates. This difference in significance is likely due to many confounding factors, such as increased humidity inside the orchard as compared to the edge and differing levels of predation on the wasps. Future studies with hawthorn fruits need to be done in order to compare to my results, which are primarily in apples.

It is predicted that patterns seen in apples will be magnified in hawthorns, which have more intense competition and higher parasitism rates (Feder 1995). Warming temperatures are also more likely to have a greater effect on both apple maggot larvae and parasitoid larvae in the smaller hawthorn fruits, which offer little buffer against temperature.

While it is unlikely that climate change will impact tephritids and their biotic associates in the same and equal ways across all ecosystems, this study gives insight to the effects of anthropogenic climate change and management practices on tephritid species in temperate zones. As anthropogenic factors continue to alter native ecosystems, pest management practices will need to adapt. These findings will help inform future management practices and add to the understanding of temperature effects on biological control agents such as parasitoid wasps. Additionally, these results help provide a foundation for improved forecasting of population dynamics of tephritids under climate change.

Figures

Figure 1.1: Location of the apple orchard used in all Chapter 1 experiments with the orchard circled in red. Individual trees used can be found under experiment-specific methods. Inset shows larger surrounding area for reference.

Figure 1.2: Hawthorn trees used in all Chapter 1 hawthorn experiments, with trees labeled 1-5 in the magnified inset.

Figure 1.3: After pupation, all *R. pomonella* puparia were placed in condiment cups on moist vermiculite. Another layer of moist vermiculite was placed over the puparia to simulate puparia in soil.

Figure 1.4: A. Entry hole of codling moth (Washington State University Extension 2019) B. Apple maggot oviposition sting (Grigg-McGuffin 2014) C. Plum curculio oviposition damage (Longstroth 2013)

A **B** **C**

Figure 1.5: Heating enclosure design from Chapter 1, *Experiment 1*. A. PVC frame used as a base for the heating enclosures. B. heated side as shown from outside. C. heated side as shown from the inside.

Figure 1.6: Locations of each tree used in in Chapter 1, *Experiment 1*, heating enclosure experiment in the field.

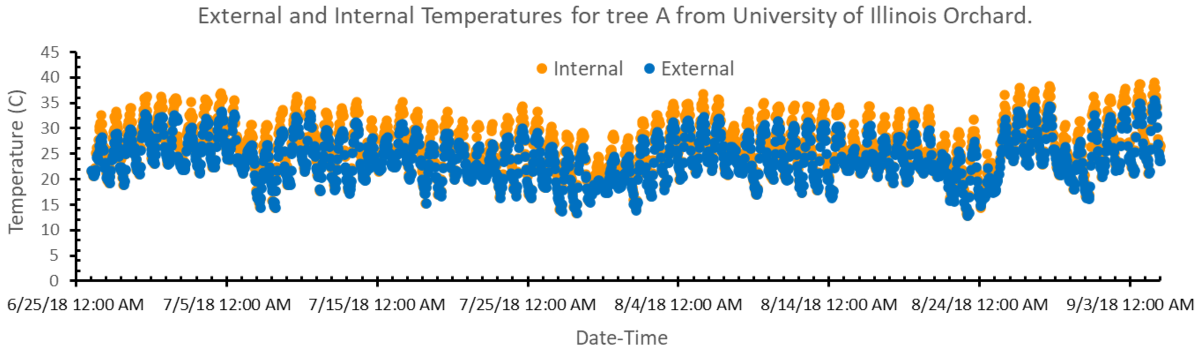


Figure 1.7. Temperatures recorded with digital recorders outside of passive heating enclosure (external, control) and inside of passive enclosure (internal, experimental). Total span of data recording was June 25 to September 9, 2018, but 1 day was trimmed from the beginning of the data series, and 5 days from the end, to obtain intuitively spaced numbers for the X-axis (inside tick marks represent 1 day intervals). Internal data points were graphed behind the external points. Note the consistency of the internal temperature increase across the entire study period.

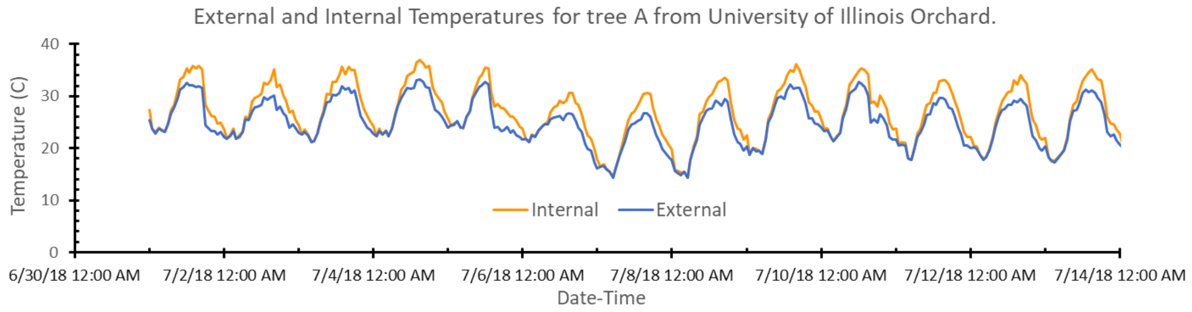
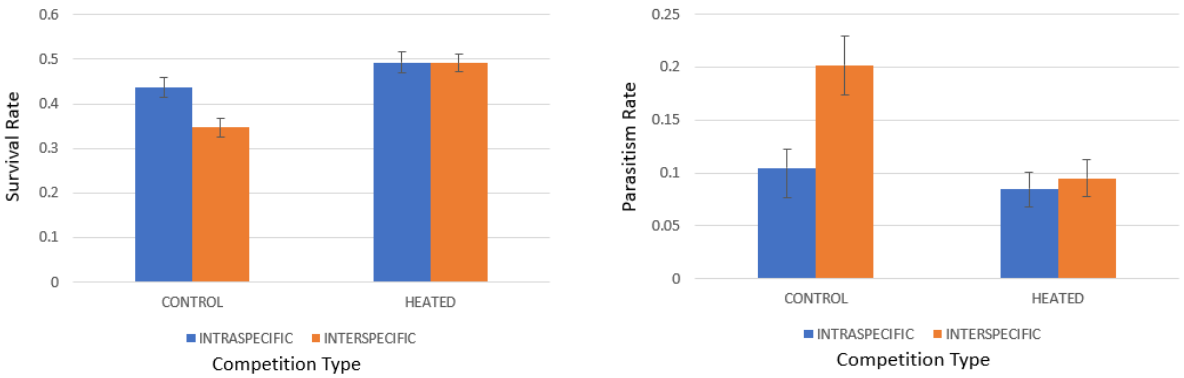
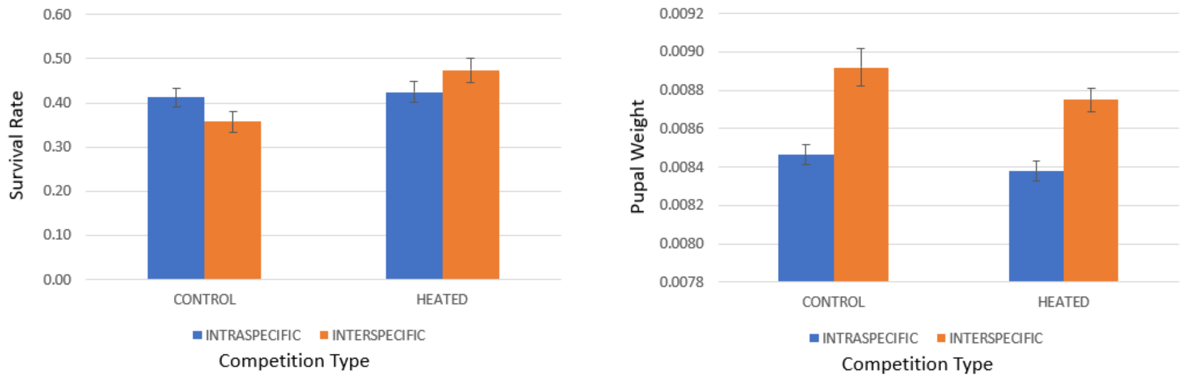


Figure 1.8. Two-week sub-set of temperatures from Figure 7, showing temperature changes in external and data logger positions. Dates graphed are July 1 to 14, 2018. The essentially identical internal and external temperatures at night, and higher external temperatures only during daytime, are quite apparent.



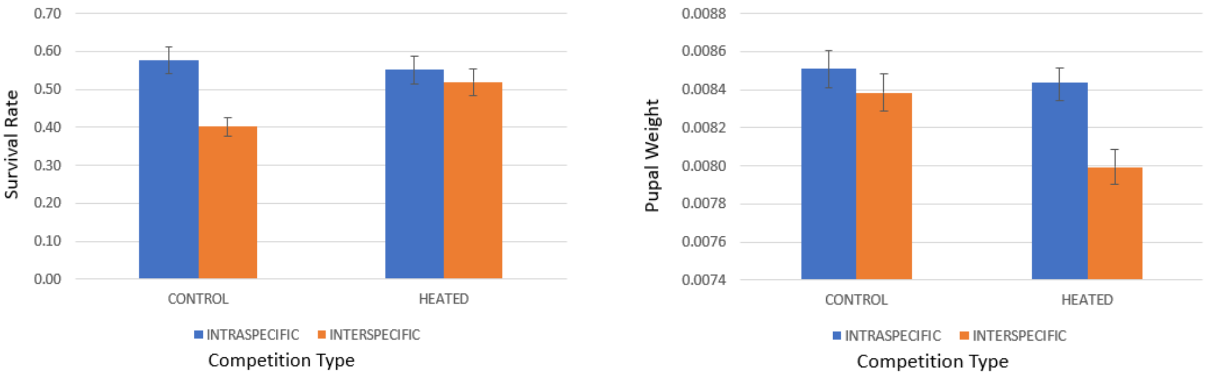
A B

Figure 1.9. *Experiment 1* (heating enclosures field experiment). Apple host race *R. pomonella* larvae. Comparisons of apples with *R. pomonella* and only conspecifics (intraspecific) or *R. pomonella* and non-conspecifics (interspecific). A. Mean parasitism rates ± 1 SE graphed against treatment with interactions by competition type. Type of competition is the only significant source of variation ($p < 0.001$). B. Mean survival rates ± 1 SE graphed against treatment with interactions by competition type. Treatment type ($p = 0.008$) and interaction between treatment type and competition type ($p = 0.031$) are the only significant sources of variation.



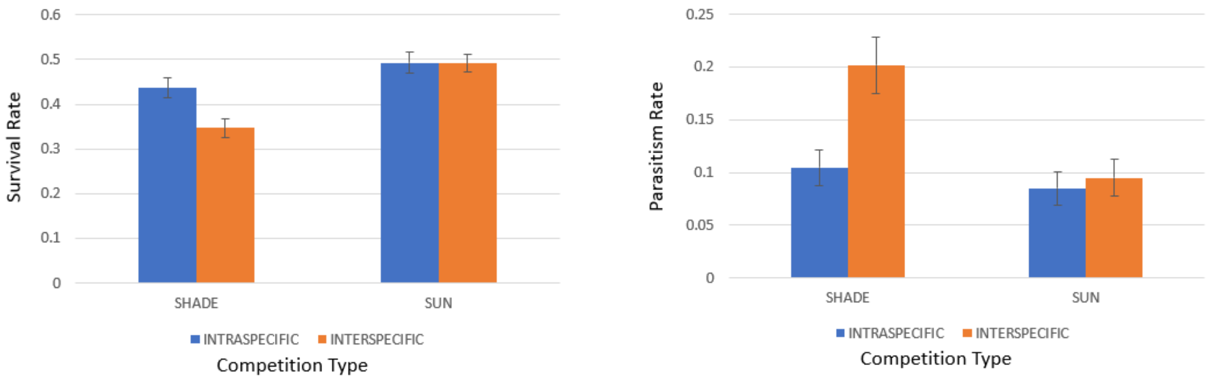
A B

Figure 1.10: *Experiment 2* (environment chambers laboratory experiment). Comparisons of apples with *R. pomonella* and only conspecifics (intraspecific) or *R. pomonella* and non-conspecifics (interspecific). A. Mean pupal weights ± 1 SE graphed against treatment with interactions by competition type. Type of competition is the only significant source of variation ($p < 0.001$). B. Mean survival rates ± 1 SE graphed against treatment with interactions by competition type. Treatment type ($p = 0.008$) and interaction between treatment type and competition type ($p = 0.031$) are the only significant sources of variation.



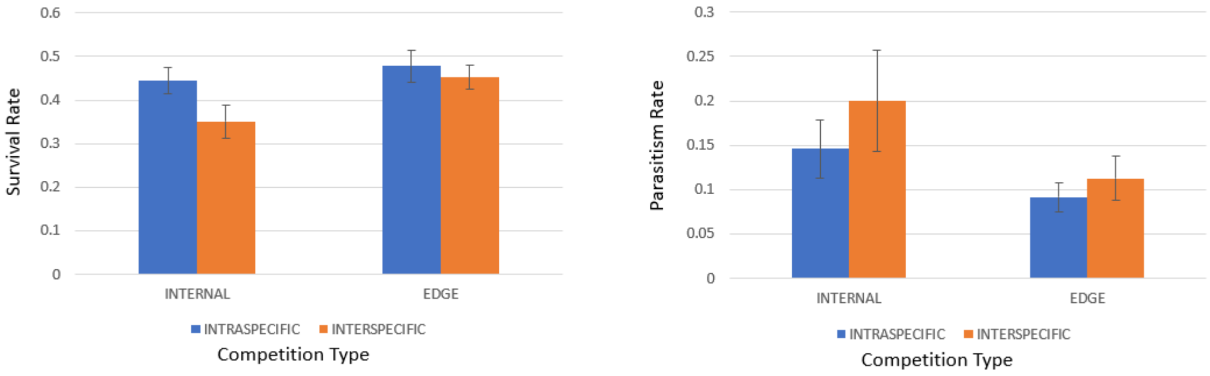
A B

Figure 1.11: *Experiment 2* (environment chambers laboratory experiment). Comparisons of hawthorn fruits with *R. pomonella* and only conspecifics (intraspecific) or *R. pomonella* and non-conspecifics (interspecific). A. Mean pupal weights ± 1 SE graphed against treatment with interactions by competition type. Type of competition ($p = 0.003$) and treatment type ($p = 0.011$) are the only significant sources of variation. B. Mean survival rates ± 1 SE graphed against treatment with interactions by competition type. Type of competition ($p = 0.003$) and treatment type ($p = 0.011$) are the only significant sources of variation.



A B

Figure 1.12: *Experiment 3* (sunlight vs shade field experiment). Comparisons of apples with *R. pomonella* and only conspecifics (intraspecific) or *R. pomonella* and non-conspecifics (interspecific). A. Mean survival rates ± 1 SE graphed against treatment with interactions by competition type. Both type of competition and treatment, as well as the interaction between the two factors was significant. B. Mean parasitism rates ± 1 SE graphed against treatment with interactions by competition type. Both type of competition and treatment, as well as the interaction

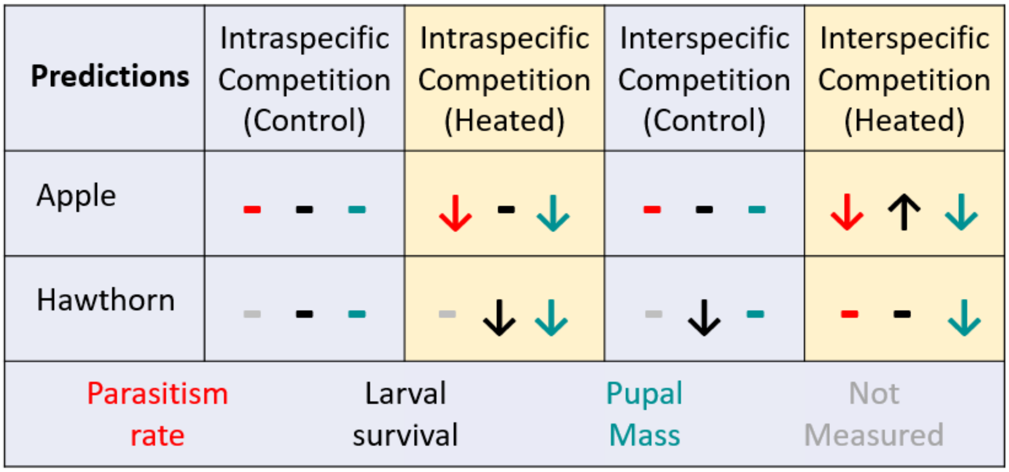


A B

Figure 1.13: *Experiment 4* (internal vs edge effects field experiment). Comparisons of apples with *R. pomonella* and only conspecifics (intraspecific) or *R. pomonella* and non-conspecifics (interspecific). A. Mean survival rates ± 1 SE graphed against treatment with interactions by competition type. Only treatment was significant. B. Mean parasitism rates ± 1 SE graphed against treatment with interactions by competition type. Neither factor nor interaction was significant.

Tables

Table 1.1. Predicted effects of interaction of host fruit, type of competition, and heat on parasitism rate (**red**), survival rate of apple maggot larval (**black**) and mass of apple maggot pupa (**blue**). Arrow up indicates a predicted increase, while arrow down indicates a predicted decrease. Dash indicates no change, as compared to 'Intraspecific Competition (control)' for each respective fruit. Heat treatment columns are highlighted in yellow. Parasitism rates were not tested in hawthorns.



Predictions	Intraspecific Competition (Control)	Intraspecific Competition (Heated)	Interspecific Competition (Control)	Interspecific Competition (Heated)
Apple	- - -	↓ - ↓	- - -	↓ ↑ ↓
Hawthorn	- - -	- ↓ ↓	- ↓ -	- - ↓

Parasitism rate Larval survival Pupal Mass Not Measured

Table 1.2. *Experiments 1-4* strengths and weaknesses of each Chapter 1 study in assessing effects of temperature on competition and parasitism rates

	Experiment 1: Heating Enclosures (field)	**Experiment 2: Environment Chambers (lab)**	**Experiment 3: Effect of Shade vs. Sun (field)**	**Experiment 4: Effect of Interior vs Edge Trees (field)**
Design	Passive heating enclosures built around one half of apple tree, other half with insect netting as a control	Abscised fruits brought into climate-controlled rooms	Abscised fruits were collected and placed in cups under the shaded portion of a tree or the unshaded portion of the same tree	Apples grown on either interior or edge trees were allowed to abscise before being taken into the lab for larvae to be reared in climate-controlled rooms
Strengths	1. More realistic 2. ~Fall larvae development 3. Parasitoids not physically hindered	1. Easier to control 2. Both fruits	1. Non-manipulated effects of sun 2. Parasitoids not temporally hindered	1. Non-manipulated effects off tree location 2. Parasitoids not physically hindered
Weaknesses	1. Less controllable 2. Apples only 3. Small temporal limitation to parasitoids	1. Less realistic 2. Limited time in controlled temperatures 3. Did not measure parasitism	1. Possibly physical hinderance to parasitoids 2. Apples only	1. Apples only 2. Small temporal limitation to parasitoids

Table 1.3: *Experiment 1* results. Means of survival rates and parasitism rates in apple, pooled data.

Host	Competition Type	Treatment	Survival Rate	Parasitism Rate
Apple	Intraspecific	Shade	43%	10.5%
Apple	Intraspecific	Sun	49%	8.5%
Apple	Interspecific	Shade	35%	20.2%
Apple	Interspecific	Sun	49%	9.5%

Table 1.4: *Experiment 2* results. Means of survival rates and pupal weight in both host races of *R. pomonella* larvae.

Host	Competition Type	Treatment	Survival Rate	Pupal Weight (g)
Apple	Intraspecific	Control	41%	0.0085
Apple	Intraspecific	Heated	42%	0.0084
Apple	Interspecific	Control	36%	0.0089
Apple	Interspecific	Heated	47%	0.0087
Hawthorn	Intraspecific	Control	57%	0.0085
Hawthorn	Intraspecific	Heated	55%	0.0084
Hawthorn	Interspecific	Control	40%	0.0084
Hawthorn	Interspecific	Heated	52%	0.0080

Table 1.5: *Experiment 3* results. Means of survival rates and parasitism rates in apple host races of *R. pomonella* larvae.

Host	Competition Type	Treatment	Survival Rate	Parasitism Rate
Apple	Intraspecific	Shade	44%	10.5%
Apple	Intraspecific	Sun	49%	8.5%
Apple	Interspecific	Shade	35%	20.2%
Apple	Interspecific	Sun	49%	9.5%

Table 1.6: *Experiment 4* results. Means of survival rates and parasitism weight in apple host races of *R. pomonella* larvae.

Host	Competition Type	Treatment	Survival Rate	Parasitism Rate
Apple	Intraspecific	Internal	44%	14.6%
Apple	Intraspecific	Edge	47%	9.2%
Apple	Interspecific	Internal	35%	20%
Apple	Interspecific	Edge	45%	11.3%

Table 1.7. Results of testing Hypotheses 1 and 2 in Experiments 1-4, Chapter 1.

Hypothesis	Host	Experiment	Intraspec. comp.	Interspec. comp.
1. parasitism	apple	1. paired	reduced	reduced
	apple	1. pooled	reduced	reduced
	apple	2.	not examined	not examined
	apple	3.	reduced	reduced
	apple	4.	NS	NS
2. survival	apple	1. paired	NS	NS
	apple	1. pooled	NS	NS
	apple	2.	increased	increased
	apple	3.	increased	increased
	apple	4.	increased	increased
2. mass	apple	1. paired	not examined	not examined
	apple	1. pooled	not examined	not examined
	apple	2.	NS	NS
	apple	3.	not examined	not examined
	apple	4.	not examined	not examined
2. survival	haw	1. paired	not examined	not examined
	haw	1. pooled	not examined	not examined
	haw	2.	NS	NS
	haw	3.	not examined	not examined
	haw	4.	not examined	not examined
2. mass	haw	1. paired	not examined	not examined
	haw	1. pooled	not examined	not examined
	haw	2.	reduced	reduced
	haw	3.	not examined	not examined
	haw	4.	not examined	not examined

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CHAPTER 2: CHARACTERIZING ANT SPECIAL SPATIAL ARRANGEMENTS AND ATTRACTION TO *RHAGOLETIS POMONELLA* (TEPHRITIDAE: DIPTERA) LARVAE IN AN UNMANAGED APPLE ORCHARD

Introduction

Many tephritid fruit flies are major pests of fruits and other plant structures in North America. The medfly (*Ceratitis capitata*), for example, is a pest of more than 300 species of fruit and vegetable (Szyniszewska and Tatem, 2014). Its establishment in California alone is predicted to have economic costs of over $1 billion as a consequence of control efforts and markets losses due to embargo / quarantine (Siebert and Cooper, 1995). Much of the literature on biological control of tephritids has focused on parasitoid wasps, which oviposit into tephritid eggs or larvae while they are still in the fruit (e.g., Ayala *et al*., 2018, Calla *et al*., 2015, Haran *et al*., 2019). However, ants are another potentially important group that may limit tephritid populations through predation (e.g., Allen and Hagley 1990, Peng & Christian 2006, Abdulla *et al*., 2017). Assessing the efficacy of ants as biological control agents for tephritids will require information on key variables, including specific-specific attraction to fruit fly life stages or infested fruit as prey, and the spatial variation in ant identity and abundance in relation to the tree hosts. Tree species, orchard management, and tree location all impact any species diversity and interaction with tephritid prey (e.g., Fernandes *et al*., 2012).

Ecology of the apple maggot, Rhagoletis pomonella

Apple maggots historically utilized native North American hawthorn fruits (*Crataegus* spp.), but by 1867 had undergone a host shift in New England to cultivated apples (*Malus domestica*), introduced from Europe (Walsh 1867). Subsequently, the apple maggot became an enormously important agricultural pest, such that quarantines and phytosanitation methods are often required to export applies to apple maggot-free areas, increasing costs for growers (e.g., Hong *et al*., 2019).

Like many other tephritids, *R. pomonella* causes direct damage to fruit via puncture marks made during oviposition and larval feeding on fruit pulp. This damage contributes to early rot and drop in fruit, can make fruit unsalable, and result in substantial economic losses. Apple maggots are often managed using insecticidal sprays (e.g., Reissig, 2003, Wise *et al*., 2020). However, concerns related to pesticide toxicity to non-target species, the evolution of insecticide resistance, and the cost of spraying have increased interest in integrative pest management practices. One such method that has proven effective is supporting natural enemies to reduce populations of pest insects.

Parasitoid wasps are useful in lowering numbers of many tephritid species over time, as they decrease the number of larvae that survive to adulthood and subsequently reproduce (Ayala *et al*., 2018; Calla *et al*., 2015, Haran *et al*., 2019). However, there are multiple drawbacks to relying solely on parasitoid wasps for apple maggot control, including low parasitism rates (Feder 1995) and high temperatures (Chapter 1). Rising global temperatures (NASA/GISS 2016) may therefore reduce the ability of parasitoid wasps to control apple maggot. Of immediate concern is the fact that any damage from apple maggot to apples can result in unsalable fruit. Moreover, *R. pomonella* adults from previous years could still emerge from the soil and cause a season of loss to a grower.

As low efficacy of parasitoid wasps is a concern for their use as sole biological control agents in tephritids, a few studies have examined alternatives to use in place of, or in conjunction with, parasitoid wasps. Biological control agents of particular value would be those that can prevent oviposition, either by reducing population size before mating or by deterring oviposition directly. Ants have a long history of use in agriculture for management of pests, and ancient Chinese farmers cultured citrus ants to protect citrus crops (Huang and Yang, 1987). Multiple ant species defend coffee berries from berry borers (Escobar-Ramírez *et al*., 2919), two species of ants have been investigated as biological control agents against the tea mosquito bug (Peng *et al.*, 1997; Sreekumar *et al.*, 2019), and weaver ants have potential as biocontrol agents for a multitude of pests (e.g. Peng and Christian, 2008;). Some species of ants may meet the criterion of reducing or preventing oviposition for apple maggot biological control. For example, arboreal weaver ants (*Oecophylla* spp.) can reduce losses due to tephritid fruit flies in mangos grown in Africa and Australia (e.g., Abdulla *et al*., 2017; Peng & Christian, 2006). Weaver ants have negative effects on parasitoid reproductive success. However, the fruit flies are more strongly suppressed by the ants than the parasitoids, making weaver ants a potential biological control agent (Migani *et al*., 2017). In addition to some historical reports of arthropod predation of larvae and pupae (e.g., Good 1915, Ceasar & Ross 1919, Hall 1940), Allen and Hagley (1990) characterized predation of apple maggots by epigeal arthropods, including ants, in Ontario. A variety of factors affect the ability of ants to prey on larvae as they emerge from the soil in preparation to pupate, including host tree, location of tree, soil moisture, and soil impaction (Fernandes *et al*., 2012; Dinis *et al*., 2015; Abeijon *et al*., 2019), so each crop system must be investigated to characterize ant species and systems in which they may be used in biological control.

In this chapter, I report the results of ecological observations and experiments designed to test the attraction of ants to the apple maggot, *Rhagoletis pomonella* (Diptera: Tephritidae). I asked three questions related to spatial variation and ant foraging ecology with the *Experimental* survey: 1. Does ant diversity or abundance vary between the edge and interior of the orchard? 2.

Does the presence of fruit fly larvae / pupae increase attractiveness of fruit to ants? 3. Which ant species are mostly likely to act as predators of fruit flies in this system? Based on preliminary examination of the ant community in my experimental plot , and the results of Fernandes *et al*. (2012), I made three taxon-specific predictions: 1. The genera *Myrmica* and *Formica* are the primary ant predators of apple maggots and will subsequently be more common in traps baited with fly larvae / pupae. 2. *Tapinoma sessile* (Say) is primarily attracted to sugar resources provided by apples and only opportunistically feeds on small or dead apple maggot larvae. Therefore *T. sessile* will be most common in traps with apples regardless of the presence of apple maggot larvae. 3. Due to its preference for nesting in open areas or at forest edges (Trager, 1984), *Nylanderia parvula* (Mayr) predation will be observed primarily along the edge of the orchard. Predictions are summarized in Table 1.1.

Methods and Materials

Study Location and Trapping

All data were obtained from an apple orchard owned by the University of Illinois at Urbana-Champaign, located at the corner of Race Street and Windsor Avenue in Urbana, IL (approximate latitude 40.083°, longitude 88.214°). The orchard was originally planted in the early 1980s to assess 125 different crosses/accessions. 5 trees of each cross, for a total of 625 trees were planted at that time to establish the orchard. The orchard was allowed to overgrow by the early 1990s, and it was used subsequently only to monitor insect phenology in the absence of insecticides. In 2006, an adjacent, managed orchard was planted, and the original orchard became a rich source for apple pests for use for research (Rick Weinzierl, personal communication). The orchard understory is composed of both native and non-native species including poison ivy (*Toxicodendron radicans* (L.)) and three invasive species: Amur honeysuckle (*Lonicera maackii* (Rupr.), lesser burdock (*Arctium minus* (Hill)), and American pokeweed (*Phytolacca americana*(L.)). Non-native plant species impact many arthropod communities (e.g. Loomis and Cameron, 2014). *L. maackii*, for example, has negative effects on native forest caterpillar communities (Stireman III *et al.*, 2014) and alters population dynamics between native and introduced mosquito populations (Muturi *et al.*, 2015). The introduced species are more common at the edge of the orchard, while poison ivy and other small, herbaceous plants are more common in the interior. Little to no management of weeds occurs on the interior of the orchard, while the edges are frequently trimmed back and managed, creating distinct plant populations under the edge trees as compared to interior trees. The edge of the orchard is composed of short-mown lawn which is heavily managed.

To assess species at the edge and the interior of the orchard, pitfall traps used in all surveys consisted of red Solo® cups (top diameter: 8.89 cm, bottom diameter: 5.72 cm, height: 10.8 cm). Soil was removed to the depth of the cup so that the top of the cup was level with the surrounding soil. No preservative was used in the cups because it could potentially alter the attraction of ants to the traps. A ring of petroleum jelly was placed approximately 3 cm above the highest point of the bait to prevent caught ants from escaping, and ants trapped in the petroleum jelly were counted. Ants were collected the following day (picked up in the same order in which they were placed). The contents of each trap were placed in vials (labeled by trap number) in 70% ethyl alcohol to be identified later. Ants were identified to genus using *Ants of North America: a guide to the genera* (Fisher and Cover, 2007) and to species using AntWeb (2018). The presence of one or more ants of a given species in a trap was denoted as a “1”, while the absence of the species was denoted as a “0” (see *Statistical Analysis* below). Specific methodology for each survey can be found in their respective sections below.

Overview of surveys on ant species and ant attraction to apple maggot in the UIUC orchard

The experiments were based on three separate collections of ants: *Survey*, *Exploratory*, and *Experimental*. The *Survey* collection (summer 2017) consisted of identifying all ant species collected in 10 unbaited pitfall traps (Appendix B) and provided baseline information on the ant community at the orchard. The *Exploratory* collection (summer 2018) used unbaited pitfall traps at edge and interior areas to examine spatial variation in ant communities at the orchard (Figure 2.2). Finally, the *Experimental* collection consisted of placing replicate sets of 4 trap types at edge and interior orchard locations (Figure 2.3), with each set containing a trap with no bait, with apples only, with apples plus apple maggot larvae, and only apple maggot puparia (Figure 2.4).

Preliminary survey

Each tree in the orchard was assigned a number, and ten numbers were drawn using a random number generator. A single pitfall trap (as described in *Study Location and Trapping*) was placed at each randomly drawn location.

Exploratory survey

Each apple tree in the orchard was assigned a number. To ensure each portion of the orchard was surveyed, the orchard was divided into three vertical sections: left (7 rows of trees), center (8 rows), and right (7 rows). Then 15 exterior and 15 interior trees were drawn for sampling using a random number generator for a pseudo-randomized design of least four internal and four external traps were in each section. To simplify trap placement, each selected tree was then assigned a number from 1 to 15 for exterior trees or from 16 to 30 for interior trees (Figure 2.2). At each randomly selected tree, a pitfall trap was placed in the morning (beginning at 7:00 am) on July 15, 2017 for one 29-hour window of sampling.

Experimental Survey

The apple orchard was divided into 20 rows following the original planted rows of apple seedlings (22 original rows, both exterior rows were excluded). On July 14, 2018 each of the following pitfall traps was placed 5 cm apart at each location: no bait, baited with apple with no larvae, baited with apple with larvae, baited with puparia (no apple) (Fig. 3). To ensure ants could find the traps, the edges of each trap were lightly rubbed with the bait (exterior of apple, oviposition mark, or puparia) before being placed into the trap. All apples and puparia were collected from under a single tree and were selected based on only having apple maggot oviposition marks so as to remove confounding factors of apple variety and other species in the apple. Apples were also selected based on size (all measured between 49 and 53 mm wide) and number of oviposition marks (6-10 oviposition marks for the apples plus larvae category, 0 oviposition marks for the apples only category). One full set of all four traps was placed at the edge of each row and at approximately the same depth into the orchard (interior trees) along each row (Fig. 3). All pitfall traps were placed at the northernmost point of the chosen tree. Therefore, all edge pitfall traps were exposed to sun for a portion of the day, while interior traps remained under the shade of the canopy. 2.5 cm of soil was placed in the pitfall trap, and apples were placed atop the soil (replicating an abscised apple). Puparia were placed at a depth of 1.25 cm in the soil. All fallen apples, debris, and undergrowth were removed from a 0.6x0.6 m area around the traps. Traps were placed in the early morning (~7 am) on a sunny day following three sunny days and were picked up the following afternoon (~12 pm) in the same order they were set. Ants from the traps were placed in vials containing 70% ethyl alcohol. All apples in the "apple plus larvae" category were dissected at the end of the experiment to ensure larvae were present in the apples, and at least 3 larvae were confirmed present in each apple.

Statistical Analyses

Using worker abundance as a measure of activity can be problematic due to interspecific differences in foraging behavior, colony densities, and worker size (Bestelmeyer *et al.,* 2000). Therefore, I used a conservative measure of "occurrence" by scoring each species as either present or absent in each trap (i.e. if any species of ant was found in a trap, it was marked with a "1" to indicate presence, and if not, it was marked with a "0" to indicate absence.).

Species composition was assessed with a relative occurrence table. To assess spatial composition, contingency X^2 tests were performed due to the binary nature of the data (with Yates correction for continuity used in all cases, not mentioned henceforth). Where sample sizes were small, bivariate Fisher's exact tests were used. Interactions were tested using bivariate tests (X^2 or Fisher's exact) and, for more complicated interactions between three variables (e.g., species, bait status, and trap location), multiple two-way tests were carried out and all strong interactions identified. Pooling across treatments to test a single variable runs the risk of obscuring interactions, but, again, interactions were detected first with bivariate tests; moreover, the gain in power from pooling is necessary because of the relatively small sample sizes (full details in Table 2.1).

Results

Preliminary Survey

This initial survey (Table 2.2) revealed the presence of the five generalist ant species in the apple orchard in which subsequent experiments took place, in order of abundance from greatest to least: *Tapinoma sessile, M. americana* (Weber), *F. pallidefulva* (Latreille), *M. spatulata* (Smith), and *N. parvula* (Table 2.4).

Exploratory Survey

All species found in the *Preliminary* survey were also found in this survey. In addition to the species found in the *Preliminary Survey,* this collection revealed the presence of *Camponotus pennsylvanicus*, a wood-inhabiting species that is very rare in the orchard (Table 2.3). Order of abundance, from greatest to least, for this survey was as follows: *T. sessile, M. americana, F. pallidefulva, M. spatulata, N. parvula*, and *C. pennsylvanicus* (Table 2.4). Ants, as a whole and as individual species, were as likely to be captured in the interior as at the edge of the orchard ($p = 0.920$, $\chi^2 = 0.01$, $df = 1$), although there was a non-significant trend for more captures at the edge of the orchard than at the interior when considering individual species ($p = 0.108$, $df = 5$). Presence of a species was not significantly affected by location of a trap in the interior or the edge of the orchard.

Experimental Survey

An edge effect of more ants detected at the edge of the orchard ($p = 0.014$, $\chi^2 = 6.0$, $df = 1$) was found in the *Experimental* survey when data from all traps with ants were pooled across all species and trap treatments. However, ant catch in traps containing no bait did not differ experimentally ($p = 0.233$, $\chi^2 = 1.4$, $df = 1$) between captures at the edge versus the interior. There was a non-significant trend for more captures at the edge, as was the case for the (unbaited) traps in the *Exploratory* survey. Particular ant species were more likely to be captured at the edge in the *Experimental* trappings ($p << 0.001$, $\chi^2 = 45.33$, $df = 4$) when data from all 4 trap treatments were pooled, and the same finding was obtained for traps with apples containing larvae ($\chi^2 = 18.11$, $p = 0.001$, $df = 4$).

Bait status had a pronounced effect on total trap captures ($p < 0.001$, $\chi^2 = 34.7$, $df = 3$). The order (from most captures to least) was apple with larvae, apple only, puparia, no bait. In a more narrowly focused test, traps baited with apples caught almost 200% as many ants as traps without bait (species pooled), and traps with apples plus larvae caught almost 150% as many ants as traps with apples only (p = 0.010, χ^2 = 9.2, df = 1). Additionally, there were interactions between location of trap and bait status, with a significant difference in species composition in interior versus edge traps baited with apple plus larvae and in interior versus edge traps baited with puparia only.

Discussion

This study has yielded new information on ant attraction to apples and their insect fauna. I examined how ant occurrence in pitfall traps varied in response to spatial position and the presence of fruit or apple maggot larvae / pupae at an orchard in central Illinois. Ants may affect fruit fly population dynamics, and potentially control of *R. pomonella* and other tephritids. In addition, some of these findings will facilitate further study on the effects of climate change on the ecology of *R. pomonella*, its ant predators, and the interactions between them. As so little is known about ant-*Rhagoletis* predatory interactions, much of this work was exploratory, with the aim of revealing which species may be mostly likely to interact with *Rhagoletis,* and the goal of identifying hypotheses to test in future experiments.

Ants are often habitat specialists, with edge habitats generally, and orchards in particular, attracting a particular community of species (Altieri and Schmidt, 1984; Bolger *et al*., 2000). I did not see evidence for spatial variation in ant occurrence in the *Exploratory* survey. However, the *Experimental* survey, which explicitly was designed to detect differences between the edge and interior, did reveal edge and interior dwelling ants. Two species, *M. spatulata* and *N. parvula*, appear to be specialists, the former on the edge, and *N. parvula* on the interior, in contrast to my prediction based on nest site descriptions by (Trager 1984). Three other species, *M. americana*, *F. pallidefulva*, and *T. sessile*, appear to be generalists with respect to edge vs interior. The extent to which these spatial niche divisions are relevant to commercial apple production remain to be tested. Altieri and Schmidt (1984), working with a depauperate ant community in commercial orchards, reported a more equal distribution of ants between edge and interior, at least in organic apple orchards.

Most ants are dietary generalists. However, they still need to balance carbohydrate (typically plant-based) and protein (typically insect-based) resources to meet the diverse needs of the colony (Pontin 1978, Stadler and Dixon 2005). Taxon-specific responses to these resources can provide insight into which nutritional needs are limiting for each species (Dussotour and Simpson 2009). With respect to the baited traps, ants generally responded to food in traps, with apple + larvae preferred to apple alone, which was preferred to puparia alone, which were more attractive than traps with no bait. This pattern suggests both that apples are attractive, likely due to the presence of carbohydrates, and that ants can detect apple maggot larvae in the fruit. Exactly what cue ants respond to when they to detect larvae is unknown, but possible candidate sources include damage made to the fruit by boring larvae and increased rot to the fruit. Due to the study methods (baited traps sunk into the soil), it is unlikely the ants respond to close-range factors such as vibrations resulting from larval movement.

Myrmica and *Formica* species have been previously reported to prey on tephritid larvae (e.g., Fernandes *et al.*, 2012), but, prior to this study, it was unknown whether they are opportunistic predators or actively seek out larvae and/or pupae. Observations of the natural history and behavior of the ants suggest *M. americana* and *T. sessile* are attracted to the apple itself, with no significant attraction to larvae or puparia. It is likely these species are attracted to the apples as a sugar source and may only opportunistically feed on larvae. *Tapinoma sessile* was predicted to be primarily attracted to the apples as a carbohydrate source, but it was unexpected that such was also the case with *M. americana*. Both species are common, with *T. sessile* being the most abundant (found in 29 traps in the *Exploratory* survey and in 118 traps in the *Experimental* survey), followed by *M. americana* (found in 28 traps in the *Exploratory* survey and in 80 in the *Experimental* study). In contrast, *F. pallidefulva* was attracted to and likely preys upon apple maggot larvae in the orchard, supporting my prediction of *Formica* species attraction to apple maggot. Nineteen of the total traps in the *Exploratory* survey and 62 in the *Experimental* study contained this species. *N. parvula* was found primarily in the interior of the orchard, with only one edge trap containing this species in the *Exploratory* survey and none in the *Experimental* survey, contrary to my prediction that it would be an edge specialist. This species does not seem to be attracted to apples (with or without larvae) but it may be attracted to the apple maggot pupae. However, as only seven traps from the *Exploratory* survey and 15 in the *Experimental* survey contained this species, significant differences may be an artifact of the low numbers of this species in this orchard.

Other species were not attracted to any of the baited traps in substantial numbers. *Myrmica spatulata* was found primarily at the edge of the orchard, with only 4 interior traps containing this species in the *Exploratory* survey and none in the *Experimental* study. No significant enhancement of trap catch with the use of any baits was found with this species, which thus is likely to be an opportunistic predator of apple maggot larvae or pupae. *Camponotus pennsylvanicus* was found in only two traps in the *Exploratory* survey and none in the *Experimental* study, suggesting that its preferred habitat of rotting wood is not abundant in this orchard.

There likely are trophic niche differences between these communities that would have become apparent if I had been able to sample the entire insect community at edge and interior and had data collected on the exploitation of these communities by arthropods generally. Future studies should examine ant predation on puparia in the soil and on *R. pomonella* larvae in apples still on the tree. Hawthorn fruits, which are smaller than apples, may also provide apple maggot larvae less protection from ant predators and/or may provide fewer obstacles for ants seeking larvae. Competitor larvae (moths and weevils) in the fruit are also known to drive apple maggot larvae toward the surface, which may make them easier targets for foraging ants. Such interactions with parasitoid wasps as the natural enemy have been conducted (e.g., Feder 1995), but similar studies have not been done with ants. Finally, in this study I examined ant predation only within an apple orchard, so future studies under hawthorn trees are needed to confirm this speculation.

These findings will be useful as concern for excessive pesticide usage, and an increased interest in preserving natural enemies of pests, grows over time (e.g. Wilkins *et al.*, 1994; Gross, 2014; Settele and Settle, 2018; Ullah and Nawab, 2019). Culturing appropriate ant species to manage orchard pests has a long history (Huang and Yang, 1987), and ants are increasingly considered as biological control agents. This study offers the first examination of which species are attracted specifically to apple maggot larvae and pupae, and these results will help to inform integrative orchard pest management decisions.

Tables

Table 2.1. Specific questions asked with tests and rationale used for each question.

Specific question	Surveys	Tests Used and Rationale
Spatial Questions		
Are ants, as a whole, more common at the edge or in the interior of the orchard?	Exploratory, Experimental	Contingency X^2 (with Yates correction for continuity in all cases, not mentioned henceforth) on number of traps with ants vs. no ants pooled across all species
	Experimental	X^2 test only the "no bait" results of number of traps with ants vs. no ants pooled across all species
Are particular ant species more common at the edge or in the interior of the orchard? (Spatial x species interactions)	Exploratory	Contingency X^2 test on trap results across the 6 species
	Exploratory	Contingency X^2 test on trap results pooled across all 4 trap treatments to maximize statistical power
		Contingency X^2 test on only the traps baited with apples with larvae, as this is the bait that is closest to what the ants normally encounter in fallen apples in the orchard
Bait Attraction Questions		
When ant species are pooled, do the 4 bait treatments differ in number of traps with ants? (Are some bait treatments more attractive than others?)	Experimental	X^2 on traps with ants irrespective of species with an expected number of 1/4 of the total ants for each trophic treatment
Do traps with apples catch more ants than unbaited traps? (Is there a general tendency for the orchard ants as a whole to be attracted to carbohydrates?).	Experimental	X^2
Do traps baited with apple maggot larvae as well as apples catch more ants as a group than traps with apples? (Is there a general tendency for the orchard ants as a whole to be attracted to insect prey?)	Experimental	X^2
Interaction Questions		
For particular species, do the 4 bait treatments each capture different numbers of ants at the orchard edge than the orchard interior?	Experimental	Four Contingency X^2 tests, one for each bait treatment

Table 2.2. Ant species in each trap in the *Preliminary* trappings. Tree number corresponds with locations in Fig. 1. Rows at the bottom are the total number of traps with a given species.

Tree	***Formica pallidefulva***	***Myrmica americana***	***Myrmica spatulata***	***Nylanderia parvula***	***Tapinoma sessile***
1	1	1	0	0	1
2	0	1	1	0	1
3	1	1	1	0	1
4	1	1	1	0	1
5	1	1	1	0	1
6	0	1	0	0	1
7	1	0	1	0	1
8	1	1	0	1	1
9	0	1	0	1	1
10	1	0	1	0	1
Total	**7**	**8**	**6**	**2**	**10**

Table 2.3. Ant species in each trap in the *Exploratory* trappings. Tree number corresponds with locations in Fig. 2. Trees 1-15 are edge trees, while trees 16-30 are interior trees. Rows at the bottom are the total number of traps with a given species, total number of edge traps with a given species, and total number of interior traps with a given species.

Tree	***Formica pallidefulva***	***Camponotus pennsylvanicus***	***Myrmica americana***	***Myrmica spatulata***	***Nylanderia parvula***	***Tapinoma sessile***
1	1	0	1	1	0	1
2	1	0	1	1	1	1
3	1	0	1	1	0	1
4	1	0	1	0	0	1
5	0	0	1	1	0	1
6	1	0	1	1	0	1
7	1	0	1	1	0	1
8	0	0	1	1	0	1
9	1	0	1	0	0	1
10	1	0	0	1	0	1
11	0	0	1	1	0	1
12	1	0	1	1	0	1
13	1	0	1	0	0	1
14	0	0	1	1	0	1
15	0	0	1	1	0	1
16	0	0	1	1	0	1
17	1	0	1	0	1	0
18	0	0	1	0	0	1
19	0	0	1	1	0	1
20	1	0	1	0	1	1
21	1	0	1	0	0	1
22	1	0	1	0	1	1
23	0	0	1	0	0	1
24	1	0	1	0	1	1
25	1	0	1	0	0	1
26	0	1	1	1	0	1
27	1	1	0	0	0	1
28	1	0	1	0	1	1
29	0	0	1	0	0	1
30	1	0	1	0	1	1
Total	**19**	**2**	**28**	**15**	**7**	**29**
Total Edge	**10**	**0**	**13**	**11**	**1**	**14**
Total Interior	**9**	**2**	**15**	**4**	**6**	**15**

Table 2.4. Relative occurrence of each species found in the *Preliminary* and *Exploratory* surveys.

Species	**Count (Preliminary Survey)**	**Relative Occurrence (Preliminary Survey)**	**Count (Exploratory Survey)**	**Relative Occurrence (Exploratory Survey)**	**Count (Total)**	**Relative Occurrence (Total)**
F. pallidefulva	7	0.7	19	0.633	26	0.65
C. pennsylvanicus	0	0	2	0.0667	2	0.05
M. americana	8	0.8	28	0.933	36	0.9
M. spatulata	6	0.6	15	0.5	21	0.525
N. parvula	2	0.2	7	0.233	9	0.225
T. sessile	10	1	29	0.967	39	0.975

Figures

Figure 2.1: Location of each pitfall trap used in the *Preliminary* trappings in the orchard.

Figure 2.2: Location of each pitfall trap used in the *Exploratory* trappings in the orchard. Trees 1-15 (yellow) are exterior and 16-30 (turquoise) are Interior.

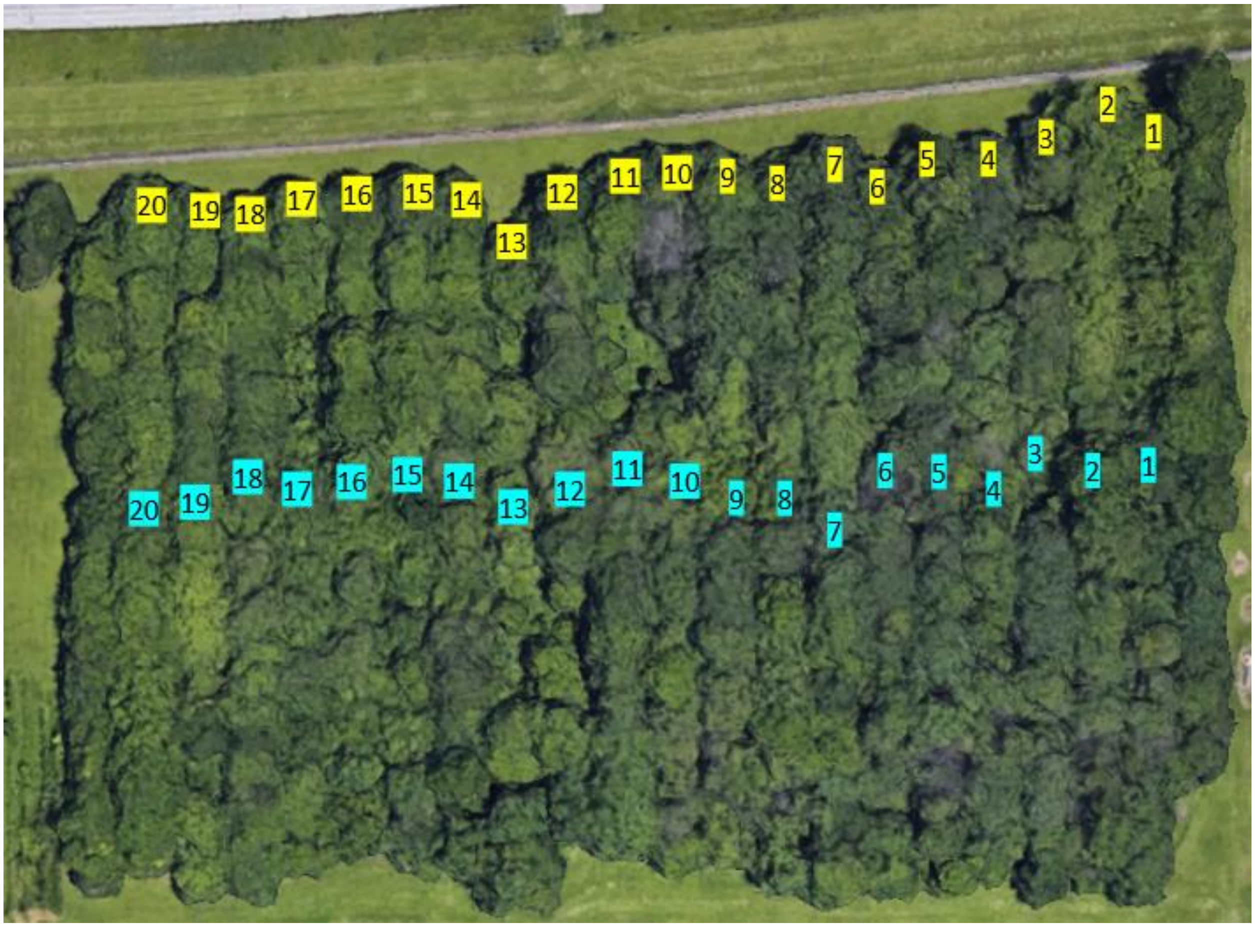

Figure 2.3: Location of each set of four pitfall traps in the *Experimental* trappings. Yellow indicates an edge location, turquoise indicates an interior location.

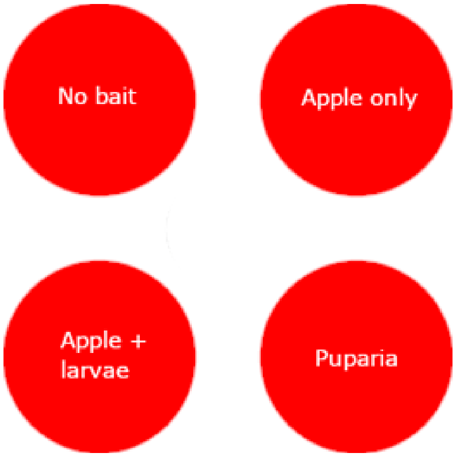

Figure 2.4: Arrangement of pitfall traps in each replicate of pitfall traps. No bait was placed in the northwest corner trap, apple only was placed in the northeast corner trap, apple with larvae was placed in the southwestern corner trap, puparia only was placed in the southeastern corner trap, and the soil sample was taken in the middle of the four traps.

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CHAPTER 3: *ZONOSEMATA ELECTA* (DIPTERA: TEPHRITIDAE) INFESTATION RATES IN *SOLANUM CAROLINENSE* (SOLANALES: SOLANACEAE) AND RATES OF PARASITISM BY *DIACHASMIMORPHA SANGUINEA* (HYMENOPTERA: ICHNEUMONIDAE) IN CHAMPAIGN COUNTY, ILLINOIS

Introduction

Introduced plants used as crops by humans provide opportunities for host shifts in many native phytophagous insects. Examples exist across a wide variety of taxa, including a shift of *Acanthoscelides obtectus* (Say) beetles from common bean, *Phaseolus vulgaris* (L.), to chickpea (*Cicer arietinum* L.) (Vuts *et al.*, 2018); *Wiseana* spp. moths from native plants to exotic pasture plants (Atijegbe *et al.*, 2020); the cotton-melon aphid, *Aphis gossypii* (Glover), from cucurbits to cotton (Xu *et al.*, 2014); and several tephritid fruit fly species. The olive fly, *Bactrocera oleae,* shifted hosts as cultivated olives replaced its original wild olive host (Nardi *et al.*, 2010). The Oriental fruit fly, *Bactrocera dorsalis* (Hendel), has shifted to several new crop hosts, with an associated lower genetic diversity suggesting partial host specialization (Wan *et al.*, 2014). The apple maggot, *Rhagoletis pomonella* (Walsh), is a classic example of host shifts leading to distinct host races, which are "a population of species that is partially reproductively isolated from other conspecific populations as a direct consequence of adaptation to a specific host" (Diehl and Bush, 1989) *R. pomonella* switched hosts from its native hawthorn *Crataegus* (hawthorn) fruits to introduced apples (Walsh 1867), which may have allowed it to expand its range in North America (Sim *et al*., 2017). The apple maggot has also become a model organism for the study of sympatric speciation (e.g., Bush 1969; Berlocher and Feder, 2002; Hood et al. 2020). Due to the pepper maggot's similarity to the apple maggot in terms of biology, distribution, and host shift from a small fruit to a large fruit, it provides a parallel system to the apple maggot for examining sympatric speciation.

The pepper maggot, *Zonosemata electa* (Say), is patchily distributed throughout North America, with records from the midwestern, eastern, and portions of southern United States and southeastern Ontario, Canada (USDA 1959, Foott 1963). The ancestral host, *Solanum carolinense* (L.), a perennial herbaceous species in the nightshade family (Solanaceae) (Foott 1968), is common in North America. However, by 1921 the pepper maggot acquired as novel hostplants peppers (*Capsicum annuum* (L.)) of several varieties and eggplant (*Solanum melongena* (L.)), introduced crop plants with much larger fruits than those of horsenettle (Peterson 1923). This shift was coupled with an earlier oviposition period (early- to mid-July in peppers, versus early- to mid-August in horsenettle), but no known host races have formed (Foott 1963). As with many tephritids, damage to the fruit is caused by females ovipositing into the fruit and leaving scars and by larvae feeding within the fruit. The net result of these activities is that up to 97% of unprotected pepper crops can be damaged (Peterson 1923, Boucher *et al*., 2005). Although oviposition scars may not deter consumers from purchasing these fruits, a single maggot is considered unacceptable in the marketplace (Jude 1994), making the pepper maggot an important, though sporadic, economic pest along the East Coast and in southwestern Ontario, Canada, where populations of pepper maggots regularly infest peppers (USDA 1959, Foott 1963).

The pepper maggot is univoltine throughout its range; eggs hatch in 10 to 12 days, and larvae require approximately 18 days to mature (Burdette 1935, Foott 1963). Mature larvae leave the host fruit, drop to the ground, and burrow into the soil to overwinter as pupae (Peterson 1923, Foott 1963). In peppers, less than one-half of all oviposition punctures contain eggs, and up to 18 eggs are laid per pepper fruit (Foott 1963; Boucher *et al*. (2005) found between ~5-24% of scars resulted in eggs that hatched into larvae. In horsenettle, Foott (1963) typically found one egg (rarely up to three) per fruit, whereas Wise (2007) found many eggs within a single fruit and as many as twenty immature larvae. These differences in egg numbers suggest that ovipositing pepper maggot flies have responded to external factors, such as climate or average fruit size across the pepper maggot's distribution, or that, in the decades since Foott's observations, pepper maggot females have increased the number of eggs they lay per fruit. In both studies, typically only one mature larva emerged per fruit.

However, little is known of the basic ecology of the pepper maggot on its native host plants throughout its range and how it differs on its introduced hosts. In particular, detailed studies of populations ovipositing on horsenettle are available only from Ontario, Canada, and northeastern United States (Foot 1963, Boucher *et al.*, 2005; Wise 2007). Even less is known about its natural enemies. *Diachasmimorpha sanguinea* (Ichneumonidae, Hymenoptera (Ashmead)) is a parasitoid of the pepper maggot (Ashmead 1889, Gahan 1915) found across its distributional range (Wharton and Marsh, 1978), although it is typically found at low rates and not considered to be an effective biological control agent in agricultural settings. *Diachasmimorpha sanguinea* is found across the distribution range of the pepper maggot (Wharton and Marsh 1978). Lacking from the literature are quantitative data of parasitism rates in pepper maggots in horsenettle, and previous studies alluded only to "low numbers" of *D. sanguinea* parasitism in pepper maggot larvae(e.g., Wise 2007). In this study, my goal was to fill some of these knowledge gaps by quantifying infestation rates and rates of parasitism of pepper maggot in native horsenettle in the Midwest region of the U.S. I also investigated the suitability of the pepper maggot as a parallel system to the apple maggot to study sympatric speciation.

Materials and Methods

Location

I focused my study on populations of horsenettle plants located in Urbana, Illinois (Champaign County, Illinois) (Table 3.1). Locations were chosen based on the abundance of plants with available fruit, as horsenettle is patchy in distribution and often grows alongside corn and soybean fields where it may be mowed prior to fruit set. Since it is difficult to monitor adult flies (e.g., Dively *et al*., Judd 1994, Boucher 1996), I did not rely on passive trappings (e.g., yellow sticky traps or sphere traps) to monitor populations. Instead, I collected fruit after noting oviposition marks, signaling that pepper maggots were in the area. Only sites with at least 10 plants that had at least one oviposition mark in a fruit were used. Sites with few or no oviposition marks in my survey are recorded in Table 3.6. A total of 339 fruits across 7 locations were collected for the main survey. Fruits were collected in late August to early September, 2018, one week after pepper maggot oviposition marks were noted on several fruits in the area, allowing time for parasitism to occur. At each location, 10 fruits with oviposition marks were dissected on the day they were collected to calculate the egg-to-oviposition mark ratio at that location. Both eggs and larvae were counted.

Larval rearing

After counting oviposition marks, I placed each fruit in an individual cup (Crystalware brand, top diameter: 29.7cm, height: 3.3cm, bottom diameter: 3cm) on a shallow layer of vermiculite so that larvae that had finished feeding could fall out of the fruit to the bottom of the cup for collection, without drowning in fluid from the rotting fruits. Cups were placed in climate-controlled rooms (~19°C) for larval rearing. Fruits were checked daily at approximately 9:00 pm for puparia. After two weeks, fruits were removed from the cups and dissected to score for fly larvae still remaining within the fruits. Puparia were maintained for two weeks in moist vermiculite (see Figure 1.1, Chapter 1) in individual cups, and then placed in a cold room (~-8°C) for eight weeks to simulate overwintering. Each cup contained a layer of moist vermiculite both above and below the puparia to simulate soil. At the end of the overwintering period, puparia were dissected to count late instar parasitoids in order to assess parasitism rates.

Infestation Rates

Infestation rates were calculated as the number of fruits from which larvae emerged (or from which larvae which were dissected) divided by the number of total fruit.

Survivorship

Pepper maggot oviposition marks cannot serve as a proxy for number of eggs as can apple maggot oviposition marks, since more than half of all oviposition marks in Foott's (1963) observations of horsenettle did not contain eggs. Instead, fly larval survivorship was calculated as the number of larvae that eclosed after the overwintering period divided by the number of larvae that emerged and/or were dissected out of the horsenettle fruits.

Results

A total of 339 fruits across 7 locations were collected for the survey (Table 3.1). Of the ten marked fruit collected from each location (70 fruit total), there was a total of 115 oviposition marks. No fruits with more than 6 oviposition marks were found. In total, 38 eggs or larvae were dissected out of the fruit for an egg-to-oviposition mark ratio of 0.33.

Of the 339 total fruits collected for the primary survey, 131 had oviposition marks, while 208 had none, for an overall percentage of 39% of fruits with oviposition marks. The average number of oviposition marks among fruit with any oviposition marks was 1.77 ($\sigma = 1.1$). Individual locations ranged from 28% to 49% marked fruits with between 1.45 to 2.27 mean oviposition marks per fruit with any oviposition marks (Table 3.2). Of the 339 total fruits, 53 had larvae, while 286 had none, for a true infestation rate of 16%. Only one fruit had more than one larva dissected out, and no fruits had more than one larva emerge. Individual locations ranged from an infestation rate of 11 to 24%. (Table 3.3). Only three *D. sanguinea* larvae were dissected out of the pepper maggot larvae. No pepper maggot larva had more than one parasitoid dissected out of it (Table 3.4) and the overall parasitism rate was ~0.06. Out of 53 larvae, 23 larvae survived the overwintering period for a survival rate of 43%. Survival rates by area ranged from 38% to 55% (Table 3.5). There were a total of 232 oviposition marks and 53 larvae, meaning 22% of oviposition marks resulted in middle to late instar larvae. However, of those 53 larvae, only 23 survived overwintering. Thus only 9% of oviposition marks resulted in adult flies.

Discussion

I found relatively low larval emergence to pupation despite a high number of oviposition marks by pepper maggot in study sites in Illinois. This pattern is similar to that reported by Foott (1968) in Ontario and lower than Wise's (2007) observations in northern Virginia. However, Wise harvested fruit to rear out larvae as soon as eggs were laid, and likely missed larval losses to parasitism or cannibalism, both of which could have contributed to the lower rates of emergence in my survey.

Consistent with previous research, it was rare for more than one larva to be found in a single fruit, suggesting either cannibalism of early instar larvae or avoidance by ovipositing females of fruit that already contain larvae. Some species of tephritids (e.g., *R. mendax, R. pomonella*) use oviposition pheromones to mark fruit and discourage other females from ovipositing (e.g., Prokopy *et al*., 1976; Faraone *et al.*, 2016), but mechanisms of larval exclusion in the pepper maggot remain unknown and are in need of future research. In addition, because the apple maggot (despite using oviposition marking pheromones) often produces multiple pupae per fruit in both hawthorns and apples, any mechanisms for exclusion may be species-specific and not characteristic of fruit-feeding tephritids.

These data, combined with data from the literature, suggest that, due to the patchy nature of both the pepper maggot and its native host plant, populations of *D. sanguinea* are similarly sparsely distributed. Further surveys are needed to determine the generality of this pattern across the species range, as the sparse distribution detected here could be specific to the Midwest or even to Champaign County.

The overall survival rate of 43% for pepper maggot is intermediate between those seen for the apple and hawthorn races apple maggots in Champaign County (Chapter 1). However, these numbers are not directly comparable, as apple maggot oviposition marks were used as a proxy for number of eggs laid, whereas a similar proxy cannot be used for pepper maggots due to the low egg-to-oviposition mark ratio. Despite this difference in oviposition mark-to-egg ratio, the comparable survival rates between species support the use of pepper maggot as a model for speciation to complement the apple maggot model.

This survey adds to the literature on oviposition, emergence, and parasitism rates of pepper maggots in horsenettle. Further studies to characterize the mechanism by which conspecific larvae outcompete one another such that fruits ultimately produce only one pupa are needed. More data on infestation rates, parasitism rates, and survival rates in peppers and eggplants are also needed, especially among geographically separated populations. As the literature is lacking in genetic and behavioral plasticity differences between populations of pepper maggots, these factors must be examined prior to making direct comparisons between the apple maggot and the pepper maggot. Finally, the pepper maggot has potential as a system complementary to that of the apple maggot for studying sympatric speciation and host shifts.

Tables

Table 3.1. Collection locations of horsenettle fruits from which pepper maggot larvae were reared out. Each fruit collected was assigned a unique number.

Location Number	Fruit Numbers	Collection Location	Collection Date
1	1-46	E Curtis Road between Neil and Lincoln, Urbana IL (~ 40.0700515,-88.2727395)	07/25/2018
2	47-88	S Lincoln Ave between Windsor and Curtis, Urbana IL (~40.069261, -88.218366)	07/25/2018
3	89-114	Pollinatarium (606 W Windsor, Urbana IL) (40.0872599,-88.216751)	07/25/2018
4	115-151	Apple orchard (~corner of Country Rd 1400 N and Race St) (~40.083428, -88.210893)	07/26/2018
5	152-204	Race Street between Windsor and Old Church, Urbana IL (~40.054679, -88.208901)	07/26/2018
6	205-239	E Perkins Rd (~2277 E Perkins Rd to Saline Ditch bridge), Urbana IL (~@40.1272549,-88.1793159)	08/4/2018
7	240-339	Phillips Tract and Trelease Prairie (1725 N Cottonwood Rd, Urbana IL) (~40.1305677,-88.1468751)	08/5/2018

Table 3.2. Number and percentage of fruits with oviposition marks and mean oviposition marks per fruit with any oviposition marks.

Location Number	Total Fruit	Fruit w/Oviposition Marks	Percent Fruit with Oviposition Marks	Mean Oviposition Marks per Marked Fruit
All Locations	339	131	0.39	1.77
1	46	21	0.47	1.67
2	42	15	0.36	2.27
3	26	11	0.42	1.45
4	37	17	0.46	1.88
5	53	21	0.40	1.62
6	35	10	0.28	1.60
7	100	36	0.36	1.81

Table 3.3. Number and percentage of fruits with larvae and mean larvae per fruit with any larvae.

Location Number	Total Fruit	Fruit w/Larvae	Percent Fruit with Larvae	Mean Larvae Per Fruit with Larvae
All Locations	339	53	0.16	1.02
1	46	8	0.17	1
2	42	5	0.12	1
3	26	5	0.19	1
4	37	9	0.24	1.1
5	53	11	0.21	1
6	35	4	0.11	1
7	100	11	0.11	1

Table 3.4. Parasitism rates of pepper maggot by *D. sanguinea*.

Location Number	Total Larvae	Larvae with Parasitoid	Percent Larvae Parasitized	Mean Parasitoid per Parasitized Larvae
All Locations	53	3	0.06	1
1	8	1	0.12	1
2	5	1	0.2	1
3	5	0	0	N/A
4	10	0	0	N/A
5	11	0	0	N/A
6	4	0	0	N/A
7	11	1	0.09	1

Table 3.5. Survival rate of pepper maggot larvae.

Location Number	Total Larvae	Total Larvae Survived	Survival Rate
All Locations	53	23	0.43
1	8	3	0.38
2	5	2	0.40
3	5	2	0.40
4	10	3	0.30
5	11	5	0.45
6	4	2	0.50
7	11	6	0.55

Table 3.6: Locations of additional horsenettle patches, including pepper maggot oviposition and larvae numbers at each location

Location	Number of Horsenettle Plants	Fruit with Oviposition Marks	Fruit with Larvae
County Rd 1900 N (between Prospect and N Market St), Champaign IL (40.1559765,-88.257858 to 40.156771, -88.239317)	23	4	2
Corner of Olympian Dr. and N Lincoln Ave, Champaign IL (40.1605172,-88.2127039)	6	0	0
~3200 E Ford Harris Rd, Urbana IL (40.1712636,-88.1655379)	13	1	0
~4300 E Leverett Rd, Champaign IL (40.1886641,-88.1668735)	33	7	3
~1400 Flatville Rd, Thomasboro IL (40.2392625,-88.1769174)	17	3	3
~300 Ellen Ave, Savoy IL (40.0519416,-88.2552969)	8	0	0
~1000 Country Rd 1200 E, Tolono IL (40.0252178,-88.2402494)	41	9	5

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APPENDIX A: CHAPTER 1 SUPPLIMENTARY MATERIALS

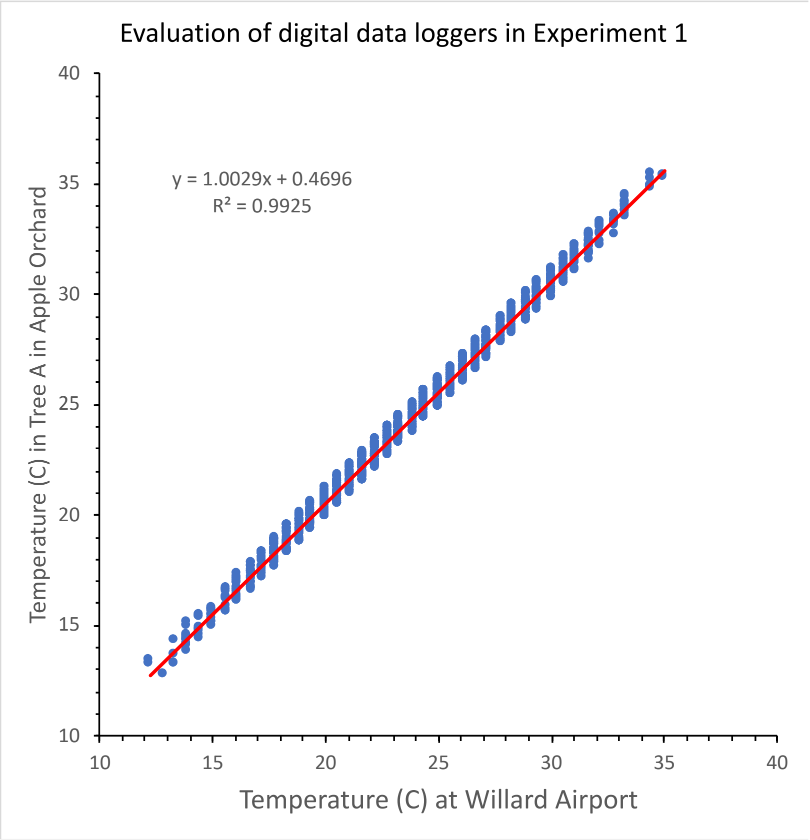


Figure A.1. Regression of temperatures from experimental digital data loggers (Table A.1) on temperature at Willard Airport, Illinois.

Internal and external temperatures for heating enclosures, which were consistent with Willard Airport air temperatures (shown in Figure A.1 above).

Date	Time	Tree 1 - Internal (C)	Tree 1 - External (C)	Tree 2 - Internal (C)	Tree 2 - External (C)	Tree 3 - Internal (C)	Tree 3 - External (C)	Willard (C)
6/25/2018	1:00	19.7	19.6	19.5	19.6	19.7	19.4	19.4
6/25/2018	2:00	18.3	18.4	18.3	18.3	18.8	18.3	18.3
6/25/2018	3:00	18.0	18.0	18.1	17.9	18.4	18.0	17.8
6/25/2018	4:00	18.4	18.2	18.1	18.1	18.2	18.1	17.8
6/25/2018	5:00	18.3	18.2	18.2	18.1	18.3	18.1	17.8
6/25/2018	6:00	18.4	18.4	18.5	18.3	18.6	18.2	18.3
6/25/2018	7:00	20.1	19.6	19.8	19.5	19.9	19.5	19.4
6/25/2018	8:00	22.1	21.9	22.4	21.9	22.1	21.7	21.1
6/25/2018	9:00	25.7	23.9	24.9	23.9	24.9	23.7	23.3
6/25/2018	10:00	28.1	26.1	27.9	26.1	27.3	26.1	25.0
6/25/2018	11:00	27.5	25.7	27.8	25.6	27.2	25.5	25.0
6/25/2018	12:00	28.8	26.5	28.5	26.4	28.5	26.3	25.6
6/25/2018	13:00	28.2	26.0	29.1	26.0	29.2	26.0	26.1
6/25/2018	14:00	30.5	27.4	31.3	27.5	30.6	27.3	26.7
6/25/2018	15:00	31.5	27.8	32.0	27.7	31.0	27.7	26.7
6/25/2018	16:00	31.6	27.5	32.2	27.4	31.1	27.4	26.7
6/25/2018	17:00	31.1	27.1	31.4	26.9	31.4	27.0	26.1
6/25/2018	18:00	30.2	25.8	29.6	25.8	29.4	25.7	25.0
6/25/2018	19:00	26.3	23.5	26.6	23.4	27.0	23.5	23.3
6/25/2018	20:00	25.1	22.2	24.7	22.2	25.8	22.2	22.2
6/25/2018	21:00	25.2	22.2	25.2	22.2	25.0	22.1	21.7
6/25/2018	22:00	24.2	21.3	23.5	21.3	23.7	21.3	21.1
6/25/2018	23:00	22.8	21.0	23.1	21.0	22.5	20.9	21.1
6/25/2018	0:00	23.7	21.6	23.4	21.6	23.0	21.6	20.6
6/26/2018	1:00	21.4	21.5	21.7	21.5	21.8	21.5	21.1
6/26/2018	2:00	21.4	21.3	21.6	21.2	21.6	21.2	20.6
6/26/2018	3:00	21.1	20.8	20.9	20.6	21.0	20.7	20.6
6/26/2018	4:00	20.7	20.6	20.6	20.6	20.5	20.5	20.6
6/26/2018	5:00	21.2	21.1	21.1	21.1	21.0	21.1	21.1
6/26/2018	6:00	21.4	21.1	21.3	21.1	21.0	21.1	21.1
6/26/2018	7:00	22.2	21.9	22.2	21.7	22.0	21.8	21.7
6/26/2018	8:00	25.1	24.3	24.5	24.2	24.8	24.3	23.3
6/26/2018	9:00	26.2	24.7	25.7	24.6	25.8	24.7	23.9
6/26/2018	10:00	25.8	24.0	25.2	23.9	25.7	24.0	23.9
6/26/2018	11:00	25.7	23.8	25.6	23.8	25.4	23.8	23.3
6/26/2018	12:00	27.7	25.4	27.5	25.4	27.6	25.4	25.0
6/26/2018	13:00	29.6	26.6	29.1	26.6	29.1	26.6	26.7

6/26/2018	14:00	30.3	27.8	31.2	27.8	31.6	27.8	26.7
6/26/2018	15:00	31.1	27.4	30.4	27.3	30.6	27.3	27.2
6/26/2018	16:00	32.5	28.2	31.7	28.0	32.3	28.0	27.2
6/26/2018	17:00	30.8	27.4	31.0	27.4	31.2	27.4	26.7
6/26/2018	18:00	29.2	26.0	29.5	25.9	29.8	25.9	25.6
6/26/2018	19:00	28.7	25.6	29.3	25.5	29.5	25.5	24.4
6/26/2018	20:00	26.3	23.0	25.8	22.8	25.7	22.9	22.8
6/26/2018	21:00	25.1	22.1	25.0	22.0	24.8	22.0	22.2
6/26/2018	22:00	26.0	23.3	26.2	23.3	25.3	23.1	22.2
6/26/2018	23:00	23.9	22.1	24.6	22.0	24.4	22.0	21.7
6/26/2018	0:00	22.4	20.3	22.3	20.3	22.0	20.2	20.0
6/27/2018	1:00	21.1	20.8	20.9	20.7	21.0	20.7	20.0
6/27/2018	2:00	19.8	19.7	19.6	19.7	19.6	19.7	18.9
6/27/2018	3:00	20.9	20.5	20.5	20.5	20.9	20.5	19.4
6/27/2018	4:00	20.0	20.0	20.2	20.0	19.9	20.0	18.9
6/27/2018	5:00	19.3	19.3	19.4	19.2	19.2	19.3	18.9
6/27/2018	6:00	20.6	20.4	20.4	20.4	20.4	20.3	19.4
6/27/2018	7:00	22.1	21.6	21.7	21.6	21.9	21.7	21.1
6/27/2018	8:00	24.2	23.8	24.1	23.7	24.3	23.7	22.8
6/27/2018	9:00	25.6	24.5	25.6	24.5	25.5	24.4	24.4
6/27/2018	10:00	25.5	23.9	25.2	23.9	25.1	23.9	23.9
6/27/2018	11:00	28.0	25.5	27.1	25.4	27.1	25.5	25.6
6/27/2018	12:00	29.3	27.1	29.3	27.1	29.4	27.0	26.7
6/27/2018	13:00	29.8	27.2	29.9	27.1	30.2	27.1	26.1
6/27/2018	14:00	32.3	28.7	32.5	28.7	31.3	28.6	27.8
6/27/2018	15:00	31.5	28.2	32.2	28.3	31.8	28.1	27.8
6/27/2018	16:00	33.3	28.6	33.0	28.5	33.2	28.6	28.3
6/27/2018	17:00	32.4	29.0	33.6	29.0	32.9	28.9	27.8
6/27/2018	18:00	30.8	27.7	30.9	27.6	31.6	27.6	27.2
6/27/2018	19:00	29.9	26.1	29.6	25.9	29.3	26.0	25.0
6/27/2018	20:00	27.6	24.4	28.1	24.4	26.9	24.4	23.3
6/27/2018	21:00	24.9	22.4	25.5	22.3	25.4	22.3	21.7
6/27/2018	22:00	24.3	22.0	24.0	21.9	24.6	21.9	21.7
6/27/2018	23:00	23.7	21.7	23.9	21.6	24.0	21.5	21.7
6/27/2018	0:00	24.1	22.3	23.9	22.3	24.1	22.2	21.7
6/28/2018	1:00	21.4	21.3	21.2	21.2	21.4	21.2	21.1
6/28/2018	2:00	20.2	20.3	20.5	20.3	20.1	20.2	20.0
6/28/2018	3:00	20.8	20.3	20.7	20.2	20.4	20.3	20.0
6/28/2018	4:00	18.9	18.8	18.7	18.8	18.8	18.7	18.9
6/28/2018	5:00	19.4	19.5	19.5	19.4	19.5	19.5	18.3
6/28/2018	6:00	21.9	21.9	22.0	21.9	22.1	21.9	21.1

6/28/2018	7:00	25.0	25.0	25.1	24.9	25.1	24.9	23.9
6/28/2018	8:00	27.0	26.2	26.8	26.1	26.5	26.1	25.6
6/28/2018	9:00	29.0	27.6	28.7	27.5	28.6	27.6	26.7
6/28/2018	10:00	29.0	27.6	28.6	27.6	29.2	27.5	27.2
6/28/2018	11:00	30.5	28.5	29.9	28.4	30.5	28.4	27.8
6/28/2018	12:00	31.3	28.8	31.2	28.7	30.9	28.8	28.9
6/28/2018	13:00	32.6	29.7	32.7	29.7	32.6	29.7	28.9
6/28/2018	14:00	32.7	29.8	32.5	29.7	33.3	29.7	28.9
6/28/2018	15:00	34.0	29.6	32.8	29.5	32.7	29.5	28.9
6/28/2018	16:00	34.0	29.2	33.4	29.2	33.3	29.2	28.3
6/28/2018	17:00	31.2	27.5	31.9	27.5	31.0	27.4	27.2
6/28/2018	18:00	29.4	25.9	30.3	25.8	30.3	25.8	25.6
6/28/2018	19:00	28.5	25.2	28.6	25.1	28.4	25.0	25.0
6/28/2018	20:00	29.2	26.1	29.4	26.0	29.9	26.0	25.0
6/28/2018	21:00	27.2	24.7	27.8	24.6	27.6	24.7	23.9
6/28/2018	22:00	24.9	22.8	25.1	22.8	24.9	22.7	22.8
6/28/2018	23:00	26.0	23.9	25.5	23.9	26.1	23.8	22.8
6/28/2018	0:00	23.8	22.3	24.1	22.2	24.5	22.3	22.2
6/29/2018	1:00	21.8	21.7	21.7	21.6	22.0	21.6	21.1
6/29/2018	2:00	21.7	21.4	21.4	21.4	21.4	21.5	20.6
6/29/2018	3:00	21.4	21.4	21.3	21.3	21.2	21.3	21.1
6/29/2018	4:00	21.5	21.4	21.5	21.3	21.6	21.4	20.6
6/29/2018	5:00	20.9	20.9	20.8	20.9	21.0	20.8	20.0
6/29/2018	6:00	22.5	22.3	22.4	22.3	22.3	22.3	22.2
6/29/2018	7:00	26.2	25.6	25.8	25.4	25.8	25.6	25.0
6/29/2018	8:00	28.8	28.1	28.4	28.0	28.5	28.1	27.2
6/29/2018	9:00	30.1	29.0	30.1	29.0	29.9	29.0	28.9
6/29/2018	10:00	31.5	30.3	31.6	30.2	31.4	30.3	30.0
6/29/2018	11:00	32.5	30.9	32.6	30.8	32.6	30.9	30.6
6/29/2018	12:00	33.6	31.4	33.9	31.4	34.0	31.4	31.1
6/29/2018	13:00	35.9	32.7	35.4	32.7	35.1	32.5	31.7
6/29/2018	14:00	35.7	32.7	36.5	32.6	35.9	32.6	31.7
6/29/2018	15:00	34.9	31.8	35.8	31.8	35.1	31.8	31.7
6/29/2018	16:00	35.8	31.9	36.4	31.9	35.8	31.9	31.7
6/29/2018	17:00	36.2	32.2	36.2	32.1	35.7	32.2	31.1
6/29/2018	18:00	33.4	30.3	34.7	30.1	34.8	30.1	29.4
6/29/2018	19:00	31.9	28.8	31.7	28.7	32.0	28.7	28.9
6/29/2018	20:00	31.1	28.5	32.1	28.4	31.8	28.4	27.8
6/29/2018	21:00	30.0	27.2	29.7	27.1	30.3	27.2	26.7
6/29/2018	22:00	29.7	27.2	29.9	27.1	29.8	27.1	26.1
6/29/2018	23:00	28.0	25.9	28.0	25.8	27.5	25.8	25.0

6/29/2018	0:00	26.6	24.9	27.1	24.9	26.3	24.8	24.4
6/30/2018	1:00	24.0	23.5	23.9	23.4	23.6	23.4	23.3
6/30/2018	2:00	24.1	23.8	24.2	23.6	23.8	23.8	23.3
6/30/2018	3:00	23.7	23.6	23.5	23.4	23.8	23.5	23.3
6/30/2018	4:00	23.6	23.4	23.7	23.3	23.6	23.4	22.8
6/30/2018	5:00	23.1	23.0	23.1	22.9	22.8	22.8	22.8
6/30/2018	6:00	25.0	24.7	24.7	24.7	24.9	24.6	24.4
6/30/2018	7:00	26.6	26.1	26.1	26.0	26.1	26.0	25.6
6/30/2018	8:00	28.5	28.1	28.5	28.1	28.4	28.0	27.8
6/30/2018	9:00	31.4	30.1	31.2	30.1	31.2	30.0	29.4
6/30/2018	10:00	32.3	31.1	32.7	31.0	32.4	31.0	30.6
6/30/2018	11:00	32.9	31.0	32.6	31.0	32.5	30.9	30.6
6/30/2018	12:00	34.1	32.1	34.2	32.1	34.1	32.0	31.7
6/30/2018	13:00	34.5	32.1	34.9	32.2	34.9	32.2	31.7
6/30/2018	14:00	34.5	31.9	35.6	31.8	34.5	31.8	31.7
6/30/2018	15:00	33.8	30.5	33.5	30.4	34.7	30.4	30.6
6/30/2018	16:00	36.2	32.2	36.1	32.1	36.3	32.1	31.7
6/30/2018	17:00	35.3	32.0	36.1	31.8	35.8	31.8	31.1
6/30/2018	18:00	34.0	30.3	33.4	30.2	34.4	30.2	30.0
6/30/2018	19:00	32.1	28.7	32.3	28.7	32.0	28.6	27.8
6/30/2018	20:00	29.2	26.4	29.0	26.3	30.2	26.3	26.1
6/30/2018	21:00	28.8	26.1	28.6	26.0	28.8	26.0	25.6
6/30/2018	22:00	27.7	25.1	27.7	25.0	27.3	25.1	24.4
6/30/2018	23:00	26.3	24.5	26.6	24.5	26.3	24.4	24.4
6/30/2018	0:00	27.3	25.4	26.8	25.4	27.4	25.3	24.4
7/1/2018	1:00	23.8	23.7	24.1	23.6	23.9	23.7	23.3
7/1/2018	2:00	23.1	22.8	22.7	22.8	23.2	22.7	22.2
7/1/2018	3:00	24.0	23.8	24.1	23.7	23.9	23.7	22.8
7/1/2018	4:00	23.6	23.5	23.5	23.5	23.6	23.5	22.8
7/1/2018	5:00	23.2	23.2	23.2	23.2	23.1	23.1	22.8
7/1/2018	6:00	24.9	24.7	24.6	24.6	24.9	24.7	23.9
7/1/2018	7:00	27.2	26.6	26.6	26.5	26.7	26.6	26.1
7/1/2018	8:00	28.4	27.8	28.2	27.8	28.0	27.8	27.8
7/1/2018	9:00	30.9	29.5	30.6	29.5	30.7	29.4	28.9
7/1/2018	10:00	33.3	31.2	32.3	31.1	32.2	31.1	30.0
7/1/2018	11:00	33.7	31.7	33.3	31.7	33.5	31.6	31.1
7/1/2018	12:00	35.3	32.6	35.0	32.5	34.9	32.6	31.7
7/1/2018	13:00	34.5	32.1	34.3	32.0	34.7	32.0	31.7
7/1/2018	14:00	35.8	32.1	35.2	31.9	34.6	31.9	31.7
7/1/2018	15:00	35.4	31.8	35.2	31.8	34.8	31.7	31.7
7/1/2018	16:00	35.8	32.0	35.5	32.0	35.5	32.0	31.1

7/1/2018	17:00	35.2	31.6	35.7	31.6	35.1	31.5	30.6
7/1/2018	18:00	28.4	24.5	27.8	24.5	27.6	24.6	23.9
7/1/2018	19:00	27.3	23.9	27.4	23.9	26.6	23.9	23.3
7/1/2018	20:00	26.2	23.3	26.8	23.2	27.1	23.3	22.8
7/1/2018	21:00	26.1	23.3	26.3	23.1	26.2	23.2	22.2
7/1/2018	22:00	24.8	22.6	24.7	22.5	25.1	22.6	22.2
7/1/2018	23:00	24.9	23.1	25.2	23.1	25.3	23.0	22.2
7/1/2018	0:00	23.6	22.2	23.7	22.2	24.4	22.1	22.2
7/2/2018	1:00	22.0	21.8	21.7	21.7	21.8	21.7	21.7
7/2/2018	2:00	22.5	22.3	22.7	22.2	22.7	22.3	21.7
7/2/2018	3:00	23.8	23.3	23.2	23.2	23.7	23.3	22.2
7/2/2018	4:00	21.8	21.9	21.9	21.8	22.0	21.9	21.7
7/2/2018	5:00	22.4	22.2	22.1	22.1	22.2	22.2	21.1
7/2/2018	6:00	23.3	23.1	23.0	23.1	23.1	22.9	22.8
7/2/2018	7:00	26.0	25.6	25.9	25.5	25.7	25.6	24.4
7/2/2018	8:00	25.7	25.4	25.7	25.3	25.9	25.3	25.0
7/2/2018	9:00	29.0	27.0	28.0	26.9	28.1	26.9	26.1
7/2/2018	10:00	29.6	27.9	29.2	27.9	28.9	27.8	27.8
7/2/2018	11:00	30.0	28.0	30.0	27.9	29.9	28.0	27.2
7/2/2018	12:00	30.4	28.4	30.9	28.4	30.6	28.3	28.3
7/2/2018	13:00	32.6	29.8	32.7	29.8	32.0	29.7	28.9
7/2/2018	14:00	32.2	29.3	32.7	29.2	32.7	29.3	29.4
7/2/2018	15:00	33.1	29.8	32.7	29.6	33.6	29.6	29.4
7/2/2018	16:00	35.2	30.2	34.4	30.1	33.6	30.1	29.4
7/2/2018	17:00	31.8	27.3	31.6	27.2	31.5	27.4	27.2
7/2/2018	18:00	32.3	28.0	31.5	28.0	31.2	27.9	27.2
7/2/2018	19:00	30.1	26.7	30.1	26.6	29.6	26.7	26.7
7/2/2018	20:00	29.1	26.2	29.1	26.0	28.8	26.0	25.0
7/2/2018	21:00	26.9	23.9	26.8	23.8	26.8	23.8	23.9
7/2/2018	22:00	27.2	24.6	27.0	24.5	26.6	24.6	23.9
7/2/2018	23:00	25.6	23.9	25.6	23.9	25.9	23.9	22.8
7/2/2018	0:00	24.5	22.9	24.7	22.8	24.7	22.8	22.8
7/3/2018	1:00	22.7	22.6	22.8	22.5	22.6	22.5	22.2
7/3/2018	2:00	23.6	23.2	23.6	23.1	23.4	23.1	22.2
7/3/2018	3:00	22.7	22.4	22.8	22.4	22.4	22.4	21.7
7/3/2018	4:00	21.3	21.1	21.1	21.0	21.2	21.1	21.1
7/3/2018	5:00	21.4	21.4	21.3	21.3	21.3	21.2	21.1
7/3/2018	6:00	22.8	22.8	22.7	22.8	23.0	22.8	22.8
7/3/2018	7:00	25.5	25.3	25.5	25.2	25.3	25.3	24.4
7/3/2018	8:00	27.1	26.6	26.9	26.5	27.2	26.6	26.7
7/3/2018	9:00	30.5	28.8	29.8	28.8	29.8	28.7	27.8

7/3/2018	10:00	30.3	29.0	30.2	28.9	30.1	28.9	28.9
7/3/2018	11:00	32.8	30.3	32.2	30.2	31.9	30.2	29.4
7/3/2018	12:00	32.7	30.2	32.2	30.2	32.9	30.1	29.4
7/3/2018	13:00	34.1	30.7	33.0	30.7	33.4	30.6	30.6
7/3/2018	14:00	35.7	31.9	35.2	31.8	35.3	31.7	31.1
7/3/2018	15:00	34.2	31.2	34.3	31.1	34.6	31.1	31.1
7/3/2018	16:00	35.6	31.6	35.2	31.6	35.4	31.5	31.1
7/3/2018	17:00	35.0	30.7	34.2	30.7	34.3	30.7	30.6
7/3/2018	18:00	35.0	31.1	34.3	31.0	34.5	31.1	30.0
7/3/2018	19:00	31.8	28.4	32.3	28.3	32.2	28.3	27.8
7/3/2018	20:00	29.7	26.3	29.0	26.2	29.2	26.2	25.6
7/3/2018	21:00	27.6	25.1	27.6	24.9	27.8	25.1	24.4
7/3/2018	22:00	26.3	24.0	26.6	24.0	26.5	24.0	23.9
7/3/2018	23:00	25.3	23.6	25.3	23.6	25.9	23.6	23.3
7/3/2018	0:00	24.2	22.8	24.9	22.8	24.3	22.8	22.8
7/4/2018	1:00	22.3	22.3	22.7	22.2	22.5	22.3	22.2
7/4/2018	2:00	23.7	23.3	23.5	23.3	23.8	23.2	22.2
7/4/2018	3:00	22.7	22.6	22.5	22.6	22.6	22.5	22.2
7/4/2018	4:00	23.4	23.3	23.4	23.2	23.3	23.2	22.2
7/4/2018	5:00	22.3	22.3	22.5	22.3	22.4	22.3	22.2
7/4/2018	6:00	23.7	23.7	23.8	23.6	23.8	23.6	22.8
7/4/2018	7:00	26.7	26.4	26.6	26.4	26.6	26.4	25.6
7/4/2018	8:00	28.4	28.1	28.7	28.0	28.7	28.1	27.8
7/4/2018	9:00	31.2	29.6	30.6	29.6	30.7	29.5	28.9
7/4/2018	10:00	32.1	30.8	31.8	30.8	32.1	30.6	30.0
7/4/2018	11:00	33.9	31.6	33.3	31.6	33.4	31.5	31.1
7/4/2018	12:00	34.3	31.5	34.2	31.4	33.7	31.3	31.1
7/4/2018	13:00	34.7	31.6	34.0	31.5	34.4	31.6	31.7
7/4/2018	14:00	36.5	33.1	36.2	33.0	36.1	33.1	32.2
7/4/2018	15:00	37.0	33.2	36.8	33.1	36.4	33.2	32.2
7/4/2018	16:00	36.3	32.7	36.9	32.7	36.9	32.7	32.2
7/4/2018	17:00	35.5	31.7	35.4	31.7	35.5	31.7	31.1
7/4/2018	18:00	35.8	31.6	34.8	31.6	34.7	31.6	30.6
7/4/2018	19:00	31.8	29.0	32.0	28.8	32.4	29.0	28.9
7/4/2018	20:00	30.6	27.3	30.7	27.3	30.2	27.3	27.2
7/4/2018	21:00	29.7	26.9	30.0	26.9	30.0	26.9	26.1
7/4/2018	22:00	28.9	26.0	28.2	25.9	28.9	26.0	25.0
7/4/2018	23:00	27.1	25.2	26.9	25.1	27.3	25.1	25.0
7/4/2018	0:00	25.8	23.9	25.6	23.9	25.9	23.8	23.9
7/5/2018	1:00	24.3	24.4	24.8	24.3	24.3	24.3	24.4
7/5/2018	2:00	24.8	24.4	24.3	24.4	24.8	24.4	24.4

7/5/2018	3:00	25.1	25.2	25.2	25.1	25.6	25.2	24.4
7/5/2018	4:00	24.1	23.9	24.1	24.0	24.1	23.9	23.3
7/5/2018	5:00	23.8	23.9	23.9	23.8	24.0	23.7	23.3
7/5/2018	6:00	25.9	26.0	25.9	26.0	26.2	26.0	25.6
7/5/2018	7:00	27.2	27.1	27.2	27.1	27.3	27.1	26.7
7/5/2018	8:00	29.8	29.4	29.6	29.2	29.6	29.2	28.9
7/5/2018	9:00	31.8	30.6	31.5	30.5	31.7	30.5	30.0
7/5/2018	10:00	33.6	31.7	33.4	31.6	33.4	31.7	30.6
7/5/2018	11:00	34.0	32.1	33.7	32.1	33.8	32.0	31.1
7/5/2018	12:00	35.5	32.7	35.4	32.5	35.0	32.5	31.7
7/5/2018	13:00	35.3	32.2	34.4	32.2	34.5	32.2	31.1
7/5/2018	14:00	31.0	27.7	30.5	27.7	30.9	27.6	27.2
7/5/2018	15:00	28.0	24.0	28.0	23.9	27.4	23.9	23.9
7/5/2018	16:00	28.5	24.1	27.6	24.0	28.0	23.9	23.9
7/5/2018	17:00	27.7	23.3	27.9	23.3	27.1	23.3	22.8
7/5/2018	18:00	27.7	23.5	26.6	23.4	27.3	23.5	22.8
7/5/2018	19:00	26.8	24.1	27.3	24.1	27.1	24.0	23.3
7/5/2018	20:00	26.0	23.0	26.8	22.9	26.4	22.9	22.8
7/5/2018	21:00	26.0	23.4	26.1	23.4	26.0	23.4	22.2
7/5/2018	22:00	25.3	22.5	24.8	22.5	25.2	22.4	21.7
7/5/2018	23:00	24.1	22.1	24.4	22.0	23.8	22.0	21.7
7/5/2018	0:00	23.8	21.6	23.8	21.6	23.4	21.6	21.7
7/6/2018	1:00	21.8	21.8	22.1	21.7	21.8	21.7	21.1
7/6/2018	2:00	21.2	21.1	21.3	21.1	21.5	21.1	21.1
7/6/2018	3:00	22.7	22.5	22.7	22.4	22.8	22.5	22.2
7/6/2018	4:00	22.3	22.2	22.2	22.1	22.2	22.2	22.2
7/6/2018	5:00	23.3	23.4	23.4	23.3	23.5	23.3	22.8
7/6/2018	6:00	24.0	23.9	23.9	23.8	24.1	23.8	22.8
7/6/2018	7:00	24.6	24.6	24.6	24.6	24.8	24.5	24.4
7/6/2018	8:00	25.1	24.6	24.9	24.6	25.0	24.5	24.4
7/6/2018	9:00	26.8	25.5	26.6	25.4	26.5	25.4	24.4
7/6/2018	10:00	27.8	25.9	27.2	25.8	27.7	25.8	25.6
7/6/2018	11:00	28.1	26.0	28.0	26.0	27.6	26.0	25.6
7/6/2018	12:00	29.2	26.3	28.4	26.1	28.5	26.2	26.1
7/6/2018	13:00	28.6	25.4	27.8	25.4	28.6	25.4	25.0
7/6/2018	14:00	29.1	26.6	30.1	26.5	30.0	26.5	26.7
7/6/2018	15:00	30.7	26.7	30.3	26.6	30.2	26.7	26.1
7/6/2018	16:00	30.6	26.6	30.7	26.6	30.4	26.5	25.6
7/6/2018	17:00	28.7	25.2	29.2	25.0	29.4	25.1	25.0
7/6/2018	18:00	28.3	24.0	27.1	23.9	28.5	24.0	23.9
7/6/2018	19:00	26.6	23.1	26.2	23.0	26.1	23.1	22.2

7/6/2018	20:00	23.9	20.8	24.3	20.7	23.9	20.8	20.0
7/6/2018	21:00	22.4	19.8	22.3	19.8	22.3	19.6	19.4
7/6/2018	22:00	21.9	19.5	21.8	19.4	21.7	19.5	18.3
7/6/2018	23:00	19.8	17.3	19.3	17.3	19.3	17.2	17.2
7/6/2018	0:00	17.9	16.2	18.2	16.2	18.2	16.2	16.1
7/7/2018	1:00	16.5	16.4	16.8	16.4	16.6	16.4	16.1
7/7/2018	2:00	16.9	16.6	16.8	16.6	16.8	16.6	15.6
7/7/2018	3:00	16.1	15.9	16.1	15.8	16.2	15.8	15.6
7/7/2018	4:00	15.5	15.5	15.5	15.4	15.6	15.5	14.4
7/7/2018	5:00	14.5	14.3	14.4	14.3	14.3	14.3	13.9
7/7/2018	6:00	16.1	16.2	16.3	16.1	16.2	16.2	15.6
7/7/2018	7:00	18.4	18.2	18.4	18.1	18.5	18.2	17.8
7/7/2018	8:00	20.8	20.0	20.5	20.0	20.3	19.9	19.4
7/7/2018	9:00	23.0	21.3	22.2	21.1	22.3	21.1	21.1
7/7/2018	10:00	25.4	23.6	24.9	23.5	24.6	23.4	22.8
7/7/2018	11:00	26.7	24.6	26.5	24.5	26.7	24.7	23.9
7/7/2018	12:00	27.0	24.7	26.8	24.7	27.0	24.6	24.4
7/7/2018	13:00	28.2	25.3	28.2	25.2	28.1	25.3	25.0
7/7/2018	14:00	29.5	25.5	28.9	25.4	28.6	25.4	25.6
7/7/2018	15:00	30.5	26.7	30.0	26.6	29.7	26.6	25.6
7/7/2018	16:00	30.7	26.7	30.8	26.7	31.5	26.6	25.6
7/7/2018	17:00	30.4	26.1	30.1	26.1	29.9	26.0	25.0
7/7/2018	18:00	27.9	24.4	28.5	24.4	28.3	24.4	24.4
7/7/2018	19:00	25.5	22.4	26.1	22.4	25.6	22.3	22.2
7/7/2018	20:00	24.1	21.1	23.8	21.1	24.7	21.0	20.0
7/7/2018	21:00	22.6	19.8	22.3	19.7	22.4	19.7	18.9
7/7/2018	22:00	21.7	19.0	21.3	18.9	21.6	19.0	18.3
7/7/2018	23:00	20.6	18.3	19.8	18.3	19.9	18.3	17.2
7/7/2018	0:00	19.8	17.7	19.8	17.6	19.2	17.7	16.7
7/8/2018	1:00	15.8	15.6	15.7	15.5	15.5	15.6	15.0
7/8/2018	2:00	15.6	15.1	15.5	15.0	15.4	15.0	15.0
7/8/2018	3:00	15.3	14.8	15.0	14.9	15.0	14.7	14.4
7/8/2018	4:00	15.5	15.4	15.5	15.4	15.4	15.5	14.4
7/8/2018	5:00	14.4	14.4	14.5	14.2	14.3	14.3	14.4
7/8/2018	6:00	17.6	17.7	17.9	17.7	17.8	17.6	16.7
7/8/2018	7:00	20.4	19.8	20.1	19.7	20.1	19.8	18.9
7/8/2018	8:00	22.3	21.7	22.1	21.7	21.9	21.6	21.7
7/8/2018	9:00	26.5	24.5	25.5	24.4	25.6	24.4	23.9
7/8/2018	10:00	27.0	25.9	27.7	25.8	27.5	25.8	25.6
7/8/2018	11:00	29.0	27.2	28.9	27.2	29.3	27.2	26.7
7/8/2018	12:00	29.8	27.5	29.8	27.3	30.2	27.5	26.7

7/8/2018	13:00	30.4	27.7	30.2	27.7	30.7	27.7	27.2
7/8/2018	14:00	31.8	29.2	31.9	29.1	32.5	29.0	28.3
7/8/2018	15:00	32.7	28.8	31.7	28.6	32.8	28.8	28.3
7/8/2018	16:00	33.0	28.2	32.7	28.2	31.8	28.2	28.3
7/8/2018	17:00	33.6	29.5	34.0	29.4	33.8	29.4	28.3
7/8/2018	18:00	33.1	29.0	32.9	28.8	32.2	28.9	27.8
7/8/2018	19:00	28.8	25.5	29.1	25.3	29.3	25.4	25.6
7/8/2018	20:00	25.4	22.6	25.1	22.6	25.1	22.5	22.2
7/8/2018	21:00	23.7	21.1	24.1	21.0	23.8	21.0	20.6
7/8/2018	22:00	23.6	20.9	23.2	20.9	23.2	20.9	20.0
7/8/2018	23:00	21.7	19.6	21.7	19.5	21.4	19.5	19.4
7/8/2018	0:00	22.5	20.3	22.1	20.2	21.7	20.3	19.4
7/9/2018	1:00	18.8	18.8	18.8	18.8	19.0	18.8	18.9
7/9/2018	2:00	20.1	20.0	20.4	19.9	20.1	19.8	19.4
7/9/2018	3:00	19.8	19.4	19.5	19.4	19.5	19.4	18.9
7/9/2018	4:00	19.5	19.5	19.7	19.4	19.7	19.4	18.3
7/9/2018	5:00	19.0	18.9	18.8	18.8	19.0	18.8	18.3
7/9/2018	6:00	21.6	21.7	21.6	21.6	21.9	21.6	21.7
7/9/2018	7:00	25.5	24.9	25.0	24.9	25.0	24.9	23.9
7/9/2018	8:00	27.1	26.3	26.8	26.2	26.5	26.2	26.1
7/9/2018	9:00	29.5	28.3	29.4	28.2	29.3	28.2	27.8
7/9/2018	10:00	30.9	29.7	31.4	29.6	31.3	29.6	28.9
7/9/2018	11:00	31.5	29.9	31.6	29.8	31.9	29.9	29.4
7/9/2018	12:00	32.4	29.5	32.2	29.4	31.7	29.5	29.4
7/9/2018	13:00	33.9	31.1	33.4	31.0	33.5	31.1	30.6
7/9/2018	14:00	35.1	32.2	34.7	32.1	35.1	32.1	31.1
7/9/2018	15:00	34.7	31.4	34.8	31.3	35.5	31.3	31.1
7/9/2018	16:00	36.2	31.6	35.2	31.4	36.2	31.5	30.6
7/9/2018	17:00	35.1	31.6	34.9	31.5	35.5	31.6	30.6
7/9/2018	18:00	33.0	29.9	33.5	29.8	34.3	29.8	29.4
7/9/2018	19:00	32.0	28.7	31.6	28.6	32.0	28.6	27.8
7/9/2018	20:00	28.8	25.7	28.6	25.6	28.1	25.5	25.6
7/9/2018	21:00	28.2	25.7	28.3	25.6	28.5	25.7	25.0
7/9/2018	22:00	27.1	24.8	27.3	24.7	26.8	24.8	24.4
7/9/2018	23:00	27.0	24.6	26.6	24.6	26.2	24.5	23.9
7/9/2018	0:00	25.4	23.9	25.8	23.9	25.8	23.8	23.3
7/10/2018	1:00	23.8	23.3	23.2	23.2	23.2	23.2	22.8
7/10/2018	2:00	23.8	23.4	23.6	23.4	23.8	23.4	22.2
7/10/2018	3:00	22.2	22.1	22.1	22.1	22.4	22.0	21.7
7/10/2018	4:00	21.4	21.4	21.4	21.5	21.6	21.3	21.1
7/10/2018	5:00	22.3	22.2	22.3	22.1	22.2	22.2	21.1

7/10/2018	6:00	22.9	23.0	23.0	22.9	23.1	23.1	22.8
7/10/2018	7:00	26.3	25.8	25.9	25.8	25.8	25.7	25.0
7/10/2018	8:00	28.3	27.6	27.9	27.6	28.0	27.5	27.2
7/10/2018	9:00	32.3	30.5	31.6	30.5	31.5	30.4	29.4
7/10/2018	10:00	32.9	30.9	32.3	30.9	32.2	30.9	30.6
7/10/2018	11:00	33.9	31.5	33.3	31.5	33.1	31.3	31.1
7/10/2018	12:00	34.9	32.8	35.0	32.7	35.0	32.8	31.7
7/10/2018	13:00	35.4	32.4	35.3	32.3	35.2	32.4	31.7
7/10/2018	14:00	35.1	31.8	35.2	31.8	35.2	31.8	31.7
7/10/2018	15:00	34.2	30.1	33.2	30.1	34.2	30.0	30.0
7/10/2018	16:00	28.7	25.0	29.3	24.9	29.1	24.9	25.0
7/10/2018	17:00	29.0	25.6	29.0	25.5	29.3	25.5	24.4
7/10/2018	18:00	28.0	24.9	29.5	24.8	28.2	24.9	25.0
7/10/2018	19:00	30.2	26.5	30.4	26.4	30.3	26.4	25.6
7/10/2018	20:00	29.0	25.7	29.4	25.6	28.3	25.6	25.0
7/10/2018	21:00	27.5	24.5	27.5	24.5	27.2	24.4	23.9
7/10/2018	22:00	25.0	22.2	25.0	22.1	25.1	22.2	22.2
7/10/2018	23:00	23.6	21.6	23.1	21.6	23.4	21.5	21.7
7/10/2018	0:00	23.8	21.6	23.5	21.6	23.1	21.5	21.1
7/11/2018	1:00	20.8	20.5	20.8	20.4	20.4	20.5	20.0
7/11/2018	2:00	21.2	20.7	21.1	20.6	21.0	20.7	20.0
7/11/2018	3:00	21.0	20.6	20.6	20.5	20.6	20.4	19.4
7/11/2018	4:00	18.1	18.1	18.0	18.0	18.3	18.0	17.8
7/11/2018	5:00	17.7	17.7	17.7	17.7	17.8	17.8	16.7
7/11/2018	6:00	20.4	20.2	20.3	20.2	20.1	20.1	19.4
7/11/2018	7:00	22.8	22.2	22.5	22.2	22.2	22.3	21.7
7/11/2018	8:00	23.9	23.1	23.3	23.1	23.6	23.0	22.8
7/11/2018	9:00	26.5	24.6	25.6	24.5	25.6	24.4	23.9
7/11/2018	10:00	28.4	26.4	27.8	26.4	27.8	26.4	25.6
7/11/2018	11:00	28.7	26.6	28.7	26.5	28.5	26.6	26.7
7/11/2018	12:00	30.7	28.6	31.3	28.5	31.1	28.5	27.8
7/11/2018	13:00	30.7	28.4	30.5	28.4	30.6	28.4	28.3
7/11/2018	14:00	32.9	29.6	32.4	29.6	32.6	29.6	28.9
7/11/2018	15:00	33.1	29.6	33.4	29.6	33.7	29.6	28.9
7/11/2018	16:00	33.0	29.3	33.8	29.2	33.9	29.2	28.3
7/11/2018	17:00	32.3	27.9	31.3	27.8	31.3	27.9	27.8
7/11/2018	18:00	30.6	27.6	31.2	27.5	31.5	27.4	27.2
7/11/2018	19:00	29.1	26.3	29.9	26.3	30.2	26.2	25.6
7/11/2018	20:00	27.4	24.1	27.3	24.0	27.1	23.9	23.3
7/11/2018	21:00	25.1	22.5	25.6	22.4	25.6	22.3	22.2
7/11/2018	22:00	23.2	20.5	23.2	20.4	22.5	20.4	20.6

7/11/2018	23:00	22.1	20.5	22.0	20.5	22.2	20.4	20.6
7/11/2018	0:00	22.1	20.0	21.6	19.9	21.8	19.8	19.4
7/12/2018	1:00	20.3	20.2	20.4	20.1	20.6	20.2	19.4
7/12/2018	2:00	20.3	19.8	19.9	19.8	20.1	19.6	18.9
7/12/2018	3:00	18.8	18.8	19.2	18.8	19.1	18.7	18.3
7/12/2018	4:00	18.1	17.8	17.8	17.8	17.8	17.7	17.8
7/12/2018	5:00	18.3	18.2	18.2	18.2	18.2	18.1	17.2
7/12/2018	6:00	19.8	19.6	19.6	19.5	19.7	19.7	19.4
7/12/2018	7:00	22.2	21.9	22.2	21.9	22.1	21.8	21.1
7/12/2018	8:00	24.7	23.9	24.2	23.9	24.0	23.9	22.8
7/12/2018	9:00	27.1	26.0	27.0	25.9	26.9	25.9	25.0
7/12/2018	10:00	29.0	27.3	29.0	27.3	28.8	27.2	26.1
7/12/2018	11:00	29.8	27.5	29.3	27.5	29.6	27.4	27.2
7/12/2018	12:00	30.8	28.3	30.9	28.2	30.3	28.2	27.8
7/12/2018	13:00	30.9	28.4	31.2	28.4	31.1	28.2	28.3
7/12/2018	14:00	33.0	29.2	33.0	29.3	32.0	29.2	28.3
7/12/2018	15:00	32.3	28.8	31.9	28.8	32.8	28.8	28.9
7/12/2018	16:00	34.0	29.5	34.0	29.4	33.9	29.4	28.3
7/12/2018	17:00	33.3	28.9	32.4	28.8	33.2	28.8	28.3
7/12/2018	18:00	32.4	28.1	31.7	28.0	31.9	28.0	27.2
7/12/2018	19:00	28.1	24.8	28.4	24.7	28.2	24.6	24.4
7/12/2018	20:00	25.6	22.3	25.9	22.2	26.1	22.2	21.7
7/12/2018	21:00	24.5	21.5	24.4	21.4	24.2	21.5	21.1
7/12/2018	22:00	22.1	20.0	22.1	20.0	22.2	20.0	19.4
7/12/2018	23:00	21.6	19.6	21.5	19.5	21.9	19.4	19.4
7/12/2018	0:00	22.0	20.4	22.5	20.3	22.5	20.4	19.4
7/13/2018	1:00	18.3	18.3	18.4	18.2	18.4	18.3	17.2
7/13/2018	2:00	17.8	17.6	17.9	17.4	17.6	17.5	17.2
7/13/2018	3:00	17.6	17.2	17.3	17.1	17.1	17.3	17.2
7/13/2018	4:00	18.3	18.1	18.1	18.1	18.1	18.0	17.2
7/13/2018	5:00	18.8	18.7	18.7	18.6	18.6	18.5	17.8
7/13/2018	6:00	19.7	19.5	19.4	19.4	19.4	19.4	18.9
7/13/2018	7:00	22.2	21.6	21.9	21.6	21.9	21.6	21.7
7/13/2018	8:00	25.6	25.1	25.4	25.0	25.5	25.1	24.4
7/13/2018	9:00	28.4	27.2	28.2	27.1	28.2	27.2	26.1
7/13/2018	10:00	29.0	27.3	28.9	27.3	28.8	27.3	27.2
7/13/2018	11:00	30.9	28.5	30.2	28.5	30.4	28.5	28.3
7/13/2018	12:00	32.9	30.6	33.0	30.6	32.8	30.5	29.4
7/13/2018	13:00	33.8	31.2	33.9	31.1	33.9	31.0	30.0
7/13/2018	14:00	34.6	30.8	33.4	30.8	34.6	30.8	30.0
7/13/2018	15:00	35.2	31.1	35.2	31.2	35.0	31.1	30.0

7/13/2018	16:00	34.1	30.6	35.4	30.6	34.9	30.5	30.0
7/13/2018	17:00	33.3	29.6	33.3	29.6	34.1	29.6	29.4
7/13/2018	18:00	33.1	28.9	33.0	28.8	32.1	28.9	28.3
7/13/2018	19:00	29.6	26.4	30.1	26.2	29.4	26.2	25.6
7/13/2018	20:00	26.0	23.1	26.0	23.0	26.5	23.2	22.2
7/13/2018	21:00	24.8	22.3	24.9	22.2	24.8	22.2	22.2
7/13/2018	22:00	24.6	22.6	25.1	22.6	24.7	22.6	22.2
7/13/2018	23:00	23.6	21.5	23.7	21.5	23.1	21.5	21.1
7/13/2018	0:00	22.8	20.7	22.7	20.7	22.8	20.6	20.6
7/14/2018	1:00	20.2	20.1	20.0	20.0	20.1	20.1	19.4
7/14/2018	2:00	20.8	20.5	20.7	20.5	20.5	20.4	19.4
7/14/2018	3:00	20.1	19.7	19.8	19.6	19.9	19.6	19.4
7/14/2018	4:00	20.0	19.7	19.8	19.6	19.6	19.7	18.9
7/14/2018	5:00	20.1	19.9	20.0	19.9	19.8	19.8	19.4
7/14/2018	6:00	21.7	21.4	21.6	21.4	21.3	21.2	20.6
7/14/2018	7:00	24.8	24.8	24.8	24.7	24.9	24.7	24.4
7/14/2018	8:00	27.2	26.4	26.6	26.4	26.7	26.4	26.1
7/14/2018	9:00	25.7	23.9	25.0	23.9	25.0	23.9	22.8
7/14/2018	10:00	24.0	22.8	24.6	22.7	24.4	22.7	21.7
7/14/2018	11:00	25.3	22.9	24.9	22.9	24.4	22.8	22.8
7/14/2018	12:00	24.6	22.2	24.8	22.1	24.4	22.1	22.2
7/14/2018	13:00	26.1	23.5	25.8	23.5	26.6	23.4	23.3
7/14/2018	14:00	30.1	26.6	29.6	26.5	29.9	26.6	25.6
7/14/2018	15:00	31.5	27.7	31.0	27.5	31.2	27.7	26.7
7/14/2018	16:00	31.6	28.0	31.7	28.0	31.7	28.0	27.2
7/14/2018	17:00	29.8	26.1	29.8	26.1	30.0	26.0	26.1
7/14/2018	18:00	28.4	24.4	28.9	24.4	27.8	24.4	24.4
7/14/2018	19:00	27.8	23.9	27.6	23.9	26.7	23.7	23.9
7/14/2018	20:00	25.7	22.8	26.3	22.8	26.3	22.7	22.8
7/14/2018	21:00	25.2	22.5	25.5	22.5	25.3	22.5	22.2
7/14/2018	22:00	25.2	22.9	25.7	22.9	25.0	22.8	22.2
7/14/2018	23:00	24.8	22.6	24.1	22.6	24.5	22.5	21.7
7/14/2018	0:00	24.6	22.7	24.5	22.6	24.1	22.6	22.2
7/15/2018	1:00	23.3	22.8	22.8	22.8	22.8	22.8	21.7
7/15/2018	2:00	21.8	21.8	21.9	21.7	22.2	21.8	21.7
7/15/2018	3:00	21.5	21.6	21.8	21.5	21.5	21.5	21.7
7/15/2018	4:00	22.0	22.0	22.0	22.0	22.1	21.9	21.1
7/15/2018	5:00	22.2	22.1	22.3	22.0	22.2	22.0	21.1
7/15/2018	6:00	22.0	22.0	22.1	21.9	22.0	21.9	21.7
7/15/2018	7:00	23.6	23.4	23.5	23.3	23.6	23.3	23.3
7/15/2018	8:00	25.4	24.9	25.3	24.8	25.2	24.9	24.4

7/15/2018	9:00	27.0	25.2	26.3	25.1	26.3	25.2	25.0
7/15/2018	10:00	28.3	26.3	27.5	26.3	27.8	26.3	26.1
7/15/2018	11:00	29.2	27.1	28.7	27.1	29.1	27.0	26.7
7/15/2018	12:00	30.1	27.3	29.9	27.2	29.8	27.2	26.7
7/15/2018	13:00	30.4	27.9	30.9	27.8	30.1	27.9	27.2
7/15/2018	14:00	30.6	27.5	31.1	27.4	30.9	27.4	27.2
7/15/2018	15:00	31.6	28.3	31.9	28.2	32.0	28.3	27.8
7/15/2018	16:00	30.4	26.5	30.7	26.3	30.5	26.5	26.1
7/15/2018	17:00	28.5	24.7	28.4	24.7	28.5	24.7	23.9
7/15/2018	18:00	28.2	25.1	28.8	25.1	29.4	25.0	24.4
7/15/2018	19:00	28.9	25.2	28.0	25.1	28.4	25.1	25.0
7/15/2018	20:00	28.2	24.7	27.4	24.6	28.2	24.7	23.9
7/15/2018	21:00	26.1	23.1	26.0	23.0	26.0	23.1	22.8
7/15/2018	22:00	24.7	22.5	25.1	22.4	25.4	22.4	22.2
7/15/2018	23:00	25.9	23.5	25.2	23.5	25.6	23.4	22.8
7/15/2018	0:00	25.2	23.7	25.1	23.6	25.3	23.6	22.8
7/16/2018	1:00	23.2	22.9	23.2	22.8	22.9	22.9	22.8
7/16/2018	2:00	22.3	22.3	22.8	22.4	22.3	22.2	22.2
7/16/2018	3:00	23.1	22.7	22.8	22.6	23.1	22.6	22.2
7/16/2018	4:00	22.4	22.3	22.3	22.2	22.4	22.2	22.2
7/16/2018	5:00	22.8	22.7	22.9	22.7	22.8	22.7	22.2
7/16/2018	6:00	23.1	23.1	23.2	23.1	23.2	23.0	22.8
7/16/2018	7:00	25.1	24.8	25.0	24.9	25.0	24.8	23.9
7/16/2018	8:00	25.5	25.1	25.5	25.0	25.5	25.1	24.4
7/16/2018	9:00	28.8	27.1	28.1	27.1	28.3	27.0	26.7
7/16/2018	10:00	30.1	28.9	30.5	28.9	30.2	28.9	27.8
7/16/2018	11:00	31.4	29.1	31.0	29.0	31.0	29.0	28.9
7/16/2018	12:00	32.6	29.7	32.0	29.6	32.0	29.5	29.4
7/16/2018	13:00	34.0	30.7	33.0	30.5	33.7	30.7	30.0
7/16/2018	14:00	34.1	30.5	33.5	30.3	33.8	30.3	30.6
7/16/2018	15:00	33.6	30.0	33.4	29.9	33.2	29.9	30.0
7/16/2018	16:00	35.1	30.8	35.5	30.8	34.7	30.8	30.0
7/16/2018	17:00	33.6	29.7	33.6	29.6	33.0	29.7	29.4
7/16/2018	18:00	32.9	29.5	33.6	29.5	33.4	29.5	28.3
7/16/2018	19:00	29.2	26.1	29.2	26.0	29.5	26.0	25.6
7/16/2018	20:00	28.0	24.7	27.2	24.7	28.3	24.6	24.4
7/16/2018	21:00	26.2	23.4	26.5	23.4	26.0	23.4	23.3
7/16/2018	22:00	26.6	24.4	27.2	24.3	26.7	24.3	23.3
7/16/2018	23:00	26.3	23.9	26.0	23.9	25.8	23.8	23.3
7/16/2018	0:00	25.6	23.4	25.3	23.3	25.3	23.3	22.2
7/17/2018	1:00	22.5	22.3	22.4	22.2	22.6	22.2	21.7

7/17/2018	2:00	21.0	20.5	20.9	20.4	20.8	20.5	20.6
7/17/2018	3:00	20.2	20.0	20.3	20.0	20.4	20.0	20.0
7/17/2018	4:00	20.8	20.7	20.6	20.6	20.9	20.7	20.6
7/17/2018	5:00	21.2	21.1	21.1	21.1	21.2	21.2	20.0
7/17/2018	6:00	21.3	21.0	20.9	21.0	21.1	20.9	20.6
7/17/2018	7:00	24.2	24.1	24.0	24.0	24.4	24.0	23.3
7/17/2018	8:00	26.1	25.9	26.2	25.8	26.2	25.8	25.6
7/17/2018	9:00	27.8	26.7	27.8	26.7	27.8	26.6	26.7
7/17/2018	10:00	29.0	27.6	29.4	27.6	29.2	27.5	27.2
7/17/2018	11:00	29.8	28.1	29.6	28.0	30.0	28.0	27.8
7/17/2018	12:00	32.2	29.6	32.0	29.5	31.7	29.6	28.9
7/17/2018	13:00	32.1	29.3	32.4	29.2	32.5	29.3	28.9
7/17/2018	14:00	32.3	29.5	32.4	29.5	33.2	29.3	28.3
7/17/2018	15:00	31.5	27.5	31.5	27.5	31.1	27.3	27.2
7/17/2018	16:00	33.3	28.4	33.0	28.3	32.2	28.4	28.3
7/17/2018	17:00	32.2	28.3	32.1	28.3	32.9	28.3	27.2
7/17/2018	18:00	30.3	26.9	30.6	26.9	30.6	26.9	26.7
7/17/2018	19:00	26.8	23.4	27.2	23.4	26.4	23.2	23.3
7/17/2018	20:00	25.8	23.0	26.1	23.1	25.9	23.0	22.8
7/17/2018	21:00	26.5	23.8	26.5	23.7	26.6	23.7	23.3
7/17/2018	22:00	24.8	22.7	24.9	22.6	25.4	22.6	21.7
7/17/2018	23:00	22.3	19.9	21.4	19.9	21.9	19.9	20.0
7/17/2018	0:00	21.5	19.3	21.3	19.3	20.9	19.4	18.9
7/18/2018	1:00	18.7	18.3	18.4	18.3	18.6	18.2	17.8
7/18/2018	2:00	18.3	17.8	17.9	17.8	18.0	17.7	17.8
7/18/2018	3:00	17.4	17.2	17.2	17.1	17.7	17.2	17.2
7/18/2018	4:00	17.2	17.2	17.4	17.1	17.2	17.1	16.1
7/18/2018	5:00	15.2	15.3	15.4	15.2	15.2	15.2	15.0
7/18/2018	6:00	18.4	18.3	18.5	18.3	18.2	18.2	18.3
7/18/2018	7:00	19.8	19.6	19.9	19.5	19.9	19.5	19.4
7/18/2018	8:00	21.5	21.3	21.7	21.3	21.8	21.3	21.1
7/18/2018	9:00	23.9	22.9	24.0	22.8	23.9	22.8	22.8
7/18/2018	10:00	26.0	24.8	26.4	24.7	26.2	24.8	24.4
7/18/2018	11:00	27.2	25.6	27.6	25.5	27.2	25.5	25.6
7/18/2018	12:00	28.1	25.5	27.7	25.4	28.1	25.4	25.6
7/18/2018	13:00	29.6	26.7	29.3	26.6	29.3	26.6	26.1
7/18/2018	14:00	29.9	26.7	29.2	26.7	29.5	26.7	26.1
7/18/2018	15:00	30.9	26.5	29.9	26.4	30.1	26.5	26.1
7/18/2018	16:00	30.6	26.5	30.2	26.5	30.9	26.6	26.1
7/18/2018	17:00	30.4	26.1	30.5	26.1	30.3	26.0	25.6
7/18/2018	18:00	29.4	25.0	29.2	25.0	28.2	25.0	23.9

7/18/2018	19:00	25.9	22.3	25.7	22.2	25.4	22.3	22.2
7/18/2018	20:00	23.3	20.5	24.0	20.4	23.2	20.4	19.4
7/18/2018	21:00	23.0	20.5	23.3	20.5	23.5	20.4	20.6
7/18/2018	22:00	22.7	20.1	22.7	20.0	22.1	20.0	20.0
7/18/2018	23:00	20.0	18.3	19.8	18.2	19.8	18.2	18.3
7/18/2018	0:00	20.2	18.3	20.4	18.1	20.0	18.2	17.8
7/19/2018	1:00	17.0	16.9	17.1	16.9	16.7	16.8	16.1
7/19/2018	2:00	17.8	17.7	17.9	17.6	17.6	17.7	16.7
7/19/2018	3:00	19.4	19.0	19.2	18.8	19.1	19.0	17.8
7/19/2018	4:00	17.3	17.1	17.0	17.0	17.1	17.0	16.1
7/19/2018	5:00	16.8	16.6	16.5	16.6	16.5	16.5	15.6
7/19/2018	6:00	17.7	17.5	17.5	17.5	17.4	17.4	16.7
7/19/2018	7:00	20.0	19.5	19.7	19.4	19.8	19.4	19.4
7/19/2018	8:00	22.5	22.1	22.3	22.0	22.2	22.0	21.7
7/19/2018	9:00	25.8	24.4	25.4	24.3	25.5	24.4	24.4
7/19/2018	10:00	27.8	26.1	27.1	26.1	27.2	26.1	26.1
7/19/2018	11:00	30.3	28.2	29.7	28.1	30.1	28.1	27.2
7/19/2018	12:00	29.3	26.7	29.1	26.5	29.4	26.5	26.7
7/19/2018	13:00	31.9	28.9	31.1	28.7	31.9	28.7	27.8
7/19/2018	14:00	30.9	28.2	30.8	28.1	31.0	28.0	27.2
7/19/2018	15:00	30.8	26.6	30.1	26.5	29.8	26.4	26.7
7/19/2018	16:00	33.3	29.0	33.3	28.9	32.8	28.8	27.8
7/19/2018	17:00	31.4	27.8	31.9	27.7	31.8	27.7	27.2
7/19/2018	18:00	31.6	27.4	30.4	27.4	31.0	27.3	26.7
7/19/2018	19:00	28.9	25.2	28.4	25.0	28.1	25.1	25.0
7/19/2018	20:00	25.8	22.6	25.8	22.6	26.0	22.6	22.2
7/19/2018	21:00	24.9	22.2	25.4	22.1	24.9	22.1	22.2
7/19/2018	22:00	26.6	23.9	25.9	23.9	26.7	23.8	22.8
7/19/2018	23:00	26.4	23.9	25.5	23.9	26.0	23.8	23.9
7/19/2018	0:00	26.1	24.0	25.4	23.9	25.3	23.9	23.3
7/20/2018	1:00	23.9	23.7	24.0	23.5	24.0	23.7	23.3
7/20/2018	2:00	21.0	20.8	21.2	20.8	20.8	20.7	20.6
7/20/2018	3:00	19.9	19.9	20.1	19.8	20.2	19.9	20.0
7/20/2018	4:00	21.9	21.7	21.8	21.7	21.8	21.7	20.6
7/20/2018	5:00	20.7	20.8	20.8	20.7	20.8	20.6	20.6
7/20/2018	6:00	21.6	21.5	21.6	21.4	21.5	21.4	21.1
7/20/2018	7:00	24.1	24.0	24.1	23.9	24.1	24.0	23.9
7/20/2018	8:00	27.2	26.5	26.8	26.6	26.9	26.5	26.1
7/20/2018	9:00	29.1	27.2	28.3	27.2	28.2	27.1	27.2
7/20/2018	10:00	27.8	26.4	27.9	26.3	27.6	26.4	25.6
7/20/2018	11:00	28.1	25.7	27.4	25.6	27.3	25.7	25.0

7/20/2018	12:00	29.5	26.6	28.8	26.5	28.6	26.5	25.6
7/20/2018	13:00	28.9	25.7	28.3	25.7	28.3	25.6	25.6
7/20/2018	14:00	30.1	26.2	29.6	26.1	28.8	26.2	26.1
7/20/2018	15:00	29.8	25.6	29.7	25.6	29.8	25.6	24.4
7/20/2018	16:00	31.4	26.4	30.1	26.4	31.0	26.4	26.1
7/20/2018	17:00	29.9	25.8	29.2	25.7	30.1	25.8	25.0
7/20/2018	18:00	28.6	24.8	28.0	24.8	28.5	24.8	23.9
7/20/2018	19:00	25.8	22.9	26.3	22.9	26.4	22.8	22.8
7/20/2018	20:00	26.3	23.0	26.3	23.0	26.3	23.0	22.2
7/20/2018	21:00	24.4	21.5	24.4	21.5	24.5	21.4	20.6
7/20/2018	22:00	23.0	20.8	23.2	20.7	22.8	20.7	20.6
7/20/2018	23:00	21.9	20.0	21.7	19.9	22.3	19.9	20.0
7/20/2018	0:00	22.8	20.9	22.4	20.8	22.4	20.7	20.0
7/21/2018	1:00	20.2	19.9	19.8	19.7	20.0	19.8	19.4
7/21/2018	2:00	20.4	20.3	20.7	20.3	20.7	20.2	19.4
7/21/2018	3:00	20.4	19.9	20.3	19.8	20.1	19.8	18.9
7/21/2018	4:00	19.9	19.7	19.9	19.7	19.8	19.6	18.9
7/21/2018	5:00	19.6	19.6	19.5	19.5	19.5	19.6	19.4
7/21/2018	6:00	21.0	20.8	20.9	20.7	20.9	20.7	20.0
7/21/2018	7:00	21.7	21.2	21.2	21.1	21.4	21.1	20.0
7/21/2018	8:00	21.3	20.7	20.9	20.6	21.2	20.7	20.6
7/21/2018	9:00	24.1	22.1	23.3	22.1	23.2	22.1	21.1
7/21/2018	10:00	23.2	21.2	22.1	21.0	23.0	21.1	21.1
7/21/2018	11:00	24.2	22.1	23.9	22.1	23.7	22.0	21.7
7/21/2018	12:00	24.7	22.7	24.8	22.7	25.0	22.6	22.2
7/21/2018	13:00	25.6	22.9	25.8	22.8	25.4	22.9	22.8
7/21/2018	14:00	28.2	24.8	28.1	24.8	27.4	24.7	24.4
7/21/2018	15:00	30.2	26.1	29.3	26.0	29.2	26.0	26.1
7/21/2018	16:00	30.1	26.0	30.1	26.0	30.2	25.9	26.1
7/21/2018	17:00	30.7	26.5	30.2	26.5	30.1	26.4	25.6
7/21/2018	18:00	30.1	25.8	29.8	25.7	29.4	25.7	25.0
7/21/2018	19:00	25.4	22.1	25.9	22.0	25.0	22.0	21.7
7/21/2018	20:00	24.1	20.9	24.3	20.8	24.2	20.8	20.0
7/21/2018	21:00	23.6	20.6	23.7	20.6	23.6	20.5	20.0
7/21/2018	22:00	23.2	20.5	22.9	20.4	23.3	20.5	19.4
7/21/2018	23:00	22.3	20.6	22.5	20.5	22.3	20.5	19.4
7/21/2018	0:00	22.0	20.1	22.3	20.1	22.0	20.1	20.0
7/22/2018	1:00	20.3	19.9	20.3	19.9	20.3	19.9	20.0
7/22/2018	2:00	21.3	20.9	20.8	20.8	21.3	20.9	20.0
7/22/2018	3:00	20.4	20.1	20.3	20.1	19.9	20.1	20.0
7/22/2018	4:00	20.3	20.0	20.3	20.0	20.2	19.9	20.0

7/22/2018	5:00	21.2	21.1	21.2	21.1	21.1	21.0	20.0
7/22/2018	6:00	21.1	20.8	20.8	20.7	21.0	20.8	20.0
7/22/2018	7:00	21.8	21.5	21.8	21.5	21.9	21.5	20.6
7/22/2018	8:00	22.9	22.3	22.6	22.2	22.7	22.3	21.7
7/22/2018	9:00	25.4	23.7	24.7	23.5	24.7	23.6	22.8
7/22/2018	10:00	25.2	24.0	25.4	23.8	25.1	24.0	23.3
7/22/2018	11:00	25.3	23.6	25.4	23.6	25.2	23.5	23.3
7/22/2018	12:00	27.0	24.9	27.6	24.8	27.6	24.8	25.0
7/22/2018	13:00	26.8	24.0	26.5	23.9	26.9	24.0	23.3
7/22/2018	14:00	29.5	25.5	29.0	25.4	28.7	25.5	25.0
7/22/2018	15:00	30.2	26.8	30.0	26.8	30.9	26.8	26.7
7/22/2018	16:00	30.9	26.1	30.3	26.0	30.3	26.0	26.1
7/22/2018	17:00	26.7	23.2	27.1	23.1	27.0	23.1	22.8
7/22/2018	18:00	26.1	22.6	26.7	22.5	27.1	22.6	22.2
7/22/2018	19:00	26.5	22.7	25.9	22.7	25.8	22.7	22.2
7/22/2018	20:00	24.3	21.2	24.4	21.1	24.4	21.2	21.1
7/22/2018	21:00	23.7	21.1	24.1	21.1	24.3	21.2	20.6
7/22/2018	22:00	22.6	19.9	22.1	19.9	22.9	19.9	20.0
7/22/2018	23:00	22.8	20.7	22.3	20.7	22.5	20.6	20.0
7/22/2018	0:00	21.0	19.4	21.0	19.4	21.0	19.4	19.4
7/23/2018	1:00	19.1	18.6	19.0	18.5	18.7	18.5	18.3
7/23/2018	2:00	18.3	18.2	18.6	18.2	18.5	18.2	17.2
7/23/2018	3:00	16.4	16.3	16.5	16.1	16.6	16.2	16.1
7/23/2018	4:00	17.3	17.4	17.2	17.3	17.4	17.4	17.2
7/23/2018	5:00	19.0	18.9	18.8	18.9	19.0	18.7	17.8
7/23/2018	6:00	18.5	18.3	18.4	18.3	18.2	18.2	18.3
7/23/2018	7:00	20.1	19.7	19.7	19.6	19.8	19.6	19.4
7/23/2018	8:00	20.9	20.1	20.3	20.0	20.4	20.1	20.0
7/23/2018	9:00	25.0	23.4	24.4	23.3	24.5	23.3	22.8
7/23/2018	10:00	26.6	25.0	26.7	25.1	26.5	25.0	24.4
7/23/2018	11:00	28.9	26.7	28.8	26.6	28.7	26.8	25.6
7/23/2018	12:00	29.0	26.6	29.2	26.5	28.6	26.5	26.1
7/23/2018	13:00	30.5	28.0	31.0	28.0	31.0	28.0	27.2
7/23/2018	14:00	28.9	25.9	29.6	25.7	29.6	25.7	25.0
7/23/2018	15:00	29.9	26.9	30.3	26.9	30.0	26.7	26.7
7/23/2018	16:00	32.1	28.3	32.4	28.3	33.1	28.3	27.2
7/23/2018	17:00	31.0	27.0	30.7	26.9	30.7	26.9	26.1
7/23/2018	18:00	31.3	27.1	31.3	27.0	30.5	27.1	26.1
7/23/2018	19:00	27.5	23.9	27.2	23.8	26.7	23.7	22.8
7/23/2018	20:00	24.1	21.2	24.0	21.2	24.9	21.1	21.1
7/23/2018	21:00	23.4	20.5	23.4	20.4	23.5	20.4	20.6

7/23/2018	22:00	22.9	20.8	23.4	20.8	22.9	20.8	20.0
7/23/2018	23:00	22.4	20.6	22.4	20.6	22.3	20.5	19.4
7/23/2018	0:00	21.5	19.7	21.7	19.7	21.8	19.5	18.9
7/24/2018	1:00	18.5	18.0	18.2	17.9	18.1	18.0	17.8
7/24/2018	2:00	18.2	18.1	18.2	18.0	18.4	18.0	17.8
7/24/2018	3:00	18.6	18.6	18.6	18.6	18.7	18.5	17.8
7/24/2018	4:00	17.7	17.7	17.9	17.7	17.9	17.7	17.2
7/24/2018	5:00	16.8	16.7	16.7	16.7	16.7	16.6	16.1
7/24/2018	6:00	18.7	18.6	18.7	18.6	18.5	18.5	17.8
7/24/2018	7:00	21.4	21.1	21.2	21.1	21.2	21.1	21.1
7/24/2018	8:00	24.1	23.9	24.3	23.8	24.4	23.8	23.3
7/24/2018	9:00	27.9	26.2	27.2	26.1	27.2	26.1	25.6
7/24/2018	10:00	29.3	27.8	29.2	27.6	29.5	27.6	26.7
7/24/2018	11:00	29.4	27.8	29.8	27.8	29.4	27.7	27.2
7/24/2018	12:00	30.1	27.8	29.7	27.8	30.1	27.7	27.8
7/24/2018	13:00	31.7	29.1	31.3	29.1	31.5	29.0	28.3
7/24/2018	14:00	33.8	30.0	32.5	30.0	32.8	29.9	28.9
7/24/2018	15:00	33.2	29.3	33.0	29.3	32.6	29.3	28.9
7/24/2018	16:00	34.3	29.3	33.4	29.3	33.4	29.2	28.9
7/24/2018	17:00	32.1	28.3	31.9	28.3	32.7	28.1	28.3
7/24/2018	18:00	30.9	27.7	32.1	27.7	30.6	27.7	27.2
7/24/2018	19:00	27.5	24.4	27.3	24.4	28.1	24.4	23.3
7/24/2018	20:00	25.0	21.8	24.3	21.8	25.2	21.7	21.1
7/24/2018	21:00	24.4	21.8	24.7	21.7	24.4	21.8	21.1
7/24/2018	22:00	22.2	19.6	22.5	19.4	21.9	19.6	19.4
7/24/2018	23:00	21.1	18.8	20.4	18.7	20.9	18.6	18.3
7/24/2018	0:00	20.6	18.4	20.3	18.3	20.5	18.5	18.3
7/25/2018	1:00	17.7	17.6	17.8	17.6	17.8	17.6	17.2
7/25/2018	2:00	16.9	16.9	17.2	16.8	17.2	16.9	16.7
7/25/2018	3:00	16.9	16.6	16.8	16.5	16.9	16.5	16.1
7/25/2018	4:00	16.7	16.6	16.7	16.6	16.6	16.5	16.1
7/25/2018	5:00	16.3	16.2	16.1	16.1	16.2	16.1	15.6
7/25/2018	6:00	18.0	17.8	17.8	17.7	18.0	17.8	17.8
7/25/2018	7:00	21.8	21.5	21.6	21.5	21.5	21.5	20.6
7/25/2018	8:00	23.5	23.3	23.8	23.3	23.8	23.3	23.3
7/25/2018	9:00	26.9	24.9	25.9	24.9	26.0	24.8	25.0
7/25/2018	10:00	29.5	27.5	28.5	27.5	28.6	27.5	26.7
7/25/2018	11:00	29.8	28.2	29.9	28.1	30.3	28.1	27.2
7/25/2018	12:00	30.2	27.7	30.5	27.7	30.2	27.7	27.2
7/25/2018	13:00	31.0	28.1	30.6	28.0	30.8	28.1	27.8
7/25/2018	14:00	31.6	27.9	31.1	27.9	31.3	27.8	27.8

7/25/2018	15:00	33.3	29.1	32.5	28.9	32.3	28.9	28.3
7/25/2018	16:00	31.3	27.1	31.1	27.0	31.9	27.1	26.7
7/25/2018	17:00	31.5	27.5	31.7	27.3	31.2	27.4	26.7
7/25/2018	18:00	29.6	25.3	29.6	25.2	28.4	25.4	25.0
7/25/2018	19:00	26.5	23.5	26.5	23.5	27.1	23.5	23.3
7/25/2018	20:00	25.8	22.3	26.1	22.2	24.9	22.2	21.7
7/25/2018	21:00	22.6	20.0	22.7	19.9	22.6	19.9	20.0
7/25/2018	22:00	23.4	21.1	24.0	21.1	23.6	21.1	20.0
7/25/2018	23:00	21.3	18.8	20.8	18.8	20.8	18.8	18.9
7/25/2018	0:00	20.8	18.5	20.3	18.5	20.6	18.4	18.3
7/26/2018	1:00	18.9	18.6	18.6	18.6	19.1	18.6	18.3
7/26/2018	2:00	18.8	18.9	19.1	18.8	19.1	18.9	17.8
7/26/2018	3:00	18.4	18.4	18.6	18.4	18.8	18.3	18.3
7/26/2018	4:00	18.5	18.3	18.2	18.3	18.4	18.3	17.2
7/26/2018	5:00	18.4	18.4	18.4	18.3	18.4	18.3	18.3
7/26/2018	6:00	19.9	19.8	19.7	19.8	19.7	19.8	18.9
7/26/2018	7:00	21.7	21.3	21.5	21.3	21.6	21.2	21.1
7/26/2018	8:00	23.6	23.3	23.5	23.2	23.8	23.3	22.8
7/26/2018	9:00	26.1	24.7	25.7	24.7	25.7	24.6	24.4
7/26/2018	10:00	27.2	25.9	27.4	25.9	27.5	25.9	25.0
7/26/2018	11:00	28.0	26.2	28.3	26.2	28.3	26.2	25.6
7/26/2018	12:00	29.0	26.2	28.2	26.2	29.0	26.2	26.1
7/26/2018	13:00	29.7	26.4	28.6	26.4	29.3	26.4	25.6
7/26/2018	14:00	30.3	26.4	29.7	26.4	29.9	26.3	26.1
7/26/2018	15:00	28.2	25.2	29.1	25.2	28.5	25.0	25.0
7/26/2018	16:00	29.0	24.6	28.7	24.5	29.2	24.6	23.9
7/26/2018	17:00	27.5	23.7	27.1	23.6	27.1	23.6	23.3
7/26/2018	18:00	27.1	23.4	26.6	23.4	26.4	23.3	22.8
7/26/2018	19:00	24.7	22.0	25.7	21.9	25.4	21.8	21.1
7/26/2018	20:00	22.7	19.4	22.0	19.3	23.2	19.3	19.4
7/26/2018	21:00	21.1	18.2	20.7	18.1	21.1	18.1	17.8
7/26/2018	22:00	19.7	17.3	19.9	17.2	19.2	17.3	17.2
7/26/2018	23:00	18.7	16.3	17.8	16.3	17.8	16.2	16.1
7/26/2018	0:00	17.6	15.7	17.8	15.7	17.1	15.7	15.0
7/27/2018	1:00	16.3	16.3	16.7	16.2	16.6	16.3	15.6
7/27/2018	2:00	15.6	15.4	15.4	15.4	15.6	15.3	14.4
7/27/2018	3:00	14.1	14.1	14.1	14.0	14.1	14.0	13.9
7/27/2018	4:00	14.5	14.6	14.8	14.5	14.5	14.6	13.9
7/27/2018	5:00	13.8	13.7	13.7	13.6	13.8	13.7	13.3
7/27/2018	6:00	14.9	15.0	15.1	14.9	14.9	14.9	15.0
7/27/2018	7:00	18.5	17.9	18.2	17.9	17.9	17.8	17.2

7/27/2018	8:00	20.2	20.0	20.4	19.9	20.1	19.9	19.4
7/27/2018	9:00	22.5	21.3	22.4	21.2	22.3	21.3	20.6
7/27/2018	10:00	23.3	21.6	23.3	21.6	23.0	21.5	21.7
7/27/2018	11:00	25.4	23.0	24.7	23.1	24.9	23.0	22.2
7/27/2018	12:00	25.9	23.5	25.8	23.5	26.0	23.4	23.3
7/27/2018	13:00	28.1	25.5	28.0	25.5	27.9	25.5	24.4
7/27/2018	14:00	28.7	25.1	28.8	25.0	27.8	25.0	24.4
7/27/2018	15:00	28.5	24.9	28.9	24.8	27.9	24.9	24.4
7/27/2018	16:00	28.5	23.5	27.7	23.6	27.3	23.5	23.3
7/27/2018	17:00	26.3	22.5	27.0	22.4	26.0	22.4	22.2
7/27/2018	18:00	27.9	24.1	27.5	24.0	27.8	24.0	23.3
7/27/2018	19:00	22.8	20.0	23.7	19.9	22.9	19.9	20.0
7/27/2018	20:00	22.7	19.8	22.7	19.8	22.7	19.7	18.9
7/27/2018	21:00	21.1	18.2	20.8	18.2	20.8	18.3	17.2
7/27/2018	22:00	20.1	17.5	19.7	17.5	19.9	17.5	16.7
7/27/2018	23:00	18.4	16.6	18.5	16.5	18.8	16.5	16.1
7/27/2018	0:00	17.2	15.7	17.3	15.6	17.3	15.7	15.6
7/28/2018	1:00	14.5	14.6	14.6	14.6	14.7	14.6	14.4
7/28/2018	2:00	14.5	14.4	14.8	14.3	14.8	14.4	13.9
7/28/2018	3:00	14.5	14.2	14.3	14.1	14.3	14.2	13.9
7/28/2018	4:00	15.3	15.1	15.1	15.0	15.2	15.0	13.9
7/28/2018	5:00	13.4	13.3	13.3	13.2	13.4	13.2	13.3
7/28/2018	6:00	15.1	15.1	15.1	15.1	15.0	15.0	15.0
7/28/2018	7:00	18.8	18.3	18.3	18.3	18.3	18.2	17.8
7/28/2018	8:00	22.2	21.7	22.2	21.6	22.2	21.6	20.6
7/28/2018	9:00	24.5	22.8	23.9	22.7	23.9	22.8	22.8
7/28/2018	10:00	25.7	24.1	25.8	24.0	25.9	23.9	23.9
7/28/2018	11:00	26.2	24.3	26.4	24.4	26.3	24.2	23.9
7/28/2018	12:00	27.0	24.6	27.2	24.5	26.6	24.5	24.4
7/28/2018	13:00	28.1	25.1	28.2	25.1	27.9	25.0	25.0
7/28/2018	14:00	28.7	25.6	29.0	25.5	28.5	25.5	25.6
7/28/2018	15:00	29.2	26.1	29.8	26.1	30.0	26.1	25.6
7/28/2018	16:00	29.0	24.9	29.6	24.9	29.0	24.8	25.0
7/28/2018	17:00	28.0	24.1	27.9	24.0	27.9	24.0	23.9
7/28/2018	18:00	28.4	24.1	28.5	24.1	28.2	24.1	23.3
7/28/2018	19:00	24.1	20.6	24.1	20.6	23.6	20.5	20.0
7/28/2018	20:00	23.7	20.2	24.1	20.2	23.0	20.3	19.4
7/28/2018	21:00	21.0	18.2	21.1	18.1	20.9	18.1	17.2
7/28/2018	22:00	19.8	17.8	19.9	17.7	20.3	17.7	16.7
7/28/2018	23:00	17.9	16.1	18.4	16.1	18.1	16.0	16.1
7/28/2018	0:00	18.1	16.5	17.9	16.5	18.0	16.4	15.6

7/29/2018	1:00	15.8	15.6	15.5	15.6	15.9	15.5	15.6
7/29/2018	2:00	15.9	15.5	15.5	15.5	15.4	15.5	15.0
7/29/2018	3:00	17.8	17.8	18.1	17.7	18.1	17.7	16.7
7/29/2018	4:00	17.1	16.9	16.8	16.8	17.1	16.9	16.1
7/29/2018	5:00	16.9	16.9	16.9	16.8	16.9	16.9	16.7
7/29/2018	6:00	17.4	17.3	17.2	17.1	17.4	17.2	16.7
7/29/2018	7:00	17.8	17.7	17.7	17.6	17.7	17.6	17.2
7/29/2018	8:00	19.1	18.8	19.0	18.7	19.3	18.8	17.8
7/29/2018	9:00	20.7	18.7	19.8	18.7	19.8	18.6	17.8
7/29/2018	10:00	20.1	18.4	20.1	18.4	19.5	18.3	18.3
7/29/2018	11:00	20.7	18.4	20.0	18.3	19.9	18.3	17.8
7/29/2018	12:00	20.1	17.9	20.0	17.9	19.9	17.8	17.8
7/29/2018	13:00	21.3	18.4	20.9	18.4	21.0	18.4	17.8
7/29/2018	14:00	22.4	18.8	22.6	18.8	21.5	18.7	18.3
7/29/2018	15:00	23.1	19.8	23.6	19.7	23.5	19.7	18.9
7/29/2018	16:00	24.5	19.5	23.4	19.4	23.9	19.4	19.4
7/29/2018	17:00	24.0	19.7	23.5	19.6	23.6	19.6	19.4
7/29/2018	18:00	22.8	19.2	23.0	19.1	23.7	19.2	18.9
7/29/2018	19:00	21.6	18.5	22.4	18.4	22.4	18.4	18.3
7/29/2018	20:00	22.0	18.7	21.9	18.6	21.8	18.7	18.3
7/29/2018	21:00	21.6	18.7	21.3	18.6	21.3	18.8	17.8
7/29/2018	22:00	20.8	18.6	21.5	18.6	20.7	18.5	17.8
7/29/2018	23:00	20.9	18.5	20.6	18.4	20.6	18.5	17.8
7/29/2018	0:00	20.4	18.8	20.6	18.8	20.6	18.6	17.8
7/30/2018	1:00	18.6	18.6	18.9	18.6	18.6	18.6	17.8
7/30/2018	2:00	19.0	18.9	18.8	18.8	19.4	18.9	17.8
7/30/2018	3:00	17.8	17.4	17.3	17.3	17.8	17.3	17.2
7/30/2018	4:00	17.6	17.6	17.7	17.6	17.5	17.5	17.2
7/30/2018	5:00	18.3	18.2	18.1	18.2	18.3	18.2	17.2
7/30/2018	6:00	17.4	17.3	17.2	17.2	17.3	17.3	17.2
7/30/2018	7:00	18.8	18.5	18.5	18.4	18.7	18.4	17.8
7/30/2018	8:00	20.2	19.9	20.2	19.9	20.3	19.7	18.9
7/30/2018	9:00	22.5	21.2	22.3	21.0	22.2	21.2	20.0
7/30/2018	10:00	21.8	20.3	21.3	20.1	21.5	20.1	20.0
7/30/2018	11:00	24.3	21.9	23.7	21.8	23.4	21.8	21.1
7/30/2018	12:00	25.6	23.2	25.8	23.2	25.8	23.1	22.2
7/30/2018	13:00	25.3	22.3	24.5	22.3	24.9	22.2	21.7
7/30/2018	14:00	25.9	23.3	26.1	23.2	26.8	23.3	22.8
7/30/2018	15:00	28.3	23.9	28.0	23.8	27.9	23.7	23.9
7/30/2018	16:00	28.8	24.5	29.1	24.5	28.0	24.4	23.9
7/30/2018	17:00	28.2	23.9	27.6	23.8	27.8	23.8	23.3

7/30/2018	18:00	27.9	23.6	27.1	23.6	27.5	23.5	22.8
7/30/2018	19:00	23.8	21.0	24.4	21.0	23.9	21.0	20.6
7/30/2018	20:00	22.1	18.8	21.4	18.8	22.6	18.8	18.9
7/30/2018	21:00	22.6	19.9	23.0	19.9	22.6	19.8	18.9
7/30/2018	22:00	21.5	19.4	22.4	19.4	22.2	19.4	18.9
7/30/2018	23:00	20.1	18.2	20.6	18.1	20.5	18.1	17.8
7/30/2018	0:00	20.5	18.6	20.1	18.5	20.4	18.5	17.8
7/31/2018	1:00	18.4	18.4	18.5	18.4	18.5	18.4	18.3
7/31/2018	2:00	19.6	19.5	19.6	19.5	19.4	19.4	18.3
7/31/2018	3:00	18.5	18.4	18.6	18.3	18.7	18.4	18.3
7/31/2018	4:00	18.8	18.6	18.7	18.6	18.7	18.5	18.3
7/31/2018	5:00	19.2	19.3	19.3	19.2	19.4	19.3	18.3
7/31/2018	6:00	19.4	19.5	19.6	19.4	19.5	19.5	18.9
7/31/2018	7:00	20.0	19.8	20.1	19.9	20.2	19.7	18.9
7/31/2018	8:00	20.5	19.8	20.3	19.8	20.3	19.8	18.9
7/31/2018	9:00	21.7	20.1	21.1	20.1	21.2	20.0	20.0
7/31/2018	10:00	23.1	21.2	22.2	21.1	22.8	21.1	20.6
7/31/2018	11:00	25.0	22.9	24.8	22.9	24.7	22.9	22.8
7/31/2018	12:00	26.1	23.8	25.9	23.8	25.9	23.8	23.3
7/31/2018	13:00	26.1	23.8	26.0	23.8	26.9	23.7	22.8
7/31/2018	14:00	26.4	23.6	26.7	23.4	27.1	23.4	23.3
7/31/2018	15:00	27.4	23.3	26.5	23.3	27.4	23.3	22.8
7/31/2018	16:00	28.1	24.4	29.1	24.3	29.2	24.4	23.9
7/31/2018	17:00	26.2	22.6	27.1	22.6	26.2	22.6	22.2
7/31/2018	18:00	25.4	21.4	25.6	21.3	25.9	21.3	21.1
7/31/2018	19:00	23.2	19.4	22.6	19.3	22.7	19.3	19.4
7/31/2018	20:00	21.4	18.8	22.6	18.8	21.3	18.8	18.9
7/31/2018	21:00	21.0	18.4	21.0	18.4	21.2	18.4	18.3
7/31/2018	22:00	20.1	17.8	20.5	17.8	20.3	17.8	16.7
7/31/2018	23:00	18.4	16.9	19.2	16.7	19.1	16.7	16.1
7/31/2018	0:00	17.4	15.1	16.7	15.0	17.2	15.0	15.0
8/1/2018	1:00	15.9	15.5	15.5	15.3	15.7	15.3	14.4
8/1/2018	2:00	15.1	14.8	15.1	14.8	14.9	14.7	14.4
8/1/2018	3:00	14.7	14.5	14.5	14.5	14.6	14.4	13.9
8/1/2018	4:00	14.1	13.8	14.0	13.8	14.1	13.8	13.9
8/1/2018	5:00	15.1	15.0	15.1	14.9	15.0	14.9	13.9
8/1/2018	6:00	15.8	15.5	15.5	15.5	15.8	15.4	15.0
8/1/2018	7:00	20.3	20.0	20.2	19.9	20.0	20.0	18.9
8/1/2018	8:00	22.2	21.7	22.1	21.6	22.2	21.5	20.6
8/1/2018	9:00	24.2	22.9	23.9	22.8	24.0	22.8	22.8
8/1/2018	10:00	26.0	24.9	26.4	24.8	26.1	24.9	23.9

8/1/2018	11:00	28.0	26.2	27.7	26.2	27.9	26.1	25.6
8/1/2018	12:00	28.1	25.5	28.1	25.5	28.0	25.4	25.6
8/1/2018	13:00	28.9	26.1	29.1	26.1	28.6	26.0	26.1
8/1/2018	14:00	31.4	27.9	31.6	27.8	31.6	27.9	26.7
8/1/2018	15:00	30.9	27.4	30.4	27.4	30.7	27.3	26.7
8/1/2018	16:00	31.4	27.7	31.4	27.6	31.9	27.7	26.7
8/1/2018	17:00	30.6	27.1	30.5	27.0	30.9	27.1	26.1
8/1/2018	18:00	28.8	25.5	28.6	25.4	29.9	25.5	25.0
8/1/2018	19:00	25.4	22.3	26.0	22.2	26.1	22.3	22.2
8/1/2018	20:00	24.0	21.0	24.0	20.9	24.6	21.0	20.0
8/1/2018	21:00	22.0	18.9	21.3	18.8	21.8	18.8	17.8
8/1/2018	22:00	22.0	19.4	21.7	19.3	22.1	19.4	18.9
8/1/2018	23:00	21.1	18.7	20.4	18.7	21.1	18.7	18.3
8/1/2018	0:00	19.3	17.7	19.1	17.7	19.6	17.7	17.8
8/2/2018	1:00	18.2	18.2	18.1	18.1	18.6	18.1	17.8
8/2/2018	2:00	18.3	17.9	18.2	17.9	18.1	17.7	17.8
8/2/2018	3:00	17.5	17.3	17.6	17.2	17.6	17.2	17.2
8/2/2018	4:00	17.0	16.7	16.7	16.7	16.8	16.7	16.7
8/2/2018	5:00	16.6	16.6	16.7	16.6	16.5	16.6	16.7
8/2/2018	6:00	19.0	18.9	19.1	18.8	18.8	18.9	17.8
8/2/2018	7:00	21.2	20.8	21.1	20.8	20.9	20.8	20.0
8/2/2018	8:00	23.8	23.3	23.5	23.2	23.8	23.2	22.8
8/2/2018	9:00	27.3	25.8	27.0	25.8	26.9	25.8	25.0
8/2/2018	10:00	29.1	27.6	29.3	27.5	28.8	27.4	26.7
8/2/2018	11:00	29.6	28.0	29.7	28.0	29.8	28.0	27.8
8/2/2018	12:00	30.9	28.4	30.8	28.3	31.2	28.3	27.8
8/2/2018	13:00	32.5	29.3	32.3	29.1	31.6	29.2	28.9
8/2/2018	14:00	31.6	29.0	32.0	29.1	32.7	29.0	28.9
8/2/2018	15:00	32.6	28.9	32.1	28.8	32.8	28.9	28.9
8/2/2018	16:00	31.6	27.5	31.7	27.3	31.4	27.3	27.2
8/2/2018	17:00	31.5	27.8	31.7	27.8	31.1	27.6	27.2
8/2/2018	18:00	30.8	26.6	29.6	26.4	29.9	26.4	26.7
8/2/2018	19:00	27.5	24.2	28.1	24.1	27.9	24.1	23.9
8/2/2018	20:00	25.0	22.2	24.9	22.1	25.7	22.1	21.7
8/2/2018	21:00	24.4	21.6	24.5	21.6	24.4	21.5	20.6
8/2/2018	22:00	24.6	22.4	24.5	22.4	24.4	22.4	21.7
8/2/2018	23:00	23.4	21.1	23.0	21.1	23.4	21.2	21.1
8/2/2018	0:00	21.2	19.0	21.1	18.9	20.7	18.9	18.9
8/3/2018	1:00	18.2	17.8	17.6	17.6	18.0	17.6	17.8
8/3/2018	2:00	19.1	19.2	19.5	19.1	19.2	19.1	18.9
8/3/2018	3:00	19.4	19.4	19.4	19.4	19.3	19.3	19.4

8/3/2018	4:00	19.2	19.1	19.0	19.0	19.1	19.0	18.9
8/3/2018	5:00	19.8	19.8	19.7	19.7	19.9	19.7	18.9
8/3/2018	6:00	20.0	20.0	20.2	19.9	20.1	19.8	19.4
8/3/2018	7:00	23.2	23.2	23.5	23.2	23.5	23.1	22.2
8/3/2018	8:00	25.5	24.7	25.2	24.7	24.9	24.6	24.4
8/3/2018	9:00	27.9	26.1	27.1	26.0	27.3	26.0	25.0
8/3/2018	10:00	29.2	27.8	29.4	27.9	29.1	27.7	26.7
8/3/2018	11:00	30.0	28.2	29.6	28.1	29.8	28.2	27.8
8/3/2018	12:00	32.8	29.9	32.2	29.9	32.0	29.9	28.9
8/3/2018	13:00	31.6	29.4	31.8	29.3	32.1	29.3	29.4
8/3/2018	14:00	33.9	31.2	34.8	31.1	34.4	31.0	30.6
8/3/2018	15:00	34.9	30.8	34.9	30.8	34.0	30.9	30.0
8/3/2018	16:00	34.1	30.4	35.0	30.3	34.8	30.3	30.0
8/3/2018	17:00	34.2	29.9	33.8	29.8	34.3	29.9	29.4
8/3/2018	18:00	32.9	29.7	32.9	29.7	33.6	29.8	28.9
8/3/2018	19:00	31.1	27.7	31.3	27.7	31.3	27.6	26.7
8/3/2018	20:00	28.9	25.6	29.3	25.6	28.6	25.5	24.4
8/3/2018	21:00	27.6	24.9	27.9	24.7	27.5	24.9	23.9
8/3/2018	22:00	26.4	23.7	26.1	23.6	26.1	23.7	23.3
8/3/2018	23:00	24.5	22.3	24.3	22.1	24.3	22.3	22.2
8/3/2018	0:00	25.3	23.0	25.1	22.9	24.5	23.0	22.2
8/4/2018	1:00	22.0	21.8	21.8	21.7	21.7	21.6	21.7
8/4/2018	2:00	19.9	20.0	20.0	20.0	20.2	20.0	20.0
8/4/2018	3:00	21.2	20.8	20.7	20.7	21.0	20.7	20.6
8/4/2018	4:00	21.0	20.8	20.8	20.7	21.0	20.7	20.6
8/4/2018	5:00	20.8	20.8	20.9	20.7	20.7	20.7	20.0
8/4/2018	6:00	20.5	20.5	20.7	20.5	20.4	20.5	20.6
8/4/2018	7:00	23.4	23.2	23.4	23.1	23.3	23.2	22.8
8/4/2018	8:00	26.7	26.3	26.6	26.2	26.7	26.2	25.6
8/4/2018	9:00	29.3	28.2	29.2	28.2	29.2	28.1	27.8
8/4/2018	10:00	32.4	30.1	31.1	30.1	31.2	30.1	29.4
8/4/2018	11:00	31.8	30.3	31.9	30.1	32.0	30.2	30.0
8/4/2018	12:00	33.1	30.2	32.3	30.1	32.7	30.1	30.0
8/4/2018	13:00	34.6	31.3	34.3	31.2	34.0	31.2	30.6
8/4/2018	14:00	33.6	30.6	34.0	30.5	33.1	30.5	30.6
8/4/2018	15:00	34.8	31.6	35.7	31.5	34.8	31.5	30.6
8/4/2018	16:00	34.6	31.0	35.3	31.0	35.1	30.9	30.6
8/4/2018	17:00	33.8	29.9	33.9	29.8	33.5	29.9	29.4
8/4/2018	18:00	32.5	28.3	32.4	28.2	31.5	28.2	28.3
8/4/2018	19:00	29.4	25.6	29.5	25.6	29.6	25.6	25.0
8/4/2018	20:00	27.0	23.7	26.5	23.6	26.8	23.7	23.3

8/4/2018	21:00	25.5	22.7	25.8	22.6	25.7	22.6	22.8
8/4/2018	22:00	26.7	23.7	26.6	23.6	25.9	23.6	23.3
8/4/2018	23:00	25.8	23.5	25.2	23.4	25.0	23.5	22.8
8/4/2018	0:00	25.3	23.5	25.3	23.4	25.6	23.4	23.3
8/5/2018	1:00	23.7	23.8	24.1	23.6	24.2	23.7	22.8
8/5/2018	2:00	23.0	22.7	22.6	22.7	23.2	22.6	22.2
8/5/2018	3:00	21.4	21.2	21.1	21.1	21.5	21.2	21.1
8/5/2018	4:00	22.6	22.3	22.3	22.4	22.5	22.2	21.7
8/5/2018	5:00	22.5	22.3	22.5	22.3	22.4	22.4	21.7
8/5/2018	6:00	22.0	21.9	22.0	21.9	21.9	21.8	21.7
8/5/2018	7:00	24.3	24.0	24.2	24.0	24.1	23.9	23.3
8/5/2018	8:00	27.6	27.2	27.4	27.2	27.5	27.0	26.1
8/5/2018	9:00	27.6	26.2	27.1	26.2	27.1	26.1	26.1
8/5/2018	10:00	30.6	28.7	30.4	28.7	30.0	28.6	28.3
8/5/2018	11:00	31.6	30.1	31.8	30.0	31.6	30.0	30.0
8/5/2018	12:00	33.9	31.1	33.5	31.1	33.5	31.0	31.1
8/5/2018	13:00	34.6	31.7	34.3	31.7	34.1	31.6	31.1
8/5/2018	14:00	34.6	31.9	35.3	31.8	35.2	31.8	31.7
8/5/2018	15:00	35.6	31.9	35.7	31.9	35.9	31.9	31.1
8/5/2018	16:00	36.8	32.2	36.4	32.1	36.0	32.1	31.1
8/5/2018	17:00	34.2	30.8	35.4	30.8	35.0	30.7	30.6
8/5/2018	18:00	32.9	29.1	32.7	29.1	32.6	29.1	28.9
8/5/2018	19:00	30.3	27.6	30.4	27.6	31.3	27.6	26.7
8/5/2018	20:00	27.5	24.8	28.1	24.7	28.2	24.7	24.4
8/5/2018	21:00	26.0	23.4	26.2	23.4	26.4	23.3	23.3
8/5/2018	22:00	27.0	24.5	26.7	24.5	26.6	24.5	23.3
8/5/2018	23:00	27.2	25.5	27.1	25.5	27.8	25.5	24.4
8/5/2018	0:00	26.7	24.4	26.5	24.4	26.1	24.3	23.9
8/6/2018	1:00	24.8	24.4	24.5	24.3	24.4	24.4	23.3
8/6/2018	2:00	23.9	23.8	23.7	23.8	23.7	23.7	22.8
8/6/2018	3:00	23.5	23.4	23.3	23.4	23.6	23.3	22.8
8/6/2018	4:00	23.5	23.4	23.6	23.3	23.7	23.4	22.8
8/6/2018	5:00	21.7	21.7	21.8	21.7	21.6	21.6	21.7
8/6/2018	6:00	22.6	22.6	22.7	22.6	22.5	22.5	22.2
8/6/2018	7:00	24.4	23.9	24.1	23.8	24.1	23.9	23.9
8/6/2018	8:00	26.6	26.2	26.4	26.2	26.7	26.1	25.6
8/6/2018	9:00	28.6	27.2	28.2	27.2	28.2	27.2	26.7
8/6/2018	10:00	31.4	29.1	30.9	29.1	30.4	29.1	28.3
8/6/2018	11:00	32.0	29.7	31.6	29.6	31.8	29.6	29.4
8/6/2018	12:00	32.5	30.2	33.0	30.2	32.4	30.1	29.4
8/6/2018	13:00	34.0	30.6	33.2	30.5	33.1	30.5	30.6

8/6/2018	14:00	34.4	31.7	34.4	31.5	34.9	31.7	30.6
8/6/2018	15:00	35.7	31.9	35.9	31.9	35.7	31.7	31.1
8/6/2018	16:00	35.6	31.1	35.0	31.1	35.4	30.9	31.1
8/6/2018	17:00	34.7	31.0	35.7	30.9	35.1	30.9	30.6
8/6/2018	18:00	32.8	29.0	32.1	29.0	32.3	28.9	28.9
8/6/2018	19:00	31.5	28.3	32.1	28.2	32.0	28.3	28.3
8/6/2018	20:00	28.6	25.5	28.4	25.6	28.3	25.5	25.6
8/6/2018	21:00	29.5	26.4	29.1	26.3	29.0	26.4	25.6
8/6/2018	22:00	28.8	26.5	28.5	26.5	29.3	26.3	25.6
8/6/2018	23:00	26.3	24.3	26.6	24.4	26.4	24.4	23.3
8/6/2018	0:00	24.7	22.9	24.6	22.8	25.0	22.7	21.7
8/7/2018	1:00	22.1	22.1	22.3	22.0	22.0	22.1	21.1
8/7/2018	2:00	21.4	21.1	21.3	21.1	21.2	21.1	21.1
8/7/2018	3:00	23.3	23.2	23.4	23.2	23.7	23.1	22.2
8/7/2018	4:00	21.6	21.5	21.6	21.4	21.6	21.4	20.6
8/7/2018	5:00	21.0	20.9	21.0	20.8	21.0	20.8	20.0
8/7/2018	6:00	20.8	20.9	21.1	20.8	20.8	20.7	20.6
8/7/2018	7:00	21.2	21.0	21.4	21.1	21.0	20.9	21.1
8/7/2018	8:00	24.3	23.8	24.2	23.8	24.0	23.7	22.8
8/7/2018	9:00	26.1	24.6	25.8	24.5	25.7	24.5	23.9
8/7/2018	10:00	27.5	26.4	27.4	26.4	27.8	26.3	25.6
8/7/2018	11:00	28.3	25.8	27.3	25.7	27.9	25.8	25.6
8/7/2018	12:00	29.2	26.3	28.8	26.3	28.3	26.2	25.6
8/7/2018	13:00	27.6	24.9	27.9	24.8	28.0	25.0	24.4
8/7/2018	14:00	29.3	25.6	28.5	25.4	28.8	25.5	25.0
8/7/2018	15:00	29.9	26.0	29.8	25.9	30.2	26.0	25.0
8/7/2018	16:00	30.5	25.6	30.0	25.6	30.3	25.7	25.6
8/7/2018	17:00	28.9	25.6	29.9	25.5	29.9	25.5	25.0
8/7/2018	18:00	29.5	25.6	29.4	25.5	28.8	25.5	24.4
8/7/2018	19:00	27.6	23.9	26.9	23.9	26.8	23.8	22.8
8/7/2018	20:00	26.7	23.3	25.9	23.2	26.4	23.3	22.8
8/7/2018	21:00	25.7	23.1	26.1	23.0	26.1	23.1	22.8
8/7/2018	22:00	25.1	22.7	24.7	22.7	25.2	22.6	21.7
8/7/2018	23:00	23.3	21.6	23.5	21.7	23.8	21.6	21.1
8/7/2018	0:00	22.7	21.3	23.3	21.2	23.4	21.3	21.1
8/8/2018	1:00	21.4	21.3	21.5	21.2	21.6	21.2	21.1
8/8/2018	2:00	21.9	21.4	21.6	21.3	21.4	21.3	20.6
8/8/2018	3:00	22.3	21.9	22.1	21.8	22.2	21.8	21.1
8/8/2018	4:00	21.8	21.8	21.9	21.8	21.7	21.6	21.1
8/8/2018	5:00	22.2	22.1	22.2	22.2	22.1	22.1	21.1
8/8/2018	6:00	21.5	21.2	21.2	21.1	21.1	21.1	21.1

8/8/2018	7:00	23.0	22.5	22.5	22.5	22.8	22.4	22.2
8/8/2018	8:00	22.9	22.2	22.5	22.0	22.7	22.1	22.2
8/8/2018	9:00	25.1	24.0	25.1	24.1	25.0	23.9	23.9
8/8/2018	10:00	28.3	26.8	28.5	26.8	27.9	26.7	26.1
8/8/2018	11:00	28.2	26.6	28.1	26.6	28.1	26.5	26.7
8/8/2018	12:00	30.6	28.3	30.6	28.3	30.7	28.2	27.8
8/8/2018	13:00	31.5	28.2	30.9	28.1	31.3	28.2	27.8
8/8/2018	14:00	32.0	29.1	32.5	29.0	31.8	29.0	28.3
8/8/2018	15:00	32.1	29.0	32.3	29.0	32.5	28.8	27.8
8/8/2018	16:00	33.3	28.6	33.1	28.5	32.6	28.5	27.8
8/8/2018	17:00	31.1	27.5	31.6	27.4	31.9	27.5	27.2
8/8/2018	18:00	30.0	26.0	29.3	26.0	29.3	25.9	25.6
8/8/2018	19:00	25.9	22.7	26.6	22.7	26.0	22.7	22.8
8/8/2018	20:00	24.5	21.8	25.1	21.8	24.8	21.9	21.7
8/8/2018	21:00	23.5	20.5	23.5	20.5	23.6	20.5	20.6
8/8/2018	22:00	22.6	19.9	22.7	19.8	22.9	19.8	19.4
8/8/2018	23:00	22.0	20.2	22.2	20.2	21.9	20.2	19.4
8/8/2018	0:00	19.7	18.3	20.5	18.2	20.4	18.2	18.3
8/9/2018	1:00	19.2	18.9	18.7	18.8	19.1	18.9	17.8
8/9/2018	2:00	17.9	17.7	17.9	17.6	17.6	17.7	17.2
8/9/2018	3:00	17.4	17.1	17.3	16.9	17.4	16.9	16.7
8/9/2018	4:00	16.9	16.9	16.9	16.8	17.1	16.8	16.7
8/9/2018	5:00	17.7	17.6	17.7	17.5	17.8	17.6	17.2
8/9/2018	6:00	18.2	18.1	18.0	18.0	18.2	18.1	17.2
8/9/2018	7:00	21.3	21.0	21.0	21.0	21.3	21.0	21.1
8/9/2018	8:00	24.3	24.0	24.2	23.9	24.2	23.9	23.3
8/9/2018	9:00	27.3	26.0	27.1	25.9	27.0	25.9	25.6
8/9/2018	10:00	29.3	27.2	28.7	27.0	28.2	27.1	26.7
8/9/2018	11:00	30.1	28.5	30.2	28.4	30.5	28.4	27.8
8/9/2018	12:00	31.9	29.7	32.3	29.6	31.7	29.6	28.9
8/9/2018	13:00	32.6	29.4	31.7	29.3	31.9	29.4	29.4
8/9/2018	14:00	32.6	29.9	33.4	29.9	32.9	29.8	30.0
8/9/2018	15:00	34.6	30.2	33.3	30.1	33.3	30.2	29.4
8/9/2018	16:00	35.0	30.6	34.7	30.6	34.1	30.5	30.0
8/9/2018	17:00	33.0	29.6	33.8	29.5	34.1	29.6	28.9
8/9/2018	18:00	32.6	29.0	32.0	29.0	32.2	28.8	27.8
8/9/2018	19:00	28.3	25.3	28.6	25.3	28.5	25.2	25.0
8/9/2018	20:00	27.3	24.2	27.5	24.2	27.7	24.1	23.3
8/9/2018	21:00	26.3	23.2	25.7	23.1	26.3	23.1	22.2
8/9/2018	22:00	24.4	21.7	24.3	21.7	24.6	21.6	21.7
8/9/2018	23:00	24.1	22.2	23.8	22.2	24.5	22.1	21.7

8/9/2018	0:00	24.9	22.6	24.7	22.5	24.6	22.5	21.7
8/10/2018	1:00	21.4	21.0	21.4	20.9	21.2	21.0	20.6
8/10/2018	2:00	21.0	21.1	21.4	21.1	21.1	21.1	20.6
8/10/2018	3:00	21.6	21.4	21.3	21.4	21.3	21.3	20.6
8/10/2018	4:00	20.5	20.6	20.7	20.6	20.5	20.5	20.6
8/10/2018	5:00	20.9	21.0	21.1	21.0	20.9	20.9	20.0
8/10/2018	6:00	19.9	19.9	20.1	19.8	20.0	19.9	20.0
8/10/2018	7:00	23.9	23.4	23.7	23.3	23.7	23.3	22.2
8/10/2018	8:00	23.3	22.7	23.1	22.6	23.2	22.7	21.7
8/10/2018	9:00	26.4	25.0	26.0	25.0	26.0	25.0	24.4
8/10/2018	10:00	28.8	27.3	28.4	27.3	28.5	27.3	27.2
8/10/2018	11:00	32.2	29.7	31.7	29.7	31.2	29.7	29.4
8/10/2018	12:00	32.5	30.2	32.3	30.1	32.3	30.1	30.0
8/10/2018	13:00	34.0	31.3	34.3	31.2	33.7	31.3	30.6
8/10/2018	14:00	34.2	31.4	34.4	31.4	34.2	31.3	30.6
8/10/2018	15:00	32.9	29.3	33.2	29.2	32.6	29.2	28.9
8/10/2018	16:00	34.4	29.9	34.7	29.9	34.0	29.8	30.0
8/10/2018	17:00	33.8	29.7	33.0	29.7	33.7	29.6	29.4
8/10/2018	18:00	30.9	27.8	32.1	27.6	32.3	27.7	27.8
8/10/2018	19:00	28.4	24.9	28.7	24.8	28.4	24.8	24.4
8/10/2018	20:00	26.6	23.1	26.5	23.0	26.3	23.0	22.2
8/10/2018	21:00	25.2	22.2	24.9	22.2	25.0	22.2	21.7
8/10/2018	22:00	26.3	23.4	26.1	23.3	26.1	23.3	22.8
8/10/2018	23:00	24.1	21.9	24.0	21.9	24.0	21.7	21.7
8/10/2018	0:00	23.7	22.2	23.6	22.0	24.2	22.2	21.7
8/11/2018	1:00	20.6	20.7	20.6	20.6	20.8	20.6	20.0
8/11/2018	2:00	21.2	20.9	20.9	20.9	21.3	20.9	20.6
8/11/2018	3:00	20.1	19.9	19.9	19.9	19.9	19.9	20.0
8/11/2018	4:00	19.9	19.8	19.9	19.8	19.9	19.8	19.4
8/11/2018	5:00	20.2	20.0	20.1	19.9	20.1	19.9	19.4
8/11/2018	6:00	19.9	19.9	20.0	19.9	19.9	19.9	19.4
8/11/2018	7:00	22.2	22.0	22.3	21.9	21.9	22.0	21.1
8/11/2018	8:00	25.1	24.4	24.7	24.4	24.7	24.4	23.3
8/11/2018	9:00	27.4	26.1	27.2	26.0	27.0	26.1	25.6
8/11/2018	10:00	27.2	26.1	27.5	26.0	27.7	26.1	26.1
8/11/2018	11:00	28.9	26.8	28.5	26.7	28.3	26.7	26.7
8/11/2018	12:00	31.2	28.6	30.7	28.5	31.0	28.6	28.3
8/11/2018	13:00	31.8	28.7	30.8	28.6	31.0	28.6	28.3
8/11/2018	14:00	34.0	30.0	32.8	29.9	32.7	30.0	29.4
8/11/2018	15:00	33.6	30.5	34.4	30.4	33.6	30.4	29.4
8/11/2018	16:00	33.6	29.4	33.3	29.3	34.1	29.4	28.3

8/11/2018	17:00	34.5	30.0	34.4	30.0	33.8	30.0	28.9
8/11/2018	18:00	30.4	27.2	30.9	27.2	31.4	27.1	26.7
8/11/2018	19:00	27.7	24.7	27.9	24.6	28.3	24.7	23.9
8/11/2018	20:00	26.1	22.6	25.9	22.5	26.4	22.7	22.2
8/11/2018	21:00	25.3	22.5	25.3	22.6	25.2	22.6	21.7
8/11/2018	22:00	23.3	21.2	23.4	21.0	23.6	21.1	20.6
8/11/2018	23:00	22.0	19.7	22.1	19.7	22.1	19.7	19.4
8/11/2018	0:00	20.0	18.4	20.1	18.3	20.1	18.3	18.3
8/12/2018	1:00	19.6	19.1	19.5	19.0	19.5	19.0	18.3
8/12/2018	2:00	19.0	18.8	19.0	18.8	19.0	18.8	18.9
8/12/2018	3:00	18.7	18.7	18.8	18.6	18.9	18.5	18.3
8/12/2018	4:00	17.3	17.4	17.3	17.4	17.4	17.3	16.7
8/12/2018	5:00	20.5	20.4	20.5	20.3	20.4	20.3	20.0
8/12/2018	6:00	18.7	18.7	18.9	18.6	18.8	18.7	17.8
8/12/2018	7:00	23.7	23.3	23.4	23.3	23.5	23.3	22.2
8/12/2018	8:00	24.9	24.3	24.8	24.2	24.6	24.3	23.9
8/12/2018	9:00	27.4	26.3	27.3	26.2	27.4	26.2	26.1
8/12/2018	10:00	30.4	29.0	30.8	28.9	30.3	28.9	28.3
8/12/2018	11:00	32.0	30.1	31.9	30.1	31.7	30.1	29.4
8/12/2018	12:00	32.1	29.1	31.3	29.1	31.2	29.1	28.9
8/12/2018	13:00	34.3	31.2	33.7	31.2	34.0	31.1	30.6
8/12/2018	14:00	33.6	30.1	33.6	30.2	32.9	30.1	30.0
8/12/2018	15:00	33.9	30.6	33.6	30.7	34.1	30.6	29.4
8/12/2018	16:00	32.1	27.9	32.1	27.8	32.5	27.8	27.8
8/12/2018	17:00	34.1	30.1	33.7	30.0	34.0	30.0	28.9
8/12/2018	18:00	31.5	27.5	31.0	27.4	31.6	27.4	27.2
8/12/2018	19:00	28.5	24.6	27.5	24.5	28.6	24.6	24.4
8/12/2018	20:00	26.0	22.7	25.1	22.6	25.6	22.5	21.7
8/12/2018	21:00	24.8	21.8	24.8	21.8	24.8	21.8	21.7
8/12/2018	22:00	23.4	20.4	23.3	20.4	22.9	20.4	20.0
8/12/2018	23:00	22.0	19.7	21.2	19.7	21.8	19.6	18.9
8/12/2018	0:00	20.6	18.8	20.8	18.8	20.8	18.7	18.9
8/13/2018	1:00	20.0	20.0	20.4	20.0	19.9	19.9	20.0
8/13/2018	2:00	19.6	19.5	19.9	19.5	19.4	19.4	18.9
8/13/2018	3:00	19.5	19.5	19.9	19.5	19.7	19.5	18.3
8/13/2018	4:00	19.5	19.4	19.6	19.4	19.3	19.3	18.3
8/13/2018	5:00	17.9	17.9	18.0	17.9	18.0	17.9	17.8
8/13/2018	6:00	18.3	18.3	18.4	18.3	18.2	18.1	17.8
8/13/2018	7:00	21.3	21.1	21.4	21.0	21.4	21.1	20.6
8/13/2018	8:00	24.0	23.5	23.9	23.4	24.0	23.4	22.8
8/13/2018	9:00	28.1	26.4	27.5	26.3	27.4	26.4	26.1

8/13/2018	10:00	30.2	28.3	29.4	28.2	30.0	28.2	28.3
8/13/2018	11:00	31.1	29.5	31.3	29.6	31.7	29.4	29.4
8/13/2018	12:00	31.8	29.0	31.2	29.0	31.0	29.0	28.9
8/13/2018	13:00	32.6	29.9	32.1	29.8	32.1	29.8	29.4
8/13/2018	14:00	33.5	30.6	34.5	30.6	34.3	30.6	29.4
8/13/2018	15:00	33.5	30.3	34.2	30.1	33.3	30.3	29.4
8/13/2018	16:00	34.8	30.7	34.7	30.7	34.4	30.7	30.0
8/13/2018	17:00	33.9	29.4	33.5	29.3	33.4	29.3	28.3
8/13/2018	18:00	31.2	27.5	32.0	27.5	30.9	27.4	27.2
8/13/2018	19:00	27.8	24.9	28.5	24.7	27.8	24.8	23.9
8/13/2018	20:00	24.5	21.2	24.9	21.2	24.2	21.2	20.6
8/13/2018	21:00	23.0	20.0	23.1	20.0	22.9	19.9	20.0
8/13/2018	22:00	22.2	20.2	23.1	20.1	22.9	20.1	20.0
8/13/2018	23:00	21.6	19.7	22.0	19.6	21.6	19.8	18.9
8/13/2018	0:00	20.4	18.2	19.8	18.2	20.4	18.2	17.8
8/14/2018	1:00	17.1	16.9	17.0	16.9	17.4	16.8	16.7
8/14/2018	2:00	17.6	17.6	17.7	17.5	17.8	17.6	17.2
8/14/2018	3:00	17.8	17.8	18.3	17.8	18.1	17.7	16.7
8/14/2018	4:00	16.4	16.3	16.5	16.3	16.1	16.3	16.1
8/14/2018	5:00	16.7	16.6	16.7	16.5	16.5	16.4	15.6
8/14/2018	6:00	17.9	17.7	17.7	17.6	17.8	17.6	17.8
8/14/2018	7:00	22.6	22.1	22.1	22.1	22.2	22.1	21.1
8/14/2018	8:00	24.4	23.6	23.8	23.6	23.9	23.5	23.3
8/14/2018	9:00	27.5	26.3	27.4	26.1	27.2	26.1	26.1
8/14/2018	10:00	29.0	27.9	29.0	27.9	29.2	27.8	27.8
8/14/2018	11:00	32.5	30.0	32.1	30.0	31.6	30.0	28.9
8/14/2018	12:00	33.2	30.3	32.2	30.3	32.5	30.2	29.4
8/14/2018	13:00	32.6	30.2	32.5	30.2	33.3	30.1	29.4
8/14/2018	14:00	33.5	30.3	33.1	30.2	33.2	30.3	29.4
8/14/2018	15:00	32.7	29.7	33.1	29.6	33.8	29.6	28.9
8/14/2018	16:00	34.2	30.0	33.6	29.9	34.6	29.9	28.9
8/14/2018	17:00	33.2	28.8	32.5	28.7	32.7	28.8	27.8
8/14/2018	18:00	30.3	27.2	31.1	27.0	30.5	27.1	26.7
8/14/2018	19:00	28.1	24.4	28.0	24.3	28.1	24.3	23.9
8/14/2018	20:00	26.8	23.5	26.2	23.4	26.4	23.4	23.3
8/14/2018	21:00	26.0	23.5	26.0	23.5	26.6	23.5	22.8
8/14/2018	22:00	25.5	23.1	25.4	23.1	25.1	23.1	22.2
8/14/2018	23:00	24.8	23.2	25.5	23.1	25.5	23.2	22.2
8/14/2018	0:00	25.0	22.7	24.6	22.7	24.4	22.7	22.2
8/15/2018	1:00	23.1	22.8	23.3	22.8	22.8	22.8	21.7
8/15/2018	2:00	22.7	22.7	23.0	22.6	22.9	22.6	22.2

8/15/2018	3:00	22.0	21.7	22.1	21.6	21.9	21.7	21.7
8/15/2018	4:00	22.0	21.9	22.0	21.8	21.8	21.8	21.7
8/15/2018	5:00	21.8	21.8	21.8	21.8	21.9	21.7	21.1
8/15/2018	6:00	21.9	21.8	21.8	21.6	21.8	21.7	21.7
8/15/2018	7:00	23.3	23.1	23.2	23.1	23.1	23.0	22.2
8/15/2018	8:00	22.5	21.7	21.9	21.6	22.1	21.6	21.7
8/15/2018	9:00	24.3	23.2	24.3	23.1	24.2	23.1	22.8
8/15/2018	10:00	25.8	24.3	25.8	24.3	25.3	24.3	23.3
8/15/2018	11:00	25.8	23.4	25.1	23.4	25.3	23.3	23.3
8/15/2018	12:00	25.9	23.8	26.5	23.7	26.4	23.8	23.9
8/15/2018	13:00	28.5	25.4	28.3	25.3	28.4	25.4	25.0
8/15/2018	14:00	27.4	24.0	27.1	24.0	26.5	24.0	23.3
8/15/2018	15:00	29.1	25.1	28.4	25.0	28.9	25.0	23.9
8/15/2018	16:00	30.9	26.0	30.0	26.0	30.4	25.9	25.0
8/15/2018	17:00	27.9	23.6	28.2	23.6	27.2	23.6	23.3
8/15/2018	18:00	27.0	22.7	25.9	22.6	26.8	22.5	22.2
8/15/2018	19:00	26.4	23.2	26.4	23.1	26.9	23.2	22.2
8/15/2018	20:00	26.3	23.6	26.5	23.6	27.1	23.6	22.8
8/15/2018	21:00	25.5	22.6	25.4	22.6	25.6	22.5	22.2
8/15/2018	22:00	25.2	22.5	25.0	22.4	24.9	22.5	21.7
8/15/2018	23:00	24.7	22.3	24.0	22.2	24.2	22.1	21.7
8/15/2018	0:00	23.4	22.0	23.4	21.9	23.7	21.9	21.1
8/16/2018	1:00	21.2	21.1	21.4	21.0	21.1	20.9	21.1
8/16/2018	2:00	22.0	21.6	21.9	21.6	21.8	21.7	21.7
8/16/2018	3:00	22.9	22.6	23.1	22.6	22.7	22.6	21.7
8/16/2018	4:00	22.4	22.1	22.1	22.1	22.0	22.0	22.2
8/16/2018	5:00	21.8	21.7	21.7	21.7	21.7	21.7	21.7
8/16/2018	6:00	23.4	23.3	23.2	23.2	23.1	23.2	22.2
8/16/2018	7:00	23.1	22.6	22.9	22.5	22.8	22.6	22.2
8/16/2018	8:00	23.9	23.1	23.3	23.0	23.2	22.9	22.8
8/16/2018	9:00	25.7	23.9	25.0	23.7	24.9	23.9	23.3
8/16/2018	10:00	26.1	24.8	26.6	24.7	26.1	24.8	24.4
8/16/2018	11:00	29.4	27.2	29.2	27.1	29.1	27.1	26.1
8/16/2018	12:00	31.5	28.8	30.7	28.7	30.8	28.7	27.8
8/16/2018	13:00	32.4	30.1	32.9	30.1	33.1	29.9	28.9
8/16/2018	14:00	32.3	29.6	33.5	29.5	32.1	29.5	28.9
8/16/2018	15:00	33.0	28.9	32.6	28.8	32.9	28.8	28.9
8/16/2018	16:00	34.4	29.5	34.2	29.5	34.1	29.4	29.4
8/16/2018	17:00	34.4	30.5	33.8	30.4	34.3	30.4	29.4
8/16/2018	18:00	32.6	28.8	32.7	28.7	32.7	28.7	27.8
8/16/2018	19:00	27.8	25.0	27.8	24.9	27.8	24.9	25.0

8/16/2018	20:00	28.5	25.0	27.5	24.9	28.7	24.9	23.9
8/16/2018	21:00	26.2	23.2	25.8	23.1	26.2	23.2	22.8
8/16/2018	22:00	27.1	24.8	27.5	24.7	27.3	24.7	23.9
8/16/2018	23:00	26.2	24.2	26.3	24.2	26.4	24.1	23.9
8/16/2018	0:00	25.8	23.9	25.7	23.8	25.9	23.9	23.9
8/17/2018	1:00	22.6	22.2	22.6	22.1	22.1	22.2	22.2
8/17/2018	2:00	23.1	22.8	23.0	22.8	22.7	22.6	22.2
8/17/2018	3:00	21.8	21.8	21.9	21.8	22.1	21.7	21.1
8/17/2018	4:00	20.6	20.5	20.7	20.4	20.5	20.5	20.6
8/17/2018	5:00	20.7	20.6	20.6	20.6	20.6	20.6	20.6
8/17/2018	6:00	21.5	21.6	21.8	21.5	21.6	21.6	21.1
8/17/2018	7:00	22.6	22.3	22.5	22.3	22.3	22.2	21.7
8/17/2018	8:00	23.2	22.6	22.8	22.6	23.0	22.5	21.7
8/17/2018	9:00	25.1	23.1	24.2	23.1	24.1	23.0	22.2
8/17/2018	10:00	24.7	23.1	24.5	23.0	24.7	23.1	22.8
8/17/2018	11:00	26.3	24.6	26.5	24.5	26.5	24.5	24.4
8/17/2018	12:00	30.4	27.5	30.0	27.5	30.2	27.5	26.7
8/17/2018	13:00	29.6	26.2	29.2	26.1	29.3	26.1	26.1
8/17/2018	14:00	30.0	27.3	30.3	27.2	30.3	27.3	26.7
8/17/2018	15:00	30.8	27.8	31.7	27.7	31.5	27.6	27.2
8/17/2018	16:00	32.3	28.0	31.9	27.9	31.7	28.0	27.8
8/17/2018	17:00	30.7	27.3	30.6	27.2	31.3	27.3	27.2
8/17/2018	18:00	30.7	26.3	30.2	26.3	29.5	26.2	26.1
8/17/2018	19:00	28.2	25.4	28.2	25.3	29.2	25.3	24.4
8/17/2018	20:00	26.3	23.2	26.6	23.1	25.8	23.2	22.8
8/17/2018	21:00	26.1	23.2	26.2	23.1	25.8	23.2	22.2
8/17/2018	22:00	25.4	23.2	26.2	23.1	25.7	23.2	22.2
8/17/2018	23:00	25.2	22.7	24.3	22.7	24.5	22.6	21.7
8/17/2018	0:00	22.4	20.5	22.1	20.5	22.0	20.5	20.6
8/18/2018	1:00	22.2	22.0	21.9	21.9	22.2	22.0	21.1
8/18/2018	2:00	21.7	21.4	21.4	21.3	21.3	21.3	20.6
8/18/2018	3:00	21.1	20.9	21.2	20.7	21.3	20.9	20.0
8/18/2018	4:00	20.6	20.5	20.7	20.6	20.7	20.6	19.4
8/18/2018	5:00	19.3	19.2	19.3	19.1	19.1	19.1	18.3
8/18/2018	6:00	20.5	20.5	20.7	20.5	20.6	20.5	20.6
8/18/2018	7:00	22.6	22.3	22.7	22.2	22.5	22.3	22.2
8/18/2018	8:00	25.2	25.0	25.3	25.0	25.5	25.0	23.9
8/18/2018	9:00	25.9	24.8	25.8	24.7	25.9	24.8	24.4
8/18/2018	10:00	27.3	26.0	27.5	26.0	27.6	25.9	25.0
8/18/2018	11:00	28.6	26.3	28.0	26.3	28.1	26.2	26.1
8/18/2018	12:00	30.6	27.6	30.0	27.6	30.1	27.6	27.2

8/18/2018	13:00	30.9	28.3	31.4	28.1	31.3	28.2	27.2
8/18/2018	14:00	30.2	27.5	30.7	27.4	30.5	27.5	27.2
8/18/2018	15:00	32.3	28.2	31.8	28.2	31.6	28.1	28.3
8/18/2018	16:00	33.2	28.3	32.3	28.3	32.2	28.3	28.3
8/18/2018	17:00	32.1	28.2	31.6	28.2	32.1	28.2	27.2
8/18/2018	18:00	28.8	25.6	30.1	25.5	29.4	25.6	25.6
8/18/2018	19:00	28.5	24.7	27.8	24.6	27.6	24.6	23.9
8/18/2018	20:00	27.1	23.9	27.4	23.8	26.4	23.8	23.3
8/18/2018	21:00	26.6	23.8	26.6	23.7	26.4	23.7	23.3
8/18/2018	22:00	25.4	23.1	25.1	23.0	25.3	23.0	22.2
8/18/2018	23:00	23.7	21.3	23.0	21.2	23.4	21.2	21.1
8/18/2018	0:00	23.0	21.6	23.1	21.6	23.0	21.6	20.6
8/19/2018	1:00	20.9	20.5	20.4	20.5	20.8	20.4	20.6
8/19/2018	2:00	21.0	20.8	20.9	20.8	21.0	20.8	20.0
8/19/2018	3:00	19.4	19.4	19.6	19.2	19.4	19.2	19.4
8/19/2018	4:00	19.6	19.5	19.5	19.3	19.6	19.3	19.4
8/19/2018	5:00	19.8	19.8	19.7	19.8	19.9	19.7	18.9
8/19/2018	6:00	20.3	20.0	20.2	20.0	19.9	20.0	19.4
8/19/2018	7:00	21.8	21.5	21.8	21.5	21.5	21.4	20.6
8/19/2018	8:00	22.9	22.4	22.6	22.3	22.6	22.3	22.2
8/19/2018	9:00	26.1	24.7	25.7	24.7	25.8	24.8	23.9
8/19/2018	10:00	28.6	26.9	28.7	26.8	28.7	26.8	26.1
8/19/2018	11:00	29.5	28.0	29.6	27.9	30.1	27.8	27.2
8/19/2018	12:00	30.6	27.8	30.0	27.7	30.0	27.7	27.8
8/19/2018	13:00	31.6	29.0	31.6	29.0	31.9	29.0	28.9
8/19/2018	14:00	33.2	30.6	33.7	30.6	33.9	30.5	29.4
8/19/2018	15:00	32.6	28.4	32.2	28.5	32.5	28.3	28.3
8/19/2018	16:00	32.5	29.0	33.5	29.0	33.2	28.9	28.3
8/19/2018	17:00	32.4	28.3	32.0	28.2	32.6	28.3	27.8
8/19/2018	18:00	31.6	27.3	31.8	27.2	31.0	27.2	26.1
8/19/2018	19:00	28.7	25.0	28.8	25.0	28.9	25.1	23.9
8/19/2018	20:00	26.1	23.3	27.1	23.3	26.2	23.3	22.8
8/19/2018	21:00	26.5	24.0	26.9	24.0	26.6	23.9	22.8
8/19/2018	22:00	25.1	22.6	25.0	22.5	24.9	22.5	21.7
8/19/2018	23:00	24.7	22.4	24.5	22.3	23.9	22.3	21.7
8/19/2018	0:00	24.3	22.8	24.3	22.7	24.2	22.6	21.7
8/20/2018	1:00	22.3	22.3	22.3	22.3	22.5	22.3	21.1
8/20/2018	2:00	21.9	21.8	22.0	21.8	22.2	21.8	21.1
8/20/2018	3:00	21.9	21.9	22.3	21.9	22.2	21.8	21.1
8/20/2018	4:00	21.8	21.8	21.7	21.8	21.8	21.7	21.1
8/20/2018	5:00	21.6	21.5	21.4	21.4	21.6	21.5	20.6

8/20/2018	6:00	21.2	21.2	21.4	21.2	21.1	21.1	21.1
8/20/2018	7:00	21.6	21.6	21.7	21.5	21.9	21.5	21.1
8/20/2018	8:00	23.2	22.7	23.2	22.6	23.1	22.6	21.7
8/20/2018	9:00	24.7	23.0	24.0	22.9	24.0	23.0	22.2
8/20/2018	10:00	24.8	22.8	24.1	22.7	23.8	22.8	22.2
8/20/2018	11:00	25.4	23.4	25.2	23.2	25.4	23.3	23.3
8/20/2018	12:00	30.7	28.1	30.4	27.9	30.2	28.1	27.2
8/20/2018	13:00	32.0	28.8	31.6	28.7	31.4	28.6	27.8
8/20/2018	14:00	33.0	29.5	32.9	29.5	33.1	29.4	28.3
8/20/2018	15:00	33.8	29.7	33.5	29.7	33.8	29.7	28.9
8/20/2018	16:00	32.4	27.7	32.2	27.7	31.9	27.7	27.2
8/20/2018	17:00	31.1	27.1	30.4	27.1	31.5	27.0	26.1
8/20/2018	18:00	28.3	24.7	28.8	24.6	28.1	24.6	24.4
8/20/2018	19:00	25.4	21.9	25.0	21.8	25.2	22.0	21.1
8/20/2018	20:00	24.5	21.7	25.3	21.6	25.1	21.6	21.7
8/20/2018	21:00	25.3	22.8	25.9	22.8	25.8	22.7	21.7
8/20/2018	22:00	24.1	21.7	24.1	21.7	23.9	21.6	21.1
8/20/2018	23:00	24.3	22.1	23.7	22.0	23.8	22.2	21.1
8/20/2018	0:00	22.8	21.4	23.6	21.4	23.0	21.3	21.1
8/21/2018	1:00	22.0	21.6	21.6	21.6	21.8	21.5	20.6
8/21/2018	2:00	22.6	22.3	22.6	22.2	22.6	22.1	21.1
8/21/2018	3:00	21.6	21.3	21.4	21.2	21.1	21.2	20.6
8/21/2018	4:00	20.7	20.5	20.4	20.4	20.6	20.5	20.6
8/21/2018	5:00	21.0	21.0	20.9	21.0	21.0	21.0	20.6
8/21/2018	6:00	22.1	22.0	22.0	22.0	21.8	22.0	21.1
8/21/2018	7:00	21.0	20.6	20.6	20.5	20.7	20.6	20.6
8/21/2018	8:00	20.9	20.6	21.0	20.6	21.0	20.6	20.6
8/21/2018	9:00	23.8	22.1	23.2	22.0	23.2	22.0	21.7
8/21/2018	10:00	25.8	23.6	24.6	23.5	25.1	23.5	22.8
8/21/2018	11:00	26.6	24.9	26.7	24.8	27.0	24.9	23.9
8/21/2018	12:00	26.1	24.0	26.0	23.9	26.4	23.9	22.8
8/21/2018	13:00	25.5	22.9	25.3	22.9	25.6	22.8	22.8
8/21/2018	14:00	25.8	22.2	25.9	22.2	25.7	22.1	22.2
8/21/2018	15:00	26.3	23.0	26.6	23.0	27.0	22.9	22.2
8/21/2018	16:00	28.6	24.2	28.8	24.1	28.6	24.1	23.3
8/21/2018	17:00	27.2	23.6	27.4	23.5	27.1	23.6	23.3
8/21/2018	18:00	26.9	23.7	27.4	23.7	27.5	23.6	22.8
8/21/2018	19:00	24.1	21.1	24.5	21.0	24.9	21.1	20.0
8/21/2018	20:00	22.9	19.6	22.6	19.5	23.1	19.4	19.4
8/21/2018	21:00	21.1	18.4	21.4	18.3	21.4	18.2	18.3
8/21/2018	22:00	23.4	20.5	23.0	20.4	22.8	20.5	20.0

8/21/2018	23:00	21.7	19.4	21.6	19.2	21.2	19.3	19.4
8/21/2018	0:00	20.9	18.9	21.1	18.9	20.3	18.9	18.9
8/22/2018	1:00	18.3	18.1	18.1	18.1	18.1	17.9	17.8
8/22/2018	2:00	17.3	17.4	17.4	17.3	17.4	17.4	16.7
8/22/2018	3:00	17.6	17.1	17.3	17.0	17.4	17.0	16.7
8/22/2018	4:00	18.4	18.2	18.5	18.1	18.4	18.1	17.2
8/22/2018	5:00	16.3	16.1	16.1	16.1	16.0	16.1	16.1
8/22/2018	6:00	15.9	15.6	15.6	15.6	15.9	15.6	15.6
8/22/2018	7:00	17.4	17.0	17.0	17.0	17.1	17.0	16.1
8/22/2018	8:00	18.4	17.8	18.2	17.7	18.1	17.8	17.8
8/22/2018	9:00	22.0	20.1	21.1	20.1	21.2	20.0	19.4
8/22/2018	10:00	23.8	21.6	22.7	21.6	23.4	21.7	21.1
8/22/2018	11:00	25.3	23.2	24.9	23.1	24.9	23.2	22.8
8/22/2018	12:00	26.4	23.7	25.8	23.6	26.1	23.6	23.3
8/22/2018	13:00	28.5	25.3	28.4	25.3	27.5	25.2	24.4
8/22/2018	14:00	29.3	25.5	28.2	25.5	28.5	25.4	24.4
8/22/2018	15:00	28.7	24.4	27.6	24.4	28.0	24.4	24.4
8/22/2018	16:00	28.7	24.5	28.7	24.5	28.6	24.6	23.9
8/22/2018	17:00	27.1	23.8	27.6	23.8	27.3	23.8	23.3
8/22/2018	18:00	25.0	21.1	24.1	21.0	25.6	21.0	21.1
8/22/2018	19:00	21.7	18.9	21.7	18.9	22.3	18.9	18.9
8/22/2018	20:00	21.9	18.9	22.5	18.9	22.7	18.9	17.8
8/22/2018	21:00	20.1	17.2	20.1	17.1	20.2	17.2	16.7
8/22/2018	22:00	17.9	15.4	17.8	15.4	17.5	15.4	14.4
8/22/2018	23:00	18.1	15.8	18.1	15.8	17.9	15.7	15.0
8/22/2018	0:00	16.2	14.7	16.6	14.6	16.3	14.6	14.4
8/23/2018	1:00	14.3	14.3	14.2	14.2	14.2	14.3	13.9
8/23/2018	2:00	14.2	14.3	14.5	14.2	14.7	14.2	13.3
8/23/2018	3:00	13.2	13.3	13.2	13.3	13.1	13.2	12.2
8/23/2018	4:00	12.8	12.8	13.1	12.8	12.8	12.9	12.8
8/23/2018	5:00	13.4	13.4	13.2	13.4	13.3	13.3	12.2
8/23/2018	6:00	13.6	13.3	13.5	13.1	13.3	13.2	13.3
8/23/2018	7:00	16.8	16.5	16.8	16.4	16.5	16.3	16.1
8/23/2018	8:00	20.6	19.8	20.1	19.6	20.1	19.7	19.4
8/23/2018	9:00	23.7	21.9	23.1	21.8	23.0	21.9	21.7
8/23/2018	10:00	26.2	24.4	25.6	24.2	25.9	24.3	23.9
8/23/2018	11:00	27.3	24.9	26.9	24.9	26.9	24.9	24.4
8/23/2018	12:00	28.5	25.6	27.9	25.5	28.1	25.5	25.0
8/23/2018	13:00	29.5	26.6	29.2	26.5	29.0	26.5	25.6
8/23/2018	14:00	28.5	25.6	28.7	25.6	29.4	25.5	24.4
8/23/2018	15:00	31.7	27.3	31.1	27.2	30.3	27.2	26.1

8/23/2018	16:00	29.5	25.7	29.3	25.6	30.2	25.7	25.6
8/23/2018	17:00	28.2	24.6	28.1	24.6	28.9	24.6	24.4
8/23/2018	18:00	26.3	22.4	25.7	22.3	26.8	22.3	22.2
8/23/2018	19:00	22.2	19.5	22.9	19.4	22.7	19.5	18.9
8/23/2018	20:00	21.4	18.0	21.6	17.9	21.4	18.0	17.2
8/23/2018	21:00	19.8	16.7	19.7	16.7	19.3	16.7	16.7
8/23/2018	22:00	19.9	17.4	20.3	17.3	19.6	17.3	16.7
8/23/2018	23:00	18.4	16.3	18.1	16.3	18.3	16.2	15.6
8/23/2018	0:00	18.0	15.7	17.8	15.6	17.3	15.6	15.0
8/24/2018	1:00	14.9	14.9	15.0	14.9	14.9	14.9	14.4
8/24/2018	2:00	16.0	15.6	16.0	15.4	15.7	15.5	15.6
8/24/2018	3:00	17.0	16.8	17.2	16.7	16.8	16.8	16.7
8/24/2018	4:00	17.5	17.3	17.5	17.2	17.3	17.2	16.1
8/24/2018	5:00	16.7	16.7	16.7	16.7	16.8	16.6	15.6
8/24/2018	6:00	16.2	16.2	16.2	16.1	16.4	16.2	16.1
8/24/2018	7:00	16.5	16.4	16.4	16.3	16.6	16.3	16.1
8/24/2018	8:00	17.4	17.1	17.4	17.0	17.2	17.1	16.1
8/24/2018	9:00	17.9	16.9	17.8	16.8	18.0	16.8	16.1
8/24/2018	10:00	18.4	17.2	18.4	17.2	18.5	17.2	16.7
8/24/2018	11:00	21.2	19.4	21.0	19.2	21.2	19.3	18.3
8/24/2018	12:00	25.0	22.2	24.6	22.2	24.3	22.2	21.1
8/24/2018	13:00	22.7	20.1	22.5	19.9	22.7	20.1	20.0
8/24/2018	14:00	23.0	20.2	23.5	20.2	23.2	20.1	19.4
8/24/2018	15:00	21.9	18.2	22.0	18.1	22.4	18.2	17.8
8/24/2018	16:00	22.5	18.8	23.0	18.8	23.6	18.7	17.8
8/24/2018	17:00	22.9	19.5	23.0	19.4	22.9	19.4	18.3
8/24/2018	18:00	23.2	19.4	22.7	19.5	22.7	19.3	18.3
8/24/2018	19:00	22.0	19.2	22.2	19.1	22.6	19.1	18.3
8/24/2018	20:00	21.7	18.9	22.7	18.8	22.3	18.8	17.8
8/24/2018	21:00	20.4	17.3	20.2	17.2	19.8	17.2	17.2
8/24/2018	22:00	21.0	18.3	21.3	18.3	20.8	18.2	17.2
8/24/2018	23:00	19.7	17.5	19.8	17.5	19.7	17.5	17.2
8/24/2018	0:00	19.3	17.7	19.1	17.6	19.3	17.6	17.2
8/25/2018	1:00	17.9	18.0	18.1	17.9	18.2	18.0	17.8
8/25/2018	2:00	19.2	19.2	19.1	19.2	19.3	19.1	18.3
8/25/2018	3:00	20.5	20.0	20.1	20.0	19.9	19.9	18.9
8/25/2018	4:00	19.7	19.5	19.4	19.3	19.6	19.5	19.4
8/25/2018	5:00	21.1	20.9	20.8	20.8	20.9	20.8	20.0
8/25/2018	6:00	21.0	20.9	21.1	20.8	21.0	20.7	20.6
8/25/2018	7:00	22.7	22.3	22.6	22.2	22.6	22.3	21.1
8/25/2018	8:00	24.0	23.5	23.8	23.4	23.9	23.5	22.8

8/25/2018	9:00	27.1	25.2	26.3	25.1	26.2	25.2	24.4
8/25/2018	10:00	27.0	25.9	27.4	25.8	27.0	25.8	25.6
8/25/2018	11:00	29.6	27.8	29.6	27.7	29.4	27.8	26.7
8/25/2018	12:00	31.2	28.3	30.7	28.3	30.3	28.3	27.2
8/25/2018	13:00	30.7	28.4	31.5	28.3	31.6	28.3	27.8
8/25/2018	14:00	32.5	29.4	32.6	29.3	32.7	29.2	28.9
8/25/2018	15:00	34.5	30.5	33.5	30.4	34.1	30.5	30.0
8/25/2018	16:00	36.5	31.7	35.9	31.7	35.7	31.6	30.6
8/25/2018	17:00	34.0	30.2	33.8	30.1	33.9	30.1	30.0
8/25/2018	18:00	32.7	29.1	33.6	29.0	33.3	28.9	28.3
8/25/2018	19:00	31.0	27.7	31.3	27.7	31.4	27.7	26.7
8/25/2018	20:00	29.2	26.4	29.0	26.4	29.4	26.4	25.6
8/25/2018	21:00	29.1	26.3	28.9	26.3	29.0	26.2	25.6
8/25/2018	22:00	27.9	25.6	28.0	25.5	28.0	25.6	25.0
8/25/2018	23:00	26.4	24.7	26.8	24.6	26.7	24.7	24.4
8/25/2018	0:00	26.8	24.8	26.8	24.7	26.2	24.8	24.4
8/26/2018	1:00	25.1	24.9	25.1	24.8	24.9	24.7	23.9
8/26/2018	2:00	24.9	24.8	24.9	24.8	25.3	24.7	23.9
8/26/2018	3:00	24.9	24.9	24.9	24.8	24.9	24.8	23.9
8/26/2018	4:00	24.4	24.2	24.0	24.0	24.2	24.0	23.9
8/26/2018	5:00	23.5	23.5	23.4	23.3	23.4	23.5	23.3
8/26/2018	6:00	24.4	24.3	24.4	24.3	24.2	24.3	23.9
8/26/2018	7:00	25.9	25.5	25.4	25.4	25.8	25.4	25.0
8/26/2018	8:00	27.8	27.5	28.0	27.4	28.0	27.5	27.2
8/26/2018	9:00	30.4	28.9	29.9	28.9	29.9	28.9	28.9
8/26/2018	10:00	32.1	30.7	32.0	30.7	31.9	30.7	30.6
8/26/2018	11:00	33.9	31.9	33.7	31.8	33.8	31.8	31.7
8/26/2018	12:00	35.8	33.3	35.5	33.3	35.5	33.1	32.2
8/26/2018	13:00	33.9	31.4	34.1	31.4	33.7	31.4	31.1
8/26/2018	14:00	35.7	32.4	35.7	32.4	35.0	32.3	31.7
8/26/2018	15:00	36.9	33.3	37.0	33.2	36.5	33.1	32.8
8/26/2018	16:00	37.9	33.0	37.7	32.9	36.8	32.9	32.2
8/26/2018	17:00	36.5	32.4	36.5	32.4	36.2	32.4	31.7
8/26/2018	18:00	35.1	31.0	35.3	30.9	34.2	30.8	30.0
8/26/2018	19:00	31.6	28.1	31.3	28.2	31.5	28.0	27.2
8/26/2018	20:00	28.9	26.1	28.6	26.0	28.8	26.0	26.1
8/26/2018	21:00	28.5	25.8	28.4	25.8	28.8	25.8	25.6
8/26/2018	22:00	27.3	25.2	27.8	25.1	27.4	25.2	24.4
8/26/2018	23:00	27.2	25.1	26.6	25.0	27.2	24.9	23.9
8/26/2018	0:00	24.9	23.3	25.5	23.3	25.3	23.3	23.3
8/27/2018	1:00	24.6	24.2	24.6	24.1	24.3	24.2	23.9

8/27/2018	2:00	23.7	23.4	23.5	23.2	23.4	23.2	23.3
8/27/2018	3:00	23.7	23.3	23.4	23.3	23.5	23.2	23.3
8/27/2018	4:00	23.5	23.4	23.5	23.3	23.4	23.4	22.8
8/27/2018	5:00	22.8	22.7	22.6	22.5	22.7	22.7	22.2
8/27/2018	6:00	22.9	22.8	23.0	22.8	22.6	22.7	22.8
8/27/2018	7:00	25.9	25.5	25.5	25.5	25.7	25.5	24.4
8/27/2018	8:00	27.3	27.1	27.6	27.2	27.4	27.1	27.2
8/27/2018	9:00	30.3	28.9	30.0	28.8	29.9	28.9	28.9
8/27/2018	10:00	32.3	31.0	32.1	30.9	32.3	30.9	30.6
8/27/2018	11:00	34.9	32.4	34.0	32.4	34.2	32.3	31.7
8/27/2018	12:00	35.2	33.1	35.6	33.0	35.6	33.1	32.2
8/27/2018	13:00	36.4	33.3	36.4	33.3	36.4	33.3	32.8
8/27/2018	14:00	37.0	33.6	36.3	33.5	37.0	33.5	32.8
8/27/2018	15:00	37.2	34.1	37.9	34.0	38.0	34.0	33.3
8/27/2018	16:00	35.9	32.2	35.9	32.2	36.0	32.1	31.7
8/27/2018	17:00	35.2	31.4	34.8	31.4	35.4	31.3	31.1
8/27/2018	18:00	33.6	29.5	33.9	29.4	33.1	29.4	29.4
8/27/2018	19:00	31.7	28.8	32.5	28.7	32.3	28.8	27.8
8/27/2018	20:00	30.4	27.5	30.5	27.4	30.7	27.5	26.7
8/27/2018	21:00	29.4	26.5	29.2	26.5	29.1	26.4	25.6
8/27/2018	22:00	29.3	26.7	29.3	26.6	29.0	26.6	25.6
8/27/2018	23:00	27.8	25.9	27.5	25.8	27.8	25.9	25.0
8/27/2018	0:00	25.7	24.2	26.3	24.0	25.8	24.1	23.9
8/28/2018	1:00	24.8	24.6	24.6	24.5	24.6	24.5	23.9
8/28/2018	2:00	23.3	23.0	23.1	22.9	23.3	22.9	22.8
8/28/2018	3:00	24.2	24.0	24.1	23.9	23.9	23.9	22.8
8/28/2018	4:00	22.9	23.0	22.9	23.0	23.0	22.9	22.8
8/28/2018	5:00	23.9	23.8	23.8	23.8	23.9	23.8	22.8
8/28/2018	6:00	23.9	23.9	23.9	23.8	23.8	23.8	22.8
8/28/2018	7:00	25.4	25.1	25.4	24.9	25.1	24.9	25.0
8/28/2018	8:00	28.3	27.9	28.4	27.8	28.1	27.9	27.2
8/28/2018	9:00	31.3	30.2	31.3	30.1	31.3	30.0	29.4
8/28/2018	10:00	33.1	31.7	33.3	31.6	33.0	31.6	31.1
8/28/2018	11:00	34.3	32.2	33.9	32.2	34.0	32.0	32.2
8/28/2018	12:00	34.8	32.7	34.7	32.6	35.1	32.6	32.8
8/28/2018	13:00	36.5	33.6	36.6	33.5	35.7	33.6	33.3
8/28/2018	14:00	37.1	34.4	37.5	34.3	37.0	34.4	33.3
8/28/2018	15:00	38.3	34.2	37.7	34.1	37.5	34.2	33.3
8/28/2018	16:00	37.7	33.8	37.5	33.8	38.4	33.8	33.3
8/28/2018	17:00	36.2	31.9	36.0	31.8	35.8	31.8	31.7
8/28/2018	18:00	34.4	30.5	35.0	30.5	33.6	30.5	30.0

8/28/2018	19:00	31.9	28.3	31.5	28.3	31.2	28.3	27.8
8/28/2018	20:00	29.2	25.9	29.5	25.9	29.4	25.9	25.0
8/28/2018	21:00	28.3	25.8	28.7	25.8	28.3	25.7	25.6
8/28/2018	22:00	28.6	25.9	28.7	25.7	28.0	25.8	25.0
8/28/2018	23:00	26.7	25.1	26.6	25.0	27.4	24.9	25.0
8/28/2018	0:00	26.2	24.1	25.5	23.9	25.8	23.9	23.9
8/29/2018	1:00	24.8	24.5	24.6	24.5	24.8	24.5	24.4
8/29/2018	2:00	23.2	23.0	23.3	23.0	22.9	23.0	22.8
8/29/2018	3:00	22.4	22.0	22.5	22.0	22.4	21.9	21.1
8/29/2018	4:00	22.2	22.0	22.0	21.9	22.2	21.9	21.1
8/29/2018	5:00	21.3	21.2	21.3	21.2	21.2	21.2	20.6
8/29/2018	6:00	20.8	20.9	21.0	20.9	20.9	20.8	20.6
8/29/2018	7:00	22.0	21.7	22.0	21.7	21.9	21.6	20.6
8/29/2018	8:00	21.4	20.8	21.2	20.7	21.0	20.7	20.6
8/29/2018	9:00	23.9	22.6	23.7	22.6	23.6	22.6	22.2
8/29/2018	10:00	25.1	23.8	24.8	23.7	25.4	23.8	23.3
8/29/2018	11:00	25.7	24.1	26.1	24.0	26.0	24.0	23.9
8/29/2018	12:00	26.4	24.4	26.6	24.3	26.9	24.3	24.4
8/29/2018	13:00	28.4	25.5	28.6	25.4	28.3	25.5	24.4
8/29/2018	14:00	27.7	25.0	27.6	24.9	27.8	25.0	23.9
8/29/2018	15:00	30.1	25.9	29.5	25.9	29.4	25.9	25.6
8/29/2018	16:00	30.7	26.3	30.4	26.3	30.4	26.3	26.1
8/29/2018	17:00	27.9	24.5	28.9	24.3	28.7	24.4	24.4
8/29/2018	18:00	27.9	23.6	27.6	23.4	28.0	23.5	23.3
8/29/2018	19:00	25.3	22.3	25.8	22.3	25.2	22.2	21.7
8/29/2018	20:00	24.6	21.2	24.4	21.1	24.5	21.2	20.6
8/29/2018	21:00	23.1	20.0	22.7	19.9	23.1	20.0	20.0
8/29/2018	22:00	22.9	20.1	22.2	20.0	22.8	20.0	18.9
8/29/2018	23:00	21.3	19.5	21.6	19.4	21.1	19.5	18.3
8/29/2018	0:00	22.1	20.7	22.2	20.7	22.8	20.6	20.6
8/30/2018	1:00	19.9	19.9	20.1	19.8	20.0	19.8	20.0
8/30/2018	2:00	19.6	19.6	19.6	19.5	19.5	19.5	19.4
8/30/2018	3:00	19.9	19.7	20.1	19.5	19.7	19.6	19.4
8/30/2018	4:00	19.6	19.4	19.5	19.2	19.5	19.3	18.9
8/30/2018	5:00	18.1	18.1	18.0	18.1	18.2	17.9	17.8
8/30/2018	6:00	18.0	18.0	17.9	17.9	17.9	18.0	17.8
8/30/2018	7:00	19.2	19.1	19.1	19.1	19.2	18.9	18.9
8/30/2018	8:00	22.1	21.8	22.1	21.6	22.1	21.8	20.6
8/30/2018	9:00	23.6	22.1	23.2	22.0	23.1	22.0	21.7
8/30/2018	10:00	24.3	22.9	24.2	22.8	24.6	22.9	22.8
8/30/2018	11:00	27.5	25.0	26.8	25.0	27.0	24.9	23.9

8/30/2018	12:00	28.7	25.8	28.4	25.7	28.0	25.7	25.0
8/30/2018	13:00	29.5	26.4	28.6	26.3	29.6	26.4	25.6
8/30/2018	14:00	29.1	26.3	29.2	26.2	30.0	26.2	26.1
8/30/2018	15:00	31.3	27.4	30.6	27.3	30.4	27.2	26.7
8/30/2018	16:00	31.4	27.1	31.6	27.1	31.5	27.0	26.1
8/30/2018	17:00	29.6	25.3	28.7	25.3	28.9	25.3	24.4
8/30/2018	18:00	26.8	23.3	26.5	23.2	27.5	23.1	22.2
8/30/2018	19:00	25.0	21.5	24.9	21.4	24.2	21.4	21.1
8/30/2018	20:00	23.3	20.3	24.1	20.2	23.0	20.2	19.4
8/30/2018	21:00	22.2	19.3	22.0	19.3	22.3	19.2	18.9
8/30/2018	22:00	20.3	17.9	20.6	17.8	20.9	17.9	17.8
8/30/2018	23:00	20.8	18.5	20.9	18.3	20.8	18.4	17.8
8/30/2018	0:00	19.4	17.4	19.1	17.3	19.3	17.3	16.7
8/31/2018	1:00	16.6	16.3	16.2	16.2	16.5	16.3	15.6
8/31/2018	2:00	18.2	17.7	18.1	17.6	17.7	17.7	16.7
8/31/2018	3:00	17.5	17.2	17.4	17.2	17.2	17.2	16.1
8/31/2018	4:00	16.7	16.7	16.9	16.6	16.7	16.7	16.1
8/31/2018	5:00	16.2	16.1	16.0	16.1	16.0	16.0	16.1
8/31/2018	6:00	16.9	16.7	16.6	16.7	16.7	16.5	16.7
8/31/2018	7:00	18.6	18.5	18.5	18.4	18.7	18.4	18.3
8/31/2018	8:00	23.0	22.7	23.0	22.6	23.1	22.6	21.7
8/31/2018	9:00	26.3	24.4	25.4	24.3	25.4	24.2	24.4
8/31/2018	10:00	29.7	28.3	29.9	28.3	29.6	28.3	27.2
8/31/2018	11:00	32.6	30.7	32.5	30.7	32.5	30.8	30.0
8/31/2018	12:00	33.3	30.3	32.7	30.2	32.4	30.2	30.0
8/31/2018	13:00	33.9	30.8	33.0	30.8	33.8	30.9	30.0
8/31/2018	14:00	36.3	32.6	35.7	32.6	35.9	32.5	31.7
8/31/2018	15:00	34.3	30.7	34.8	30.6	34.0	30.6	30.6
8/31/2018	16:00	34.8	31.2	35.4	31.2	35.9	31.2	30.6
8/31/2018	17:00	33.2	28.8	33.3	28.7	32.9	28.8	28.9
8/31/2018	18:00	31.1	27.8	31.1	27.8	31.4	27.7	27.8
8/31/2018	19:00	29.1	25.5	29.2	25.5	29.3	25.5	24.4
8/31/2018	20:00	28.6	25.5	28.7	25.4	28.7	25.4	24.4
8/31/2018	21:00	26.1	23.6	26.5	23.5	26.2	23.4	23.3
8/31/2018	22:00	26.0	23.5	26.0	23.4	26.0	23.5	22.8
8/31/2018	23:00	24.5	22.3	24.3	22.3	24.8	22.3	22.2
8/31/2018	0:00	24.1	22.2	23.6	22.1	23.6	22.1	21.7
9/1/2018	1:00	22.4	22.1	22.1	22.1	22.0	22.1	21.1
9/1/2018	2:00	20.5	20.5	20.4	20.5	20.5	20.5	20.6
9/1/2018	3:00	21.4	21.2	21.2	21.2	21.1	21.1	21.1
9/1/2018	4:00	22.0	21.8	21.8	21.8	21.8	21.8	21.7

9/1/2018	5:00	21.7	21.5	21.4	21.4	21.5	21.4	21.1
9/1/2018	6:00	22.9	22.7	22.9	22.7	22.9	22.7	21.7
9/1/2018	7:00	23.5	23.5	23.5	23.5	23.5	23.3	22.8
9/1/2018	8:00	26.4	25.5	25.9	25.4	26.0	25.5	24.4
9/1/2018	9:00	29.1	27.1	28.2	27.1	28.2	27.0	26.1
9/1/2018	10:00	30.3	28.6	30.3	28.6	30.4	28.6	27.8
9/1/2018	11:00	31.9	29.7	31.4	29.6	31.8	29.6	29.4
9/1/2018	12:00	33.5	30.7	33.1	30.6	33.2	30.7	30.0
9/1/2018	13:00	32.8	30.5	32.6	30.4	33.1	30.4	30.0
9/1/2018	14:00	35.5	31.6	35.2	31.5	34.2	31.6	30.6
9/1/2018	15:00	35.4	32.2	35.3	32.1	35.5	32.1	31.1
9/1/2018	16:00	35.8	31.6	36.1	31.5	35.8	31.4	31.1
9/1/2018	17:00	35.2	31.2	35.3	31.0	35.2	31.2	30.6
9/1/2018	18:00	32.6	29.3	33.1	29.3	32.8	29.2	28.3
9/1/2018	19:00	29.9	26.1	29.0	26.0	29.6	26.0	25.6
9/1/2018	20:00	28.3	25.4	28.5	25.3	28.6	25.4	25.0
9/1/2018	21:00	27.9	25.3	28.1	25.2	27.9	25.2	24.4
9/1/2018	22:00	26.8	23.9	26.6	23.9	26.6	23.8	23.9
9/1/2018	23:00	25.1	23.2	24.7	23.1	25.6	23.2	22.8
9/1/2018	0:00	23.9	21.7	23.4	21.6	23.2	21.7	21.7
9/2/2018	1:00	22.7	22.2	22.6	22.2	22.3	22.2	22.2
9/2/2018	2:00	22.4	22.5	22.4	22.3	22.6	22.4	22.2
9/2/2018	3:00	22.1	21.8	22.1	21.7	22.0	21.7	21.7
9/2/2018	4:00	21.9	21.9	21.8	21.9	22.2	21.8	21.1
9/2/2018	5:00	21.9	21.9	21.8	21.8	21.9	21.8	21.7
9/2/2018	6:00	23.3	23.2	23.2	23.0	23.4	23.1	22.2
9/2/2018	7:00	22.9	22.8	23.1	22.8	22.8	22.7	22.8
9/2/2018	8:00	27.2	26.5	26.7	26.4	26.8	26.5	26.1
9/2/2018	9:00	31.4	30.4	31.5	30.3	31.5	30.3	29.4
9/2/2018	10:00	31.8	30.0	31.5	29.8	31.7	30.0	29.4
9/2/2018	11:00	34.5	32.5	34.3	32.4	34.2	32.3	31.7
9/2/2018	12:00	35.2	32.2	34.6	32.2	34.2	32.1	31.1
9/2/2018	13:00	36.2	33.2	36.0	33.1	35.7	33.0	32.8
9/2/2018	14:00	36.3	33.4	36.2	33.3	36.0	33.3	32.8
9/2/2018	15:00	37.1	33.5	37.6	33.4	36.8	33.4	33.3
9/2/2018	16:00	37.8	33.1	37.0	33.0	37.1	33.0	32.8
9/2/2018	17:00	35.6	31.5	35.3	31.4	35.4	31.5	31.1
9/2/2018	18:00	33.4	29.9	34.0	29.9	33.1	29.8	29.4
9/2/2018	19:00	30.3	26.6	30.2	26.6	29.4	26.5	25.6
9/2/2018	20:00	27.0	24.2	27.6	24.2	27.3	24.2	23.9
9/2/2018	21:00	26.8	23.8	26.6	23.8	26.7	23.8	23.9

9/2/2018	22:00	27.2	24.3	26.8	24.3	26.8	24.3	23.9
9/2/2018	23:00	27.2	24.8	27.3	24.7	27.2	24.8	23.9
9/2/2018	0:00	26.0	23.9	26.1	23.9	26.0	23.8	22.8
9/3/2018	1:00	23.5	23.1	23.0	23.0	23.4	23.0	22.2
9/3/2018	2:00	22.4	22.2	22.4	22.1	22.5	22.2	22.2
9/3/2018	3:00	22.4	22.2	22.7	22.2	22.6	22.2	22.2
9/3/2018	4:00	22.4	22.1	22.3	22.1	22.2	22.1	21.1
9/3/2018	5:00	21.2	21.2	21.4	21.1	21.1	21.1	21.1
9/3/2018	6:00	21.6	21.6	21.5	21.7	21.7	21.6	21.7
9/3/2018	7:00	25.7	25.3	25.5	25.2	25.3	25.1	25.0
9/3/2018	8:00	28.5	28.2	28.5	28.0	28.6	28.2	27.2
9/3/2018	9:00	32.6	30.8	31.8	30.8	31.9	30.7	30.6
9/3/2018	10:00	34.6	33.3	34.7	33.2	34.5	33.2	32.8
9/3/2018	11:00	35.4	33.3	35.2	33.2	35.4	33.2	32.8
9/3/2018	12:00	36.0	33.5	35.8	33.5	35.6	33.5	32.8
9/3/2018	13:00	37.5	34.8	37.6	34.7	37.3	34.8	34.4
9/3/2018	14:00	35.2	32.2	35.6	32.1	35.1	32.2	32.2
9/3/2018	15:00	38.7	34.9	38.4	34.9	38.1	34.9	34.4
9/3/2018	16:00	38.6	33.8	38.3	33.7	38.5	33.8	33.3
9/3/2018	17:00	36.3	32.4	35.8	32.4	36.1	32.3	32.2
9/3/2018	18:00	35.1	30.9	34.4	31.0	35.1	30.8	30.6
9/3/2018	19:00	29.9	27.1	30.5	27.0	30.2	27.1	26.1
9/3/2018	20:00	28.8	25.8	29.0	25.8	29.3	25.7	25.0
9/3/2018	21:00	27.7	24.6	27.1	24.6	27.3	24.5	23.9
9/3/2018	22:00	27.2	24.7	26.9	24.6	27.6	24.6	24.4
9/3/2018	23:00	27.2	25.2	27.7	25.2	27.1	25.2	24.4
9/3/2018	0:00	26.0	24.3	25.8	24.3	26.5	24.3	23.9
9/4/2018	1:00	24.0	23.8	24.1	23.7	24.0	23.9	23.3
9/4/2018	2:00	23.7	23.8	24.1	23.7	23.7	23.7	22.8
9/4/2018	3:00	24.2	23.8	24.1	23.7	24.1	23.8	22.8
9/4/2018	4:00	22.7	22.8	22.9	22.7	23.0	22.8	22.2
9/4/2018	5:00	21.2	21.2	21.2	21.1	21.3	21.1	20.6
9/4/2018	6:00	21.5	21.5	21.5	21.5	21.4	21.4	20.6
9/4/2018	7:00	26.2	25.8	25.9	25.7	26.1	25.8	25.0
9/4/2018	8:00	29.9	29.4	29.8	29.3	29.7	29.3	28.3
9/4/2018	9:00	33.3	31.8	32.9	31.8	32.8	31.7	31.1
9/4/2018	10:00	34.5	33.3	34.5	33.2	35.1	33.2	32.2
9/4/2018	11:00	36.5	34.2	35.9	34.0	36.1	34.1	33.3
9/4/2018	12:00	36.6	34.0	36.3	34.0	36.1	33.9	33.3
9/4/2018	13:00	38.2	35.5	37.8	35.5	38.1	35.4	34.4
9/4/2018	14:00	39.0	35.2	38.7	35.2	37.8	35.0	34.4

9/4/2018	15:00	37.8	34.5	37.7	34.5	38.6	34.4	33.3
9/4/2018	16:00	37.8	34.2	38.0	34.2	38.1	34.2	33.3
9/4/2018	17:00	36.3	32.8	36.6	32.8	36.9	32.8	32.2
9/4/2018	18:00	34.2	30.1	34.6	30.1	33.8	30.1	30.0
9/4/2018	19:00	30.2	26.9	29.6	26.9	30.5	26.9	26.1
9/4/2018	20:00	27.9	25.2	27.9	25.1	29.0	25.2	25.0
9/4/2018	21:00	26.5	23.5	26.1	23.4	26.0	23.5	23.3
9/4/2018	22:00	26.8	24.5	26.5	24.4	26.6	24.5	23.9
9/4/2018	23:00	25.9	23.6	25.8	23.6	25.1	23.5	22.8
9/4/2018	0:00	26.6	24.4	26.5	24.4	25.9	24.3	23.3
9/5/2018	1:00	23.6	23.2	23.5	23.1	23.5	23.2	22.8
9/5/2018	2:00	24.4	24.5	24.4	24.5	24.6	24.3	23.3
9/5/2018	3:00	23.7	23.2	23.4	23.1	23.4	23.1	22.8
9/5/2018	4:00	23.5	23.3	23.5	23.2	23.4	23.2	22.8
9/5/2018	5:00	23.3	23.2	23.1	23.1	23.1	23.1	22.2
9/5/2018	6:00	22.5	22.3	22.3	22.3	22.4	22.2	22.2
9/5/2018	7:00	25.5	25.3	25.3	25.2	25.5	25.2	25.0
9/5/2018	8:00	29.5	29.1	29.7	29.1	29.6	29.1	28.3
9/5/2018	9:00	32.8	31.3	32.4	31.3	32.4	31.2	30.6
9/5/2018	10:00	34.2	32.0	33.5	32.0	33.3	32.0	31.7
9/5/2018	11:00	32.7	31.2	33.3	31.1	32.9	31.2	31.1
9/5/2018	12:00	36.4	34.0	36.3	33.9	36.6	33.9	33.3
9/5/2018	13:00	38.1	34.9	37.5	34.8	37.9	34.8	34.4
9/5/2018	14:00	39.3	35.3	38.7	35.2	38.7	35.2	35.0
9/5/2018	15:00	39.3	35.4	38.5	35.3	38.5	35.4	35.0
9/5/2018	16:00	37.7	33.6	37.4	33.6	38.5	33.6	32.8
9/5/2018	17:00	38.1	33.9	37.9	33.8	37.6	33.9	33.3
9/5/2018	18:00	35.3	31.5	35.6	31.3	35.9	31.4	30.6
9/5/2018	19:00	30.3	27.4	30.2	27.4	30.8	27.3	26.7
9/5/2018	20:00	29.1	26.5	29.5	26.4	29.0	26.5	25.6
9/5/2018	21:00	28.6	26.0	28.5	26.0	28.5	26.1	25.6
9/5/2018	22:00	27.2	25.0	27.6	24.8	26.9	24.9	24.4
9/5/2018	23:00	26.2	24.7	26.5	24.7	26.8	24.7	23.9
9/5/2018	0:00	25.5	24.0	25.9	24.0	25.7	23.9	23.3

Experiment 1 raw data.

KEY

Intra	Larvae experiencing only intraspecific competition
Inter	Larvae experiencing both types of competition
C1	Tree 1, control side
C2	Tree 2, control side
C3	Tree 3, control side
H1	Tree 1, heated side
H2	Tree 2, heated side
H3	Tree 3, heated side

* Numbers after the tree number (e.g., -001) indicate the specific apple number from that tree, treatment, and competition type e.g., Inter-C1-001 indicates an Interspecific Competition type Apple number 1 from the control treatment side of Tree 1

Apple #	**Oviposition Marks**	**Number Larvae**	**Number Parasitized**	**Parasitism Rate**	**Survival Rate**
Inter-C1-001	18	1	1	1	0.056
Inter-C1-002	7	3	0	0	0.429
Inter-C1-003	8	4	2	0.5	0.5
Inter-C1-004	17	2	2	1	0.118
Inter-C1-005	12	3	0	0	0.25
Inter-C1-006	9	3	0	0	0.333
Inter-C1-007	4	3	1	0.333	0.75
Inter-C1-008	12	1	0	0	0.083
Inter-C1-009	9	4	2	0.5	0.444
Inter-C1-010	13	1	1	1	0.077077
Inter-C1-011	10	4	0	0	0.4
Inter-C1-012	16	4	0	0	0.25
Inter-C1-013	16	2	1	0.5	0.125
Inter-C1-014	6	4	0	0	0.667
Inter-C1-015	9	2	1	0.5	0.222
Inter-C1-016	12	5	1	0.2	0.417
Inter-C1-017	12	2	0	0	0.167
Inter-C1-018	11	4	1	0.25	0.364
Inter-C1-019	7	3	0	0	0.429
Inter-C1-020	17	2	1	0.5	0.118
Inter-C1-021	8	2	0	0	0.25
Inter-C1-022	7	3	1	0.333	0.429
Inter-C1-023	10	2	0	0	0.2
Inter-C1-024	16	6	0	0	0.375

Inter-C1-025	15	1	0	0	0.067
Inter-C1-026	14	1	0	0	0.071
Inter-C1-027	5	4	2	0.5	0.8
Inter-C1-028	15	3	0	0	0.2
Inter-C1-029	12	2	1	0.5	0.167
Inter-C1-030	12	3	0	0	0.25
Inter-C1-031	15	2	1	0.5	0.133
Inter-C1-032	7	5	2	0.4	0.714
Inter-C1-033	10	4	0	0	0.4
Inter-C2-001	10	3	0	0	0.3
Inter-C2-002	17	1	0	0	0.059
Inter-C2-003	3	3	2	0.667	1
Inter-C2-004	14	2	0	0	0.143
Inter-C2-005	12	2	0	0	0.167
Inter-C2-006	7	3	2	0.667	0.429
Inter-C2-007	2	1	0	0	0.5
Inter-C2-008	10	1	1	1	0.1
Inter-C2-009	14	2	0	0	0.143
Inter-C2-010	9	2	0	0	0.222
Inter-C2-011	7	5	1	0.2	0.714
Inter-C2-012	12	5	1	0.2	0.417
Inter-C2-013	3	2	0	0	0.667
Inter-C2-014	8	3	1	0.333	0.375
Inter-C2-015	11	4	0	0	0.364
Inter-C2-016	9	4	1	0.25	0.444
Inter-C2-017	16	8	3	0.375	0.5
Inter-C2-018	14	2	0	0	0.143
Inter-C2-019	18	6	1	0.167	0.333
Inter-C2-020	10	4	0	0	0.4
Inter-C2-021	13	2	1	0.5	0.154
Inter-C2-022	18	8	3	0.375	0.444
Inter-C2-023	11	4	0	0	0.364
Inter-C2-024	15	3	0	0	0.2
Inter-C2-025	17	1	0	0	0.059
Inter-C2-026	5	5	2	0.4	1
Inter-C2-027	14	4	0	0	0.286
Inter-C2-028	8	3	2	0.667	0.375
Inter-C2-029	15	3	0	0	0.2
Inter-C2-030	16	1	0	0	0.063

Inter-C2-031	7	5	2	0.4	0.714
Inter-C2-032	2	2	0	0	1
Inter-C2-033	6	2	2	1	0.333
Inter-C2-034	7	2	0	0	0.286
Inter-C2-035	11	2	1	0.5	0.182
Inter-C2-036	16	4	0	0	0.25
Inter-C2-037	20	3	0	0	0.15
Inter-C2-038	11	4	0	0	0.364
Inter-C2-039	13	3	1	0.333	0.231
Inter-C3-001	13	1	0	0	0.077
Inter-C3-002	15	2	0	0	0.133
Inter-C3-003	18	1	1	1	0.056
Inter-C3-004	14	2	1	0.5	0.143
Inter-C3-005	17	7	0	0	0.412
Inter-C3-006	7	4	0	0	0.571
Inter-C3-007	16	3	2	0.667	0.188
Inter-C3-008	13	1	0	0	0.077
Inter-C3-009	7	4	0	0	0.571
Inter-C3-010	3	1	1	1	0.333
Inter-C3-011	5	1	1	1	0.2
Inter-C3-012	3	2	1	0.5	0.667
Inter-C3-013	17	3	0	0	0.176
Inter-C3-014	8	3	0	0	0.375
Inter-C3-015	7	2	1	0.5	0.286
Inter-C3-016	9	5	0	0	0.556
Inter-C3-017	2	2	1	0.5	1
Inter-C3-018	16	3	2	0.667	0.188
Inter-C3-019	10	3	1	0.333	0.3
Inter-C3-020	7	5	0	0	0.714
Inter-C3-021	6	4	1	0.25	0.667
Inter-C3-022	13	3	1	0.333	0.231
Inter-C3-023	16	3	0	0	0.188
Inter-C3-024	9	6	2	0.333	0.667
Inter-C3-025	11	9	0	0	0.818
Inter-C3-026	17	3	0	0	0.176
Inter-C3-027	12	5	1	0.2	0.417
Inter-C3-028	8	4	2	0.5	0.5
Inter-C3-029	16	3	0	0	0.188
Inter-C3-030	18	5	2	0.4	0.278

Inter-C3-031	15	5	0	0	0.333
Inter-C3-032	9	3	1	0.333	0.333
Inter-C3-033	4	4	0	0	1
Inter-C3-034	9	5	1	0.2	0.556
Inter-C3-035	10	4	0	0	0.4
Inter-C3-036	8	5	2	0.4	0.625
Inter-C3-037	13	4	1	0.25	0.308
Inter-C3-038	12	2	0	0	0.167
Inter-C3-039	4	3	1	0.333	0.75
Inter-C3-040	4	2	1	0.5	0.5
Inter-C3-041	13	1	0	0	0.077
Inter-C3-042	8	5	0	0	0.625
Inter-C3-043	9	4	2	0.5	0.444
Inter-C3-044	11	4	0	0	0.364
Inter-C3-045	12	2	1	0.5	0.167
TOTAL INTERSPECIFIC CONTROL		372	79	0.26	0.396
Intra-C1-001	3	2	0	0	0.667
Intra-C1-002	10	2	0	0	0.2
Intra-C1-003	6	4	1	0.25	0.667
Intra-C1-004	11	6	0	0	0.545
Intra-C1-005	11	1	0	0	0.091
Intra-C1-006	15	5	2	0.4	0.333
Intra-C1-007	7	3	0	0	0.429
Intra-C1-008	10	2	0	0	0.2
Intra-C1-009	4	2	1	0.5	0.5
Intra-C1-010	13	2	0	0	0.154
Intra-C1-011	23	5	1	0.2	0.217
Intra-C1-012	18	7	0	0	0.389
Intra-C1-013	6	5	2	0.4	0.833
Intra-C1-014	13	2	0	0	0.154
Intra-C1-015	10	3	0	0	0.3
Intra-C1-016	13	4	1	0.25	0.308
Intra-C1-017	8	3	1	0.333	0.375
Intra-C1-018	13	1	0	0	0.077
Intra-C1-019	7	3	0	0	0.429
Intra-C1-020	14	7	0	0	0.5
Intra-C1-021	22	3	0	0	0.136
Intra-C1-022	5	2	0	0	0.4

Intra-C1-023	7	2	0	0	0.286
Intra-C1-024	15	7	1	0.143	0.467
Intra-C1-025	15	4	0	0	0.267
Intra-C1-026	2	1	0	0	0.5
Intra-C1-027	22	8	1	0.125	0.364
Intra-C1-028	14	3	0	0	0.214
Intra-C1-029	15	5	0	0	0.333
Intra-C1-030	15	2	0	0	0.133
Intra-C1-031	16	2	0	0	0.125
Intra-C1-032	12	5	0	0	0.417
Intra-C1-033	7	2	0	0	0.286
Intra-C1-034	19	3	2	0.667	0.158
Intra-C1-035	14	3	0	0	0.214
Intra-C1-036	9	5	1	0.2	0.556
Intra-C1-037	13	2	0	0	0.154
Intra-C1-038	16	7	0	0	0.438
Intra-C1-039	7	4	0	0	0.571
Intra-C1-040	14	3	0	0	0.214
Intra-C1-041	6	5	0	0	0.833
Intra-C1-042	13	1	0	0	0.077
Intra-C1-043	15	3	1	0.333	0.2
Intra-C1-044	6	1	0	0	0.167
Intra-C1-045	5	1	1	1	0.2
Intra-C1-046	19	3	0	0	0.158
Intra-C1-047	5	2	0	0	0.4
Intra-C1-048	7	4	1	0.25	0.571
Intra-C1-049	19	3	0	0	0.158
Intra-C1-050	3	2	0	0	0.667
Intra-C1-051	19	2	2	1	0.105
Intra-C1-052	4	2	0	0	0.5
Intra-C1-053	3	2	0	0	0.667
Intra-C1-054	9	4	1	0.25	0.444
Intra-C1-055	13	5	0	0	0.385
Intra-C1-056	14	1	1	1	0.071
Intra-C1-057	18	2	0	0	0.111
Intra-C1-058	4	3	1	0.333	0.75
Intra-C1-059	11	4	0	0	0.364
Intra-C1-060	15	4	0	0	0.267
Intra-C1-061	9	5	1	0.2	0.556

Intra-C2-001	13	3	0	0	0.231
Intra-C2-002	4	3	0	0	0.75
Intra-C2-003	18	4	1	0.25	0.222
Intra-C2-004	5	3	0	0	0.6
Intra-C2-005	10	1	0	0	0.1
Intra-C2-006	18	3	0	0	0.167
Intra-C2-007	16	6	0	0	0.375
Intra-C2-008	8	5	0	0	0.625
Intra-C2-009	14	4	0	0	0.286
Intra-C2-010	8	5	0	0	0.625
Intra-C2-011	17	3	0	0	0.176
Intra-C2-012	9	2	0	0	0.222
Intra-C2-013	6	5	2	0.4	0.833
Intra-C2-014	17	4	0	0	0.235
Intra-C2-015	11	1	0	0	0.091
Intra-C2-016	8	4	0	0	0.5
Intra-C2-017	5	3	0	0	0.6
Intra-C2-018	6	2	0	0	0.333
Intra-C2-019	9	2	0	0	0.222
Intra-C2-020	3	1	1	1	0.333
Intra-C2-021	16	2	0	0	0.125
Intra-C2-022	9	5	0	0	0.556
Intra-C2-023	11	7	1	0.143	0.636
Intra-C2-024	8	2	0	0	0.25
Intra-C2-025	11	3	0	0	0.273
Intra-C2-026	23	4	0	0	0.174
Intra-C2-027	11	1	1	1	0.091
Intra-C2-028	2	1	0	0	0.5
Intra-C2-029	11	5	0	0	0.455
Intra-C2-030	12	4	2	0.5	0.333
Intra-C2-031	16	8	0	0	0.5
Intra-C2-032	4	3	0	0	0.75
Intra-C2-033	12	4	1	0.25	0.333
Intra-C2-034	6	5	0	0	0.833
Intra-C2-035	16	2	0	0	0.125
Intra-C2-036	11	6	1	0.167	0.545
Intra-C2-037	9	2	1	0.5	0.222
Intra-C2-038	18	3	2	0.667	0.167
Intra-C2-039	3	2	0	0	0.667

Intra-C2-040	4	2	0	0	0.5
Intra-C2-041	3	3	0	0	1
Intra-C2-042	12	3	1	0.333	0.25
Intra-C2-043	18	7	0	0	0.389
Intra-C2-044	8	6	0	0	0.75
Intra-C2-045	12	5	1	0.2	0.417
Intra-C3-001	2	1	0	0	0.5
Intra-C3-002	9	1	0	0	0.111
Intra-C3-003	10	2	0	0	0.2
Intra-C3-004	7	4	1	0.25	0.571
Intra-C3-005	8	3	0	0	0.375
Intra-C3-006	7	5	0	0	0.714
Intra-C3-007	12	9	3	0.333	0.75
Intra-C3-008	21	5	0	0	0.238
Intra-C3-009	6	1	0	0	0.167
Intra-C3-010	15	4	2	0.5	0.267
Intra-C3-011	12	2	0	0	0.167
Intra-C3-012	13	1	0	0	0.077
Intra-C3-013	4	3	0	0	0.75
Intra-C3-014	17	7	0	0	0.412
Intra-C3-015	4	4	0	0	1
Intra-C3-016	15	4	0	0	0.267
Intra-C3-017	7	2	0	0	0.286
Intra-C3-018	16	4	0	0	0.25
Intra-C3-019	19	2	0	0	0.105
Intra-C3-020	17	3	1	0.333	0.176
Intra-C3-021	13	5	0	0	0.385
Intra-C3-022	17	2	0	0	0.118
Intra-C3-023	19	4	0	0	0.211
Intra-C3-024	7	5	0	0	0.714
Intra-C3-025	15	2	1	0.5	0.133
Intra-C3-026	5	2	0	0	0.4
Intra-C3-027	11	2	0	0	0.182
Intra-C3-028	16	6	0	0	0.375
Intra-C3-029	7	3	0	0	0.429
Intra-C3-030	21	6	0	0	0.286
Intra-C3-031	9	7	0	0	0.778
Intra-C3-032	13	8	0	0	0.615
Intra-C3-033	14	2	0	0	0.143

Intra-C3-034	12	2	0	0	0.167
Intra-C3-035	7	5	0	0	0.714
Intra-C3-036	8	5	1	0.2	0.625
Intra-C3-037	15	7	0	0	0.467
Intra-C3-038	13	6	0	0	0.462
Intra-C3-039	14	4	0	0	0.286
Intra-C3-040	12	6	0	0	0.5
Intra-C3-041	15	5	1	0.2	0.333
Intra-C3-042	14	1	1	1	0.071
Intra-C3-043	6	2	1	0.5	0.333
Intra-C3-044	5	3	0	0	0.6
Intra-C3-045	11	5	0	0	0.455
Intra-C3-046	12	2	1	0.5	0.167
Intra-C3-047	10	1	0	0	0.1
Intra-C3-048	9	3	0	0	0.333
Intra-C3-049	9	1	0	0	0.111
Intra-C3-050	12	8	1	0.125	0.667
Intra-C3-051	5	1	0	0	0.2
Intra-C3-052	17	7	0	0	0.412
Intra-C3-053	12	1	1	1	0.083
Intra-C3-054	4	1	0	0	0.25
TOTAL INTRASPECIFIC CONTROL		557	53	0.100771605	0.3608
Inter-H1-001	14	3	1	0.333	0.214
Inter-H1-002	17	5	0	0	0.294
Inter-H1-003	11	1	0	0	0.091
Inter-H1-004	15	6	1	0.167	0.4
Inter-H1-005	10	3	1	0.333	0.3
Inter-H1-006	12	2	1	0.5	0.167
Inter-H1-007	4	3	0	0	0.75
Inter-H1-008	10	6	1	0.167	0.6
Inter-H1-009	7	2	0	0	0.286
Inter-H1-010	16	5	0	0	0.313
Inter-H1-011	19	3	0	0	0.158
Inter-H1-012	12	2	0	0	0.167
Inter-H1-013	8	4	0	0	0.5
Inter-H1-014	6	2	0	0	0.333
Inter-H1-015	16	3	1	0.333	0.188
Inter-H1-016	8	4	1	0.25	0.5

Inter-H1-017	12	3	0	0	0.25
Inter-H1-018	9	5	0	0	0.556
Inter-H1-019	14	3	1	0.333	0.214
Inter-H1-020	10	3	0	0	0.3
Inter-H1-021	17	3	0	0	0.176
Inter-H1-022	8	2	0	0	0.25
Inter-H1-023	17	3	0	0	0.176
Inter-H1-024	9	6	1	0.167	0.667
Inter-H1-025	4	1	0	0	0.25
Inter-H1-026	17	8	1	0.125	0.471
Inter-H1-027	3	3	1	0.333	1
Inter-H1-028	16	5	0	0	0.313
Inter-H1-029	13	4	1	0.25	0.308
Inter-H1-030	12	2	0	0	0.167
Inter-H1-031	11	3	1	0.333	0.273
Inter-H1-032	9	5	0	0	0.556
Inter-H1-033	15	2	0	0	0.133
Inter-H1-034	13	2	1	0.5	0.154
Inter-H1-035	5	4	2	0.5	0.8
Inter-H1-036	11	5	0	0	0.455
Inter-H1-037	16	6	2	0.333	0.375
Inter-H1-038	16	3	0	0	0.188
Inter-H1-039	6	3	0	0	0.5
Inter-H1-040	15	8	0	0	0.533
Inter-H1-041	10	3	0	0	0.3
Inter-H2-001	6	6	3	0.5	1
Inter-H2-002	14	1	0	0	0.071
Inter-H2-003	11	2	0	0	0.182
Inter-H2-004	6	5	0	0	0.833
Inter-H2-005	16	3	0	0	0.188
Inter-H2-006	7	4	0	0	0.571
Inter-H2-007	18	1	0	0	0.056
Inter-H2-008	17	5	0	0	0.294
Inter-H2-009	12	6	1	0.167	0.5
Inter-H2-010	16	5	0	0	0.313
Inter-H2-011	13	5	1	0.2	0.385
Inter-H2-012	7	4	0	0	0.571
Inter-H2-013	5	5	0	0	1
Inter-H2-014	9	3	2	0.667	0.333

Inter-H2-015	9	6	1	0.167	0.667
Inter-H2-016	4	3	0	0	0.75
Inter-H2-017	16	4	0	0	0.25
Inter-H2-018	5	4	0	0	0.8
Inter-H2-019	9	5	0	0	0.556
Inter-H2-020	10	3	1	0.333	0.3
Inter-H2-021	6	4	0	0	0.667
Inter-H2-022	10	6	0	0	0.6
Inter-H2-023	15	2	1	0.5	0.133
Inter-H2-024	5	3	0	0	0.6
Inter-H2-025	16	8	0	0	0.5
Inter-H2-026	14	6	1	0.167	0.429
Inter-H2-027	15	8	0	0	0.533
Inter-H2-028	5	4	0	0	0.8
Inter-H2-029	11	3	0	0	0.273
Inter-H2-030	4	4	1	0.25	1
Inter-H2-031	16	3	1	0.333	0.188
Inter-H2-032	19	2	0	0	0.105
Inter-H2-033	4	3	0	0	0.75
Inter-H2-034	11	1	1	1	0.091
Inter-H2-035	6	4	0	0	0.667
Inter-H2-036	14	3	0	0	0.214
Inter-H2-037	6	1	0	0	0.167
Inter-H2-038	15	4	1	0.25	0.267
Inter-H2-039	16	7	0	0	0.438
Inter-H2-040	13	5	0	0	0.385
Inter-H2-041	7	6	0	0	0.857
Inter-H2-042	17	5	2	0.4	0.294
Inter-H2-043	23	9	0	0	0.391
Inter-H2-044	5	3	0	0	0.6
Inter-H2-045	13	6	1	0.167	0.462
Inter-H2-046	7	4	0	0	0.571
Inter-H2-047	9	1	0	0	0.111
Inter-H2-048	15	1	1	1	0.067
Inter-H3-001	10	4	0	0	0.4
Inter-H3-002	14	6	0	0	0.429
Inter-H3-003	16	1	1	1	0.063
Inter-H3-004	9	3	0	0	0.333
Inter-H3-005	10	5	1	0.2	0.5

Inter-H3-006	9	4	0	0	0.444
Inter-H3-007	13	4	0	0	0.308
Inter-H3-008	6	5	0	0	0.833
Inter-H3-009	5	3	0	0	0.6
Inter-H3-010	11	4	0	0	0.364
Inter-H3-011	17	6	2	0.333	0.353
Inter-H3-012	18	2	1	0.5	0.111
Inter-H3-013	10	3	0	0	0.3
Inter-H3-014	5	4	0	0	0.8
Inter-H3-015	17	3	1	0.333	0.176
Inter-H3-016	3	2	1	0.5	0.667
Inter-H3-017	15	7	0	0	0.467
Inter-H3-018	14	2	0	0	0.143
Inter-H3-019	16	5	0	0	0.313
Inter-H3-020	4	3	1	0.333	0.75
Inter-H3-021	17	3	0	0	0.176
Inter-H3-022	9	5	1	0.2	0.556
Inter-H3-023	3	2	0	0	0.667
Inter-H3-024	11	7	3	0.429	0.636
Inter-H3-025	10	3	0	0	0.3
Inter-H3-026	7	1	0	0	0.143
Inter-H3-027	18	5	0	0	0.278
Inter-H3-028	11	6	1	0.167	0.545
Inter-H3-029	10	7	1	0.143	0.7
Inter-H3-030	8	6	2	0.333	0.75
Inter-H3-031	13	4	0	0	0.308
Inter-H3-032	17	5	1	0.2	0.294
Inter-H3-033	5	4	0	0	0.8
Inter-H3-034	2	2	0	0	1
Inter-H3-035	19	3	0	0	0.158
Inter-H3-036	8	6	2	0.333	0.75
TOTAL INTERSPECIFIC HEATED		490	56	0.139	0.456
Intra-H1-001	5	2	0	0	0.4
Intra-H1-002	12	3	1	0.333	0.25
Intra-H1-003	13	2	0	0	0.154
Intra-H1-004	3	1	0	0	0.333
Intra-H1-005	11	4	1	0.25	0.364
Intra-H1-006	8	5	0	0	0.625

Intra-H1-007	21	3	0	0	0.143
Intra-H1-008	3	2	0	0	0.667
Intra-H1-009	18	4	0	0	0.222
Intra-H1-010	13	5	0	0	0.385
Intra-H1-011	7	3	0	0	0.429
Intra-H1-012	14	3	1	0.333	0.214
Intra-H1-013	10	4	1	0.25	0.4
Intra-H1-014	3	2	0	0	0.667
Intra-H1-015	14	5	0	0	0.357
Intra-H1-016	19	3	0	0	0.158
Intra-H1-017	4	3	0	0	0.75
Intra-H1-018	11	3	0	0	0.273
Intra-H1-019	5	4	1	0.25	0.8
Intra-H1-020	14	3	0	0	0.214
Intra-H1-021	6	3	0	0	0.5
Intra-H1-022	8	1	0	0	0.125
Intra-H1-023	13	5	3	0.6	0.385
Intra-H1-024	12	2	0	0	0.167
Intra-H1-025	17	3	0	0	0.176
Intra-H1-026	6	1	0	0	0.167
Intra-H1-027	13	5	1	0.2	0.385
Intra-H1-028	18	4	2	0.5	0.222
Intra-H1-029	14	5	0	0	0.357
Intra-H1-030	18	9	2	0.222	0.5
Intra-H1-031	11	4	0	0	0.364
Intra-H1-032	15	5	0	0	0.333
Intra-H1-033	13	2	0	0	0.154
Intra-H1-034	4	3	1	0.333	0.75
Intra-H1-035	16	2	1	0.5	0.125
Intra-H1-036	8	3	0	0	0.375
Intra-H1-037	6	3	0	0	0.5
Intra-H1-038	15	4	0	0	0.267
Intra-H1-039	7	3	0	0	0.429
Intra-H1-040	15	4	1	0.25	0.267
Intra-H1-041	6	2	0	0	0.333
Intra-H1-042	9	4	0	0	0.444
Intra-H1-043	12	5	0	0	0.417
Intra-H1-044	7	4	1	0.25	0.571
Intra-H1-045	17	2	0	0	0.118

Intra-H1-046	9	2	0	0	0.222
Intra-H1-047	7	4	0	0	0.571
Intra-H2-001	3	1	1	1	0.333
Intra-H2-002	5	3	0	0	0.6
Intra-H2-003	21	6	0	0	0.286
Intra-H2-004	3	2	0	0	0.667
Intra-H2-005	18	8	0	0	0.444
Intra-H2-006	12	4	0	0	0.333
Intra-H2-007	14	5	0	0	0.357
Intra-H2-008	10	3	0	0	0.3
Intra-H2-009	5	1	0	0	0.2
Intra-H2-010	10	5	0	0	0.5
Intra-H2-011	10	4	2	0.5	0.4
Intra-H2-012	11	1	0	0	0.091
Intra-H2-013	4	3	0	0	0.75
Intra-H2-014	19	3	1	0.333	0.158
Intra-H2-015	4	2	0	0	0.5
Intra-H2-016	16	4	0	0	0.25
Intra-H2-017	16	2	0	0	0.125
Intra-H2-018	19	5	0	0	0.263
Intra-H2-019	18	1	0	0	0.056
Intra-H2-020	11	6	2	0.333	0.545
Intra-H2-021	6	4	0	0	0.667
Intra-H2-022	6	2	0	0	0.333
Intra-H2-023	5	3	0	0	0.6
Intra-H2-024	12	6	2	0.333	0.5
Intra-H2-025	5	2	0	0	0.4
Intra-H2-026	20	8	0	0	0.4
Intra-H2-027	19	4	0	0	0.211
Intra-H2-028	12	4	0	0	0.333
Intra-H2-029	17	5	0	0	0.294
Intra-H2-030	12	4	1	0.25	0.333
Intra-H2-031	11	5	0	0	0.455
Intra-H2-032	8	5	0	0	0.625
Intra-H2-033	4	3	0	0	0.75
Intra-H2-034	17	3	0	0	0.176
Intra-H2-035	13	7	0	0	0.538
Intra-H2-036	16	4	1	0.25	0.25
Intra-H2-037	12	3	1	0.333	0.25

Intra-H2-038	10	3	1	0.333	0.3
Intra-H2-039	11	3	0	0	0.273
Intra-H2-040	7	5	0	0	0.714
Intra-H2-041	11	8	0	0	0.727
Intra-H2-042	5	2	1	0.5	0.4
Intra-H2-043	4	2	0	0	0.5
Intra-H2-044	8	4	0	0	0.5
Intra-H2-045	15	2	0	0	0.133
Intra-H2-046	13	3	0	0	0.231
Intra-H2-047	13	1	0	0	0.077
Intra-H2-048	7	7	0	0	1
Intra-H2-049	14	9	0	0	0.643
Intra-H2-050	20	5	0	0	0.25
Intra-H2-051	14	5	1	0.2	0.357
Intra-H2-052	18	2	0	0	0.111
Intra-H3-001	19	5	0	0	0.263
Intra-H3-002	14	1	0	0	0.071
Intra-H3-003	8	6	0	0	0.75
Intra-H3-004	17	2	1	0.5	0.118
Intra-H3-005	17	7	1	0.143	0.412
Intra-H3-006	12	6	0	0	0.5
Intra-H3-007	5	3	0	0	0.6
Intra-H3-008	5	2	0	0	0.4
Intra-H3-009	14	4	1	0.25	0.286
Intra-H3-010	12	3	0	0	0.25
Intra-H3-011	15	5	0	0	0.333
Intra-H3-012	19	5	0	0	0.263
Intra-H3-013	8	6	2	0.333	0.75
Intra-H3-014	4	2	0	0	0.5
Intra-H3-015	15	2	0	0	0.133
Intra-H3-016	17	4	0	0	0.235
Intra-H3-017	5	4	0	0	0.8
Intra-H3-018	4	2	0	0	0.5
Intra-H3-019	11	5	0	0	0.455
Intra-H3-020	12	4	1	0.25	0.333
Intra-H3-021	15	7	0	0	0.467
Intra-H3-022	7	6	0	0	0.857
Intra-H3-023	13	5	0	0	0.385
Intra-H3-024	5	4	0	0	0.8

Intra-H3-025	13	3	0	0	0.231
Intra-H3-026	14	3	0	0	0.214
Intra-H3-027	12	5	1	0.2	0.417
Intra-H3-028	12	5	1	0.2	0.417
Intra-H3-029	9	1	0	0	0.111
Intra-H3-030	4	2	1	0.5	0.5
Intra-H3-031	5	1	0	0	0.2
Intra-H3-032	16	7	0	0	0.438
Intra-H3-033	15	1	0	0	0.067
Intra-H3-034	12	8	0	0	0.667
Intra-H3-035	18	10	1	0.1	0.556
Intra-H3-036	17	5	0	0	0.294
Intra-H3-037	13	5	0	0	0.385
Intra-H3-038	15	5	0	0	0.333
Intra-H3-039	14	4	0	0	0.286
Intra-H3-040	13	2	1	0.5	0.154
Intra-H3-041	17	4	1	0.25	0.235
Intra-H3-042	13	1	0	0	0.077
Intra-H3-043	3	3	0	0	1
Intra-H3-044	8	6	0	0	0.75
Intra-H3-045	4	3	1	0.333	0.75
Intra-H3-046	18	4	0	0	0.222
Intra-H3-047	19	4	0	0	0.211
Intra-H3-048	11	6	0	0	0.545
Intra-H3-049	14	4	1	0.25	0.286
Intra-H3-050	8	6	0	0	0.75
Intra-H3-051	6	4	0	0	0.667
Intra-H3-052	12	1	0	0	0.083
Intra-H3-053	18	5	0	0	0.278
Intra-H3-054	7	5	0	0	0.714
Intra-H3-055	13	5	2	0.4	0.385
Intra-H3-056	13	4	0	0	0.308
Intra-H3-057	17	7	0	0	0.412
Intra-H3-058	15	3	1	0.333	0.2
Intra-H3-059	14	5	0	0	0.357
Intra-H3-060	15	3	0	0	0.2
Intra-H3-061	14	7	1	0.143	0.5
Intra-H3-062	11	9	1	0.111	0.818
Intra-H3-063	7	5	0	0	0.714

Intra-H3-064	6	6	0	0	1
Intra-H3-065	12	4	0	0	0.333
Intra-H3-066	6	1	0	0	0.167
Intra-H3-067	19	4	0	0	0.211
Intra-H3-068	15	6	0	0	0.4
Intra-H3-069	11	4	1	0.25	0.364
Intra-H3-070	17	2	2	1	0.118
TOTAL INTRASPECIFIC HEATED		658	53	0.086	0.411

Experiment 2 raw data**.**

KEY

Intra: Larvae experiencing only intraspecific competition
Inter: Larvae experiencing both types of competition

APPLE HOST RACE			
Type	**Treatment**	**PupalMass (g)**	**SurvivalRate**
Intra	Control	0.0085	0.35
Intra	Control	0.0090	0.60
Intra	Control	0.0084	0.23
Intra	Control	0.0090	0.17
Intra	Control	0.0083	0.38
Intra	Control	0.0084	0.29
Intra	Control	0.0085	0.30
Intra	Control	0.0085	0.31
Intra	Control	0.0086	0.50
Intra	Control	0.0085	0.43
Intra	Control	0.0090	0.33
Intra	Control	0.0088	0.50
Intra	Control	0.0085	0.33
Intra	Control	0.0079	0.33
Intra	Control	0.0084	0.38
Intra	Control	0.0086	0.44
Intra	Control	0.0089	0.67
Intra	Control	0.0084	0.23
Intra	Control	0.0081	0.60
Intra	Control	0.0083	0.38
Intra	Control	0.0083	0.38
Intra	Control	0.0080	0.25
Intra	Control	0.0081	0.45
Intra	Control	0.0084	0.60
Intra	Control	0.0083	0.57
Intra	Control	0.0087	0.44
Intra	Control	0.0088	0.33
Intra	Control	0.0087	0.50
Intra	Control	0.0088	0.33
Intra	Control	0.0084	0.44
Intra	Control	0.0090	0.38
Intra	Control	0.0090	0.30
Intra	Control	0.0083	0.35
Intra	Control	0.0078	0.29
Intra	Control	0.0085	1.00
Intra	Control	0.0079	0.50
Intra	Control	0.0075	0.20
Intra	Control	0.0077	0.67
Intra	Control	0.0087	0.42
Intra	Control	0.0078	0.30
Intra	Control	0.0090	0.38
Intra	Control	0.0085	0.31

Intra	Control	0.0086	0.60
Intra	Control	0.0083	0.33
Intra	Control	0.0082	0.50
Intra	Control	0.0085	0.38
Intra	Control	0.0085	0.36
Intra	Control	0.0083	0.29
Intra	Control	0.0094	0.25
Intra	Control	0.0087	0.75
Intra	Heat	0.0080	0.44
Intra	Heat	0.0087	0.40
Intra	Heat	0.0084	0.31
Intra	Heat	0.0083	0.40
Intra	Heat	0.0089	0.60
Intra	Heat	0.0085	0.27
Intra	Heat	0.0084	0.27
Intra	Heat	0.0084	0.42
Intra	Heat	0.0089	0.50
Intra	Heat	0.0086	1.00
Intra	Heat	0.0080	0.44
Intra	Heat	0.0079	0.33
Intra	Heat	0.0085	0.38
Intra	Heat	0.0082	0.45
Intra	Heat	0.0081	0.44
Intra	Heat	0.0084	0.40
Intra	Heat	0.0090	0.75
Intra	Heat	0.0088	0.33
Intra	Heat	0.0083	0.40
Intra	Heat	0.0081	0.33
Intra	Heat	0.0079	0.45
Intra	Heat	0.0089	0.67
Intra	Heat	0.0081	0.50
Intra	Heat	0.0085	0.43
Intra	Heat	0.0081	0.45
Intra	Heat	0.0080	0.36
Intra	Heat	0.0085	0.25
Intra	Heat	0.0087	0.60
Intra	Heat	0.0083	0.38
Intra	Heat	0.0080	0.57
Intra	Heat	0.0085	0.50
Intra	Heat	0.0079	0.40
Intra	Heat	0.0091	1.00
Intra	Heat	0.0080	0.14
Intra	Heat	0.0086	0.22
Intra	Heat	0.0089	0.43
Intra	Heat	0.0087	0.29
Intra	Heat	0.0087	0.44
Intra	Heat	0.0087	0.33
Intra	Heat	0.0079	0.33
Intra	Heat	0.0078	0.27
Intra	Heat	0.0091	0.33

Intra	Heat	0.0083	0.43
Intra	Heat	0.0081	0.36
Intra	Heat	0.0084	0.60
Intra	Heat	0.0082	0.25
Intra	Heat	0.0088	0.50
Intra	Heat	0.0081	0.38
Intra	Heat	0.0077	0.30
Intra	Heat	0.0084	0.17
Inter	Control	0.0089	0.50
Inter	Control	0.0100	0.40
Inter	Control	0.0081	0.43
Inter	Control	0.0083	0.86
Inter	Control	0.0081	0.46
Inter	Control	0.0093	1.00
Inter	Control	0.0093	0.50
Inter	Control	0.0086	0.71
Inter	Control	0.0096	0.33
Inter	Control	0.0100	0.40
Inter	Control	0.0087	0.33
Inter	Control	0.0083	0.27
Inter	Control	0.0100	0.33
Inter	Control	0.0089	0.25
Inter	Control	0.0081	0.30
Inter	Control	0.0080	0.38
Inter	Control	0.0082	0.42
Inter	Control	0.0083	0.29
Inter	Control	0.0087	0.50
Inter	Control	0.0085	0.33
Inter	Control	0.0087	0.40
Inter	Control	0.0081	0.40
Inter	Control	0.0087	0.13
Inter	Control	0.0089	0.56
Inter	Control	0.0100	0.29
Inter	Control	0.0100	0.36
Inter	Control	0.0081	0.27
Inter	Control	0.0093	0.20
Inter	Control	0.0081	0.36
Inter	Control	0.0100	0.27
Inter	Control	0.0084	0.43
Inter	Control	0.0095	0.33
Inter	Control	0.0100	0.44
Inter	Control	0.0090	0.33
Inter	Control	0.0081	0.33
Inter	Control	0.0100	0.31
Inter	Control	0.0088	0.22
Inter	Control	0.0089	0.33
Inter	Control	0.0089	0.22
Inter	Control	0.0100	0.31
Inter	Control	0.0082	0.20
Inter	Control	0.0096	0.13

Inter	Control	0.0100	0.31
Inter	Control	0.0084	0.20
Inter	Control	0.0089	0.20
Inter	Control	0.0078	0.14
Inter	Control	0.0092	0.20
Inter	Control	0.0090	0.33
Inter	Control	0.0092	0.33
Inter	Control	0.0084	0.33
Inter	Heat	0.0092	0.40
Inter	Heat	0.0088	0.30
Inter	Heat	0.0090	0.67
Inter	Heat	0.0085	0.47
Inter	Heat	0.0090	0.38
Inter	Heat	0.0093	0.33
Inter	Heat	0.0089	0.43
Inter	Heat	0.0084	0.17
Inter	Heat	0.0088	0.50
Inter	Heat	0.0088	0.33
Inter	Heat	0.0085	0.28
Inter	Heat	0.0083	0.56
Inter	Heat	0.0094	0.50
Inter	Heat	0.0094	0.50
Inter	Heat	0.0093	0.33
Inter	Heat	0.0092	0.25
Inter	Heat	0.0083	0.57
Inter	Heat	0.0086	0.58
Inter	Heat	0.0091	0.57
Inter	Heat	0.0087	0.64
Inter	Heat	0.0089	0.40
Inter	Heat	0.0085	0.58
Inter	Heat	0.0095	0.40
Inter	Heat	0.0088	0.23
Inter	Heat	0.0095	0.67
Inter	Heat	0.0088	0.80
Inter	Heat	0.0093	0.14
Inter	Heat	0.0087	0.40
Inter	Heat	0.0083	0.67
Inter	Heat	0.0083	0.33
Inter	Heat	0.0082	0.31
Inter	Heat	0.0085	0.64
Inter	Heat	0.0088	0.58
Inter	Heat	0.0094	0.25
Inter	Heat	0.0096	0.50
Inter	Heat	0.0091	0.80
Inter	Heat	0.0085	0.29
Inter	Heat	0.0086	0.29
Inter	Heat	0.0086	0.60
Inter	Heat	0.0088	0.83
Inter	Heat	0.0087	0.58
Inter	Heat	0.0080	0.60

Inter	Heat	0.0088	0.33
Inter	Heat	0.0085	0.57
Inter	Heat	0.0078	0.16
Inter	Heat	0.0082	0.38
Inter	Heat	0.0085	0.86
Inter	Heat	0.0085	1.00
Inter	Heat	0.0082	0.36
Inter	Heat	0.0082	0.40

HAWTHORN HOST RACE

Type	Treatment	PupalMass (g)	SurvivalRate
Intra	Control	0.0096	0.333
Intra	Control	0.0087	0.75
Intra	Control	0.0090	0.286
Intra	Control	0.0100	0.5
Intra	Control	0.0084	0.667
Intra	Control	0.0090	0.5
Intra	Control	0.0087	0.6
Intra	Control	0.0089	0.125
Intra	Control	0.0076	0.429
Intra	Control	0.0086	0.6
Intra	Control	0.0091	0.429
Intra	Control	0.0102	0.5
Intra	Control	0.0081	0.333
Intra	Control	0.0083	0.667
Intra	Control	0.0079	0.625
Intra	Control	0.0086	1
Intra	Control	0.0098	1
Intra	Control	0.0091	0.4
Intra	Control	0.0081	0.5
Intra	Control	0.0079	0.333
Intra	Control	0.0082	0.5
Intra	Control	0.0092	1
Intra	Control	0.0090	1
Intra	Control	0.0082	0.333
Intra	Control	0.0077	0.4
Intra	Control	0.0080	1
Intra	Control	0.0096	0.333
Intra	Control	0.0091	0.333
Intra	Control	0.0095	0.5
Intra	Control	0.0081	1
Intra	Control	0.0082	0.667
Intra	Control	0.0078	1
Intra	Control	0.0085	0.25
Intra	Control	0.0084	0.5
Intra	Control	0.0093	0.5
Intra	Control	0.0085	0.333
Intra	Control	0.0086	0.5
Intra	Control	0.0087	0.5
Intra	Control	0.0079	0.667
Intra	Control	0.0080	0.2

Intra	Control	0.0080	0.333
Intra	Control	0.0077	0.667
Intra	Control	0.0077	0.75
Intra	Control	0.0080	1
Intra	Control	0.0086	0.4
Intra	Control	0.0081	0.333
Intra	Control	0.0086	0.5
Intra	Control	0.0079	0.75
Intra	Control	0.0073	1
Intra	Control	0.0080	0.5
Intra	Heat	0.0083	0.429
Intra	Heat	0.0088	0.333
Intra	Heat	0.0089	0.25
Intra	Heat	0.0084	1
Intra	Heat	0.0088	0.5
Intra	Heat	0.0092	0.5
Intra	Heat	0.0087	1
Intra	Heat	0.0077	0.6
Intra	Heat	0.0087	0.667
Intra	Heat	0.0080	0.5
Intra	Heat	0.0076	0.375
Intra	Heat	0.0080	0.5
Intra	Heat	0.0086	0.5
Intra	Heat	0.0084	0.667
Intra	Heat	0.0076	1
Intra	Heat	0.0086	0.667
Intra	Heat	0.0091	0.333
Intra	Heat	0.0087	0.5
Intra	Heat	0.0082	0.4
Intra	Heat	0.0074	0.8
Intra	Heat	0.0086	0.333
Intra	Heat	0.0080	1
Intra	Heat	0.0085	0.5
Intra	Heat	0.0082	0.25
Intra	Heat	0.0093	0.333
Intra	Heat	0.0088	0.25
Intra	Heat	0.0091	0.25
Intra	Heat	0.0078	0.667
Intra	Heat	0.0079	0.75
Intra	Heat	0.0088	1
Intra	Heat	0.0083	0.667
Intra	Heat	0.0092	0.333
Intra	Heat	0.0083	0.667
Intra	Heat	0.0090	1
Intra	Heat	0.0094	0.25
Intra	Heat	0.0086	0.375
Intra	Heat	0.0081	0.667
Intra	Heat	0.0089	0.5
Intra	Heat	0.0083	0.333
Intra	Heat	0.0082	1

Intra	Heat	0.0078	0.6
Intra	Heat	0.0080	0.5
Intra	Heat	0.0073	0.75
Intra	Heat	0.0078	1
Intra	Heat	0.0087	0.25
Intra	Heat	0.0084	0.333
Intra	Heat	0.0077	0.5
Intra	Heat	0.0086	0.333
Intra	Heat	0.0081	0.2
Intra	Heat	0.0094	0.333
Inter	Control	0.0089	0.333
Inter	Control	0.0082	0.25
Inter	Control	0.0080	0.222
Inter	Control	0.0092	0.2
Inter	Control	0.0079	0.5
Inter	Control	0.0079	0.429
Inter	Control	0.0084	0.333
Inter	Control	0.0093	0.5
Inter	Control	0.0086	0.333
Inter	Control	0.0088	0.5
Inter	Control	0.0082	0.25
Inter	Control	0.0080	0.25
Inter	Control	0.0080	0.20
Inter	Control	0.0085	0.20
Inter	Control	0.0075	0.67
Inter	Control	0.0072	0.50
Inter	Control	0.0093	0.33
Inter	Control	0.0088	0.25
Inter	Control	0.0088	0.67
Inter	Control	0.0088	0.50
Inter	Control	0.0087	0.50
Inter	Control	0.0092	0.25
Inter	Control	0.0071	0.60
Inter	Control	0.0099	0.33
Inter	Control	0.0093	0.25
Inter	Control	0.0095	0.50
Inter	Control	0.0087	0.50
Inter	Control	0.0085	0.33
Inter	Control	0.0082	0.67
Inter	Control	0.0089	0.25
Inter	Control	0.0082	0.75
Inter	Control	0.0089	0.50
Inter	Control	0.0085	0.67
Inter	Control	0.0093	0.25
Inter	Control	0.0088	0.20
Inter	Control	0.0074	1.00
Inter	Control	0.0090	0.25
Inter	Control	0.0079	0.75
Inter	Control	0.0090	0.50
Inter	Control	0.0075	0.40

Inter	Control	0.0071	0.17
Inter	Control	0.0076	0.40
Inter	Control	0.0084	0.50
Inter	Control	0.0087	0.25
Inter	Control	0.0090	0.17
Inter	Control	0.0080	0.33
Inter	Control	0.0069	0.67
Inter	Control	0.0070	0.33
Inter	Control	0.0083	0.25
Inter	Control	0.0086	0.50
Inter	Heat	0.0080	0.14
Inter	Heat	0.0081	0.29
Inter	Heat	0.0080	0.60
Inter	Heat	0.0083	0.17
Inter	Heat	0.0083	1.00
Inter	Heat	0.0089	1.00
Inter	Heat	0.0085	0.20
Inter	Heat	0.0086	0.67
Inter	Heat	0.0068	0.67
Inter	Heat	0.0083	1.00
Inter	Heat	0.0079	0.67
Inter	Heat	0.0077	0.40
Inter	Heat	0.0080	0.67
Inter	Heat	0.0085	1.00
Inter	Heat	0.0084	0.25
Inter	Heat	0.0085	0.33
Inter	Heat	0.0085	0.33
Inter	Heat	0.0072	0.40
Inter	Heat	0.0080	0.33
Inter	Heat	0.0084	0.33
Inter	Heat	0.0080	0.20
Inter	Heat	0.0068	0.75
Inter	Heat	0.0087	0.50
Inter	Heat	0.0089	0.40
Inter	Heat	0.0072	0.75
Inter	Heat	0.0072	1.00
Inter	Heat	0.0084	0.50
Inter	Heat	0.0089	0.25
Inter	Heat	0.0082	0.50
Inter	Heat	0.0080	0.50
Inter	Heat	0.0081	0.33
Inter	Heat	0.0082	0.17
Inter	Heat	0.0068	0.67
Inter	Heat	0.0086	0.50
Inter	Heat	0.0072	0.75
Inter	Heat	0.0078	0.67
Inter	Heat	0.0087	0.25
Inter	Heat	0.0086	0.50
Inter	Heat	0.0088	0.33
Inter	Heat	0.0071	0.29

Inter	Heat	0.0075	1.00
Inter	Heat	0.0077	0.67
Inter	Heat	0.0064	0.57
Inter	Heat	0.0067	0.60
Inter	Heat	0.0077	0.75
Inter	Heat	0.0081	0.50
Inter	Heat	0.0085	0.50
Inter	Heat	0.0075	0.50
Inter	Heat	0.0083	0.33
Inter	Heat	0.0082	0.17

Experiment 3 data.

KEY

Intra: Larvae experiencing only intraspecific competition
Inter: Larvae experiencing both types of competition

Type	Treatment	SurvivalRate	ParasitismRate
Intra	Shade	0.348	0.25
Intra	Shade	0.455	0
Intra	Shade	0.125	0
Intra	Shade	0.3	0
Intra	Shade	0.4375	0.143
Intra	Shade	0.5	0.222
Intra	Shade	0.25	0
Intra	Shade	0.8	0
Intra	Shade	0.25	0.333
Intra	Shade	0.583	0.143
Intra	Shade	0.4375	0.143
Intra	Shade	0.714	0
Intra	Shade	0.385	0
Intra	Shade	0.25	0.167
Intra	Shade	0.667	0
Intra	Shade	0.545	0.167
Intra	Shade	0.208	0
Intra	Shade	0.375	0.167
Intra	Shade	0.444	0
Intra	Shade	0.333	0.333
Intra	Shade	0.25	0
Intra	Shade	0.429	0
Intra	Shade	0.583	0.143
Intra	Shade	0.375	0
Intra	Shade	0.389	0.143
Intra	Shade	0.381	0
Intra	Shade	0.4375	0.143
Intra	Shade	0.273	0
Intra	Shade	0.692	0.111
Intra	Shade	0.444	0.125
Intra	Shade	0.429	0
Intra	Shade	0.533	0.125
Intra	Shade	0.611	0.182
Intra	Shade	0.5	0
Intra	Shade	0.667	0
Intra	Shade	0.176	0.333
Intra	Shade	0.364	0
Intra	Shade	0.583	0.143
Intra	Shade	0.286	0
Intra	Shade	0.154	0
Intra	Shade	0.667	0.125
Intra	Shade	0.556	0.2

Intra	Shade	0.5	0.333
Intra	Shade	0.474	0.111
Intra	Shade	0.522	0.167
Intra	Shade	0.3	0
Intra	Shade	0.333	0.5
Intra	Shade	0.381	0.125
Intra	Shade	0.462	0.167
Intra	Shade	0.667	0
Inter	Shade	0.467	0.143
Inter	Shade	0.522	0.25
Inter	Shade	0.217	0.2
Inter	Shade	0.429	0
Inter	Shade	0.368	0
Inter	Shade	0.375	0
Inter	Shade	0.143	0
Inter	Shade	0.1	0
Inter	Shade	0.714	0.6
Inter	Shade	0.125	0.5
Inter	Shade	0.333	0.4
Inter	Shade	0.333	0.333
Inter	Shade	0.2	0
Inter	Shade	0.609	0.214
Inter	Shade	0.25	0
Inter	Shade	0.286	0
Inter	Shade	0.125	0
Inter	Shade	0.444	0
Inter	Shade	0.313	0.2
Inter	Shade	0.353	0.5
Inter	Shade	0.667	0.25
Inter	Shade	0.273	0
Inter	Shade	0.191	0.25
Inter	Shade	0.278	0.4
Inter	Shade	0.308	0.25
Inter	Shade	0.286	0.25
Inter	Shade	0.348	0.375
Inter	Shade	0.25	0
Inter	Shade	0.429	0.333
Inter	Shade	0.333	0.667
Inter	Shade	0.333	0.2
Inter	Shade	0.462	0.167
Inter	Shade	0.235	0
Inter	Shade	0.455	0.2
Inter	Shade	0.429	0.333
Inter	Shade	0.5	0.429
Inter	Shade	0.429	0
Inter	Shade	0.222	0
Inter	Shade	0.25	0.4
Inter	Shade	0.375	0.333
Inter	Shade	0.191	0.25
Inter	Shade	0.364	0

Inter	Shade	0.471	0.375
Inter	Shade	0.222	0
Inter	Shade	0.55	0.273
Inter	Shade	0.357	0.4
Inter	Shade	0.692	0.222
Inter	Shade	0.2	0
Inter	Shade	0.417	0.4
Inter	Shade	0.133	0
Intra	Sun	0.571	0.125
Intra	Sun	0.538	0.143
Intra	Sun	0.5	0
Intra	Sun	0.714	0.1
Intra	Sun	0.6875	0.091
Intra	Sun	0.471	0
Intra	Sun	0.5	0.25
Intra	Sun	0.333	0
Intra	Sun	0.211	0
Intra	Sun	0.227	0.2
Intra	Sun	0.429	0
Intra	Sun	0.667	0.25
Intra	Sun	0.375	0
Intra	Sun	0.211	0
Intra	Sun	0.6	0
Intra	Sun	0.684	0.154
Intra	Sun	0.25	0
Intra	Sun	0.4	0
Intra	Sun	0.667	0
Intra	Sun	0.471	0
Intra	Sun	0.375	0
Intra	Sun	0.5	0.222
Intra	Sun	0.583	0
Intra	Sun	0.786	0.273
Intra	Sun	0.3	0.333
Intra	Sun	0.5	0
Intra	Sun	0.176	0.333
Intra	Sun	0.692	0
Intra	Sun	0.417	0.2
Intra	Sun	0.357	0
Intra	Sun	0.733	0.091
Intra	Sun	0.524	0
Intra	Sun	0.375	0.333
Intra	Sun	0.75	0
Intra	Sun	0.727	0
Intra	Sun	0.545	0
Intra	Sun	0.333	0
Intra	Sun	0.313	0.2
Intra	Sun	0.357	0
Intra	Sun	0.6	0.167
Intra	Sun	0.167	0
Intra	Sun	0.5	0

Intra	Sun	0.6875	0.091
Intra	Sun	0.643	0
Intra	Sun	0.235	0
Intra	Sun	0.636	0.286
Intra	Sun	0.682	0.267
Intra	Sun	0.75	0
Intra	Sun	0.412	0.143
Intra	Sun	0.5	0
Inter	Sun	0.429	0
Inter	Sun	0.6	0.111
Inter	Sun	0.368	0.143
Inter	Sun	0.333	0
Inter	Sun	0.7	0
Inter	Sun	0.5	0
Inter	Sun	0.4	0
Inter	Sun	0.455	0
Inter	Sun	0.588	0.2
Inter	Sun	0.538	0.143
Inter	Sun	0.313	0
Inter	Sun	0.786	0.182
Inter	Sun	0.545	0
Inter	Sun	0.467	0.286
Inter	Sun	0.611	0
Inter	Sun	0.545	0
Inter	Sun	0.333	0
Inter	Sun	0.6	0
Inter	Sun	0.438	0
Inter	Sun	0.364	0
Inter	Sun	0.526	0.3
Inter	Sun	0.313	0
Inter	Sun	0.533	0.125
Inter	Sun	0.563	0.111
Inter	Sun	0.412	0
Inter	Sun	0.471	0
Inter	Sun	0.444	0
Inter	Sun	0.357	0.2
Inter	Sun	0.278	0
Inter	Sun	0.375	0
Inter	Sun	0.316	0.167
Inter	Sun	0.381	0
Inter	Sun	0.368	0.286
Inter	Sun	0.625	0.2
Inter	Sun	0.692	0.222
Inter	Sun	0.5	0
Inter	Sun	0.533	0.25
Inter	Sun	0.444	0.125
Inter	Sun	0.636	0.286
Inter	Sun	0.556	0.4
Inter	Sun	0.158	0
Inter	Sun	0.667	0

Inter	Sun	0.529	0.111
Inter	Sun	0.5	0
Inter	Sun	0.429	0
Inter	Sun	0.625	0.4
Inter	Sun	0.778	0
Inter	Sun	0.556	0
Inter	Sun	0.333	0.167
Inter	Sun	0.75	0.333

Experiment 4 data.

KEY

Intra: Larvae experiencing only intraspecific competition

Inter: Larvae experiencing both types of competition

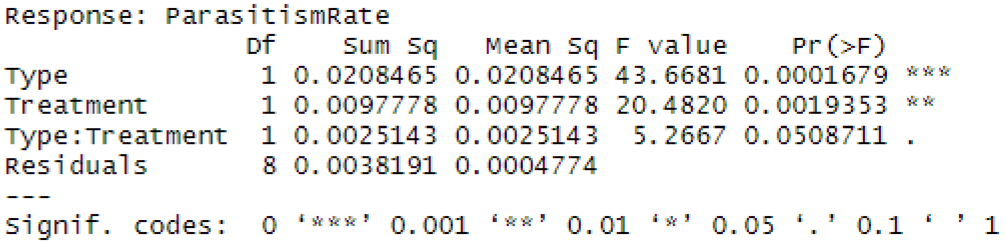
Type	Treatment	SurvivalRate	ParasitismRate
Intra	Internal	0.4	0.167
Intra	Internal	0.667	0
Intra	Internal	0.6	0
Intra	Internal	0.417	0.2
Intra	Internal	0.5	0
Intra	Internal	0.533	0
Intra	Internal	0.529	0.111
Intra	Internal	0.4375	0.286
Intra	Internal	0.455	0.1
Intra	Internal	0.158	0
Intra	Internal	0.529	0.111
Intra	Internal	0.5	0.25
Intra	Internal	0.263	0.2
Intra	Internal	0.417	0
Intra	Internal	0.222	0
Intra	Internal	0.278	0.4
Intra	Internal	0.778	0.429
Intra	Internal	0.75	0.333
Intra	Internal	0.455	0.4
Intra	Internal	0.25	0.5
Intra	Internal	0.444	0
Intra	Internal	0.429	0
Intra	Internal	0.4	0
Intra	Internal	0.278	0
Intra	Internal	0.429	0.167
Inter	Internal	0.2	1
Inter	Internal	0.2	0
Inter	Internal	0.6	0.333
Inter	Internal	0.4	0
Inter	Internal	0.158	0
Inter	Internal	0.533	0.125
Inter	Internal	0.778	0.143
Inter	Internal	0.5	0.4

Inter	Internal	0.286	0
Inter	Internal	0.191	0.25
Inter	Internal	0.188	0
Inter	Internal	0.222	0.5
Inter	Internal	0.2	0
Inter	Internal	0.35	0.143
Inter	Internal	0.188	0.333
Inter	Internal	0.533	0.375
Inter	Internal	0.714	0.2
Inter	Internal	0.2	0
Inter	Internal	0.211	0
Inter	Internal	0.625	0.2
Inter	Internal	0.278	0
Inter	Internal	0.222	0
Inter	Internal	0.2	1
Inter	Internal	0.571	0
Inter	Internal	0.222	0
Intra	Edge	0.167	0
Intra	Edge	0.556	0.2
Intra	Edge	0.462	0.167
Intra	Edge	0.25	0.2
Intra	Edge	0.2	0
Intra	Edge	0.7	0.143
Intra	Edge	0.5	0.1
Intra	Edge	0.333	0
Intra	Edge	0.6	0
Intra	Edge	0.2	0
Intra	Edge	0.8	0.125
Intra	Edge	0.467	0.143
Intra	Edge	0.6	0.25
Intra	Edge	0.571	0.125
Intra	Edge	0.478	0
Intra	Edge	0.5	0.125
Intra	Edge	0.357	0.2
Intra	Edge	0.615	0
Intra	Edge	0.167	0
Intra	Edge	0.636	0.143
Intra	Edge	0.45	0.111
Intra	Edge	0.417	0
Intra	Edge	0.75	0.167
Intra	Edge	0.733	0.091
Intra	Edge	0.436	0
Inter	Edge	0.615	0.286
Inter	Edge	0.625	0.125
Inter	Edge	0.462	0.2
Inter	Edge	0.417	0.167
Inter	Edge	0.6	0
Inter	Edge	0.5625	0.333
Inter	Edge	0.316	0
Inter	Edge	0.5	0

Inter	Edge	0.421	0
Inter	Edge	0.417	0
Inter	Edge	0.357	0.2
Inter	Edge	0.6	0
Inter	Edge	0.545	0.167
Inter	Edge	0.4	0
Inter	Edge	0.571	0.167
Inter	Edge	0.667	0.125
Inter	Edge	0.364	0
Inter	Edge	0.25	0
Inter	Edge	0.421	0
Inter	Edge	0.35	0
Inter	Edge	0.667	0.143
Inter	Edge	0.294	0.375
Inter	Edge	0.214	0.2
Inter	Edge	0.333	0.333
Inter	Edge	0.333	0

Statistical analyses for all Chapter 1 experiments.

Experiment 1: Parasitism Rates (Paired ANOVA)



```
Response: ParasitismRate
               Df    Sum Sq   Mean Sq F value    Pr(>F)    
Type            1 0.0208465 0.0208465 43.6681 0.0001679 ***
Treatment       1 0.0097778 0.0097778 20.4820 0.0019353 ** 
Type:Treatment  1 0.0025143 0.0025143  5.2667 0.0508711 .  
Residuals       8 0.0038191 0.0004774                      
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Experiment 1 (Heating Chambers): Parasitism Rates, Pooled Data

ANOVA

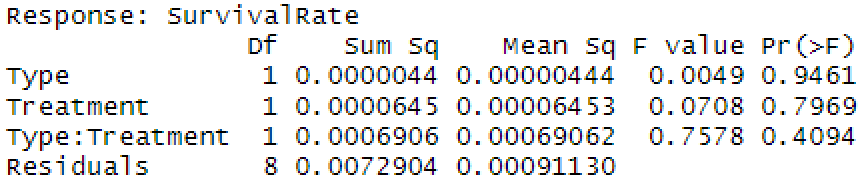
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.72	1	0.72	21.78	<.0001
Treatment	1.92	1	1.92	58.08	<.0001
Interaction	0.26	1	0.26	7.86	0.0051
Within	36.73	1111	0.03		
Total	39.63	1114			

Experiment 1 (Heating Chambers): Parasitism Rates, Pooled Data (Tukey HSD Test)

	HSD [.05]
Type	0.02
Treatment	0.02
Interaction	0.04

GROUP	**MEAN**
Intra Control	0.097
Intra Heated	0.064
Inter Control	0.206
Inter Heated	0.141

Experiment 1: Survival Rates (Paired ANOVA)



```
Response: SurvivalRate
               Df    Sum Sq    Mean Sq F value Pr(>F)
Type            1 0.0000044 0.00000444  0.0049 0.9461
Treatment       1 0.0000645 0.00006453  0.0708 0.7969
Type:Treatment  1 0.0006906 0.00069062  0.7578 0.4094
Residuals       8 0.0072904 0.00091130               
```

Experiment 1 (Heating Chambers): Survival Rates, Pooled Data

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.04	1	0.04	1.08	0.2989
Treatment	0.06	1	0.06	1.61	0.2048
Interaction	0.04	1	0.04	1.08	0.2989
Within	41.3	1111	0.04		
Total	41.44	1114			

Experiment 1 (Heating Chambers): Survival Rates, Pooled Data (Tukey HSD Test)

	HSD [.05]
Type	0.02
Treatment	0.02
Interaction	0.04

GROUP	**MEAN**
Intra Control	0.419
Intra Heated	0.413
Inter Control	0.404
Inter Heated	0.369

Experiment 2 (Rooms Experiment): Apple host race pupal mass

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	8.5716E-06	1	8.5716E-06	36.4060535	7.8621E-09
Treatment	8.3107E-07	1	8.3107E-07	3.52981139	0.0617591
Interaction	8.6074E-08	1	8.6074E-08	0.36558272	0.54612127
Within	4.6147E-05	196	2.3544E-07		
Total	5.5636E-05	199			

Experiment 2 (Rooms Experiment): Apple host race survival rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.00028403	1	0.00028403	0.00971493	0.92158493
Treatment	0.20905292	1	0.20905292	7.15038639	0.0081273
Interaction	0.13761955	1	0.13761955	4.70709958	0.03124158
Within	5.73037185	196	0.02923659		
Total	6.07732835	199			

Experiment 2 (Rooms Experiment): Hawthorn host race pupal weights

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	3.7061E-06	1	3.7061E-06	8.82343726	0.00335361
Treatment	2.7584E-06	1	2.7584E-06	6.56711657	0.01115437
Interaction	1.268E-06	1	1.268E-06	3.01894012	0.08390074
Within	8.0645E-05	192	4.2003E-07		
Total	8.8378E-05	195			

Experiment 2 (Rooms Experiment): Hawthorn host race survival rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.48932563	1	0.48932563	8.94986381	0.00313898
Treatment	0.10619692	1	0.10619692	1.9423629	0.16502326
Interaction	0.24176398	1	0.24176398	4.42191172	0.03678341
Within	10.4974246	192	0.05467409		
Total	11.3347112	195			

Experiment 3 (Effects of Sun vs Shade): Apple host race survival rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.104604678	1	0.104605	4.348878	0.038
Treatment	0.504665229	1	0.504665	20.98116	8.24E-06
Interaction	0.095509229	1	0.095509	3.97074	0.048
Within	4.714437924	196	0.024053		
Total	5.41921706	199			

Experiment 3 (Effects of Sun vs Shade): Apple host race parasitism rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.143113	1	0.143113	7.367836	0.007
Treatment	0.20111	1	0.20111	10.35364	0.002
Interaction	0.094995	1	0.094995	4.890595	0.028
Within	3.807115	196	0.019424		
Total	4.246333	199			

Experiment 4 (Effects of Edge vs Interior): Apple host race survival rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.089552	1	0.089552	3.150645	0.079066
Treatment	0.113035	1	0.113035	3.97684	0.049
Interaction	0.029	1	0.029	1.020288	0.315
Within	2.728637	96	0.028423		
Total	2.960224	99			

Experiment 4 (Effects of Edge vs Interior): Apple host race parasitism rates

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Type	0.035364	1	0.035364	1.072742	0.302929
Treatment	0.125769	1	0.125769	3.815165	0.053702
Interaction	0.006689	1	0.006689	0.202924	0.653387
Within	3.164692	96	0.032966		
Total	3.332514	99			

APPENDIX B: CHAPTER 2 SUPPLIMENTARY MATERIALS

Statistical tests for all surveys

Exploratory data. χ^2 on number of traps with ants vs. no ants pooled across all 6 species. Conclusion: **Not Significant**.

	OBS	EXPT	χ^2	df	p
Edge	49	50	0.005		
Interior	51	50	0.005		
	100	100	0.01	1	0.920

Exploratory data. Contingency χ^2 and Fisher exact tests on trap results. Although some small cell numbers were included (e.g., 2), a Fisher exact 2 x 5 test yielded a 2-sided p = 0.112, very similar to that from contingency □^{2}. Conclusion: **Not Significant.**

	M. spatulata	M. americana	F. pallidefulva	T. sessile	N. parvulva	C. pennsylvanicus	df	p
Edge	11	13	10	14	1	0		
Interior	4	15	9	15	6	2	5	0.108

Experimental data. χ^2 on number of traps with ants vs. no ants pooled across all 5 species and across all 4 trap treatments. Conclusion: **Significant**.

	OBS	EXPT	χ^2	df	p
Edge	176	154	3.002		
Interior	132	154	3.002		
	308	308	6.003	1	0.014

Experimental data. χ^2 test on only the "no bait" results of number of traps with ants vs. no ants pooled across all 5 species. Conclusion: **Not Significant**.

	OBS	EXPT	χ^2	df	p
Edge	27	22.5	0.711		
Interior	18	22.5	0.711		
	45	45	1.422	1	0.233

Experimental data. Contingency χ^2 test pooled across all 4 trap treatments to maximize statistical power. Conclusion: **Significant**.

	M. spatulata	M. americana	F. pallidefulva	T. sessile	N. parvulva	df	p
Edge	33	43	34	66	0		
Interior	0	37	28	52	15	4	3.39E-09

Experimental data. Contingency χ^2 and Fisher Exact test on only the traps baited with apples with larvae. Conclusion: **Significant**.

	M. spatulata	M. americana	F. pallidefulva	T. sessile	N. parvulva	df	p
Edge	13	16	16	19	0		
Interior	0	17	11	20	5	4	0.001

Experimental data. χ^2 on traps with ants pooled across species and across locations with an expected number of 1/4 of the total ants for each trophic treatment. Conclusion: **Significant**.

	OBS	EXP	χ^2	df	p
No bait	45	77	12.886		
Apple + larvae	117	77	20.263		
Apple only	80	77	0.081		
Puparia	66	77	1.432		
	308	308	34.662	3	0.000

Experimental data. χ^2 on apple only and unbaited traps with ants pooled across species. Conclusion: **Significant**.

	OBS	EXPT	χ^2	df	p
No bait	45	62.5	4.624		
Apple only	80	62.5	4.624		
	125	125	9.248	1	0.002

Experimental data. χ^2 on traps baited with apple + larvae vs. apples, with the 5 species pooled, and traps from both edge and interior also pooled to increase sample size. Conclusion: **Significant.**

	OBS	EXPT	χ^2	df	p
Apple +larvae	117	98.5	3.289		
Apple only	80	98.5	3.289		
	197	197	6.579	1	0.010

Experimental data. 4 contingency χ^2 tests, one for each baiting status, of the capture different numbers of ants at the orchard edge vs. the orchard interior. Test results are arranged in descending order of χ^2. Conclusion: **Significant results** for puparium and larvae tests.

		M. spatulata	M. americana	F. pallidefulva	T. sessile	N. parvulva	χ^2	df	p
No bait	Edge	6	7	4	10	0			
	Interior	0	6	4	7	1	6.048	4	0.196
Apple	Edge	6	14	5	18	0			
	Interior	0	11	7	17	2	8.319	4	0.081
Puparium	Edge	8	6	9	19	0			
	Interior	0	3	6	8	7	17.472	4	0.002
Larvae	Edge	13	16	16	19	0			
	Interior	0	17	11	20	5	18.108	4	0.001

Trap data from *Experimental* trapping study including location, bait type, and species found within found in each trap. Tree number corresponds with locations in Figure 2.3.

Location	Bait	Trap	*M. spatulata*	*M. americana*	*F. pallidefulva*	*T. sessile*	*N. parvulva*	TOTALS
Edge	No bait	E-N-1	0	0	1	1	0	
Edge	No bait	E-N-2	0	1	0	1	0	
Edge	No bait	E-N-3	0	0	0	1	0	
Edge	No bait	E-N-4	1	1	0	1	0	
Edge	No bait	E-N-5	0	0	0	1	0	
Edge	No bait	E-N-6	1	0	0	0	0	
Edge	No bait	E-N-7	0	0	1	0	0	
Edge	No bait	E-N-8	1	0	0	0	0	
Edge	No bait	E-N-9	1	0	0	1	0	
Edge	No bait	E-N-10	0	0	0	0	0	
Edge	No bait	E-N-11	0	0	0	0	0	
Edge	No bait	E-N-12	0	0	1	0	0	
Edge	No bait	E-N-13	0	1	0	0	0	
Edge	No bait	E-N-14	0	0	0	1	0	
Edge	No bait	E-N-15	1	1	0	0	0	
Edge	No bait	E-N-16	0	0	0	1	0	
Edge	No bait	E-N-17	0	1	1	0	0	
Edge	No bait	E-N-18	1	1	0	1	0	
Edge	No bait	E-N-19	0	0	0	0	0	
Edge	No bait	E-N-20	0	1	0	1	0	
TOTALS EDGE-NO BAIT			6	7	4	10	0	27
Interior	No bait	I-N-1	0	1	0	1	0	
Interior	No bait	I-N-2	0	0	1	0	0	
Interior	No bait	I-N-3	0	1	1	0	0	
Interior	No bait	I-N-4	0	0	0	0	0	
Interior	No bait	I-N-5	0	0	0	0	0	
Interior	No bait	I-N-6	0	0	1	1	1	
Interior	No bait	I-N-7	0	1	0	0	0	
Interior	No bait	I-N-8	0	0	0	0	0	
Interior	No bait	I-N-9	0	0	0	0	0	
Interior	No bait	I-N-10	0	0	0	1	0	
Interior	No bait	I-N-11	0	0	0	0	0	
Interior	No bait	I-N-12	0	1	0	0	0	
Interior	No bait	I-N-13	0	0	0	0	0	
Interior	No bait	I-N-14	0	1	0	1	0	
Interior	No bait	I-N-15	0	0	0	1	0	
Interior	No bait	I-N-16	0	0	0	0	0	
Interior	No bait	I-N-17	0	0	0	0	0	
Interior	No bait	I-N-18	0	0	0	1	0	
Interior	No bait	I-N-19	0	1	0	1	0	

Interior	No bait	I-N-20	0	0	1	0	0	
TOTALS INTERIOR-NO BAIT			0	6	4	7	1	18
Edge	Apple (Larvae)	E-L-1	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-2	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-3	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-4	1	1	0	1	0	
Edge	Apple (Larvae)	E-L-5	1	0	0	1	0	
Edge	Apple (Larvae)	E-L-6	1	0	1	1	0	
Edge	Apple (Larvae)	E-L-7	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-8	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-9	1	0	0	1	0	
Edge	Apple (Larvae)	E-L-10	0	1	0	0	0	
Edge	Apple (Larvae)	E-L-11	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-12	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-13	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-14	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-15	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-16	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-17	1	1	1	1	0	
Edge	Apple (Larvae)	E-L-18	1	0	1	1	0	
Edge	Apple (Larvae)	E-L-19	0	1	1	1	0	
Edge	Apple (Larvae)	E-L-20	1	1	1	1	0	
TOTALS EDGE-LARVAE			13	16	16	19	0	64
Interior	Apple (Larvae)	I-L-1	0	1	1	1	1	
Interior	Apple (Larvae)	I-L-2	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-3	0	0	1	1	0	
Interior	Apple (Larvae)	I-L-4	0	1	0	1	0	
Interior	Apple (Larvae)	I-L-5	0	1	0	1	1	
Interior	Apple (Larvae)	I-L-6	0	0	0	1	1	
Interior	Apple (Larvae)	I-L-7	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-8	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-9	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-10	0	1	0	1	0	
Interior	Apple (Larvae)	I-L-11	0	1	1	1	1	
Interior	Apple (Larvae)	I-L-12	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-13	0	0	0	1	0	
Interior	Apple (Larvae)	I-L-14	0	1	0	1	0	
Interior	Apple (Larvae)	I-L-15	0	1	0	1	1	
Interior	Apple (Larvae)	I-L-16	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-17	0	1	1	1	0	
Interior	Apple (Larvae)	I-L-18	0	1	0	1	0	
Interior	Apple (Larvae)	I-L-19	0	1	0	1	0	
Interior	Apple (Larvae)	I-L-20	0	1	1	1	0	

TOTALS INTERIOR-LARVAE			0	17	11	20	5	53
Edge	Apple only	E-A-1	0	1	0	1	0	
Edge	Apple only	E-A-2	0	1	1	1	0	
Edge	Apple only	E-A-3	0	1	1	1	0	
Edge	Apple only	E-A-4	0	1	0	1	0	
Edge	Apple only	E-A-5	1	0	0	1	0	
Edge	Apple only	E-A-6	0	0	1	1	0	
Edge	Apple only	E-A-7	0	0	0	1	0	
Edge	Apple only	E-A-8	1	1	0	1	0	
Edge	Apple only	E-A-9	1	1	0	1	0	
Edge	Apple only	E-A-10	1	1	0	0	0	
Edge	Apple only	E-A-11	0	0	1	0	0	
Edge	Apple only	E-A-12	0	1	0	1	0	
Edge	Apple only	E-A-13	1	1	0	1	0	
Edge	Apple only	E-A-14	0	1	0	1	0	
Edge	Apple only	E-A-15	0	1	0	1	0	
Edge	Apple only	E-A-16	0	1	0	1	0	
Edge	Apple only	E-A-17	0	1	0	1	0	
Edge	Apple only	E-A-18	1	0	1	1	0	
Edge	Apple only	E-A-19	0	1	0	1	0	
Edge	Apple only	E-A-20	0	0	0	1	0	
TOTALS EDGE-APPLE ONLY			6	14	5	18	0	43
Interior	Apple only	I-A-1	0	0	0	1	0	
Interior	Apple only	I-A-2	0	1	1	1	0	
Interior	Apple only	I-A-3	0	0	0	1	0	
Interior	Apple only	I-A-4	0	1	0	0	0	
Interior	Apple only	I-A-5	0	1	0	1	0	
Interior	Apple only	I-A-6	0	1	0	1	1	
Interior	Apple only	I-A-7	0	0	1	1	0	
Interior	Apple only	I-A-8	0	0	1	1	0	
Interior	Apple only	I-A-9	0	1	1	1	0	
Interior	Apple only	I-A-10	0	1	0	0	0	
Interior	Apple only	I-A-11	0	0	0	1	1	
Interior	Apple only	I-A-12	0	1	0	1	0	
Interior	Apple only	I-A-13	0	0	0	1	0	
Interior	Apple only	I-A-14	0	1	0	1	0	
Interior	Apple only	I-A-15	0	1	0	1	0	
Interior	Apple only	I-A-16	0	0	1	1	0	
Interior	Apple only	I-A-17	0	1	1	1	0	
Interior	Apple only	I-A-18	0	0	0	0	0	
Interior	Apple only	I-A-19	0	1	0	1	0	
Interior	Apple only	I-A-20	0	0	1	1	0	
TOTALS INTERIOR-APPLE ONLY			0	11	7	17	2	37

Edge	Puparia	E-P-1	1	0	1	1	0	
Edge	Puparia	E-P-2	1	0	0	1	0	
Edge	Puparia	E-P-3	0	0	0	1	0	
Edge	Puparia	E-P-4	1	1	0	1	0	
Edge	Puparia	E-P-5	1	0	0	1	0	
Edge	Puparia	E-P-6	0	0	1	1	0	
Edge	Puparia	E-P-7	0	0	1	1	0	
Edge	Puparia	E-P-8	0	0	1	1	0	
Edge	Puparia	E-P-9	0	0	0	1	0	
Edge	Puparia	E-P-10	0	1	0	0	0	
Edge	Puparia	E-P-11	0	0	1	1	0	
Edge	Puparia	E-P-12	0	0	0	1	0	
Edge	Puparia	E-P-13	0	1	1	1	0	
Edge	Puparia	E-P-14	0	0	1	1	0	
Edge	Puparia	E-P-15	1	0	0	1	0	
Edge	Puparia	E-P-16	0	0	0	1	0	
Edge	Puparia	E-P-17	1	1	0	1	0	
Edge	Puparia	E-P-18	1	1	0	1	0	
Edge	Puparia	E-P-19	0	0	1	1	0	
Edge	Puparia	E-P-20	1	1	1	1	0	
TOTALS EDGE-PUPARIA			8	6	9	19	0	42
Interior	Puparia	I-P-1	0	0	0	1	1	
Interior	Puparia	I-P-2	0	0	0	0	0	
Interior	Puparia	I-P-3	0	0	1	0	0	
Interior	Puparia	I-P-4	0	0	1	0	0	
Interior	Puparia	I-P-5	0	0	0	0	0	
Interior	Puparia	I-P-6	0	0	1	0	1	
Interior	Puparia	I-P-7	0	1	1	1	1	
Interior	Puparia	I-P-8	0	0	0	0	0	
Interior	Puparia	I-P-9	0	0	0	0	0	
Interior	Puparia	I-P-10	0	0	0	1	0	
Interior	Puparia	I-P-11	0	0	0	0	1	
Interior	Puparia	I-P-12	0	1	0	0	1	
Interior	Puparia	I-P-13	0	0	0	1	0	
Interior	Puparia	I-P-14	0	0	0	1	0	
Interior	Puparia	I-P-15	0	0	0	1	1	
Interior	Puparia	I-P-16	0	0	1	0	1	
Interior	Puparia	I-P-17	0	0	0	0	0	
Interior	Puparia	I-P-18	0	0	0	1	0	
Interior	Puparia	I-P-19	0	1	0	1	0	
Interior	Puparia	I-P-20	0	0	1	0	0	
TOTALS INTERIOR-PUPARIA			0	3	6	8	7	24
TOTALS ALL			33	80	62	118	15	308

APPENDIX C: CHAPTER 3 SUPPLIMENTARY MATERIALS

Raw data from pepper maggot survey, excluding locations in Appendix 2.

Fruit	Ovi Marks	Larvae	Number parasitoids	Survived
Location: E Curtis Road between Neil and Lincoln				
1	0	0	0	0
2	2	0	0	0
3	2	1	0	1
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	4	0	0	0
8	2	1	0	0
9	1	0	0	0
10	0	0	0	0
11	1	0	0	0
12	1	1	0	0
13	0	0	0	0
14	1	0	0	0
15	0	0	0	0
16	0	0	0	0
17	1	0	0	0
18	1	0	0	0
19	0	0	0	0
20	2	1	0	1
21	1	1	0	0
22	2	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	1	0	0	0
27	4	1	0	1
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	2	0	0	0
34	1	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0

38	0	0	0	0
39	1	0	0	0
40	0	0	0	0
41	1	1	0	0
42	3	1	0	0
43	0	0	0	0
44	0	0	0	0
45	1	0	0	0
46	0	0	0	0
Location: S Lincoln Ave between Windsor and Curtis				
47	0	0	0	0
48	0	0	0	0
49	2	1	0	1
50	2	0	0	0
51	1	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	2	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	3	0	0	0
63	6	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	5	1	1	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	1	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	2	0	0	0
77	0	0	0	0
78	0	0	0	0
79	1	0	0	0

80	2	1	0	1
81	1	0	0	0
82	1	1	0	0
83	4	1	0	0
84	0	0	0	0
85	0	0	0	0
86	1	0	0	0
87	0	0	0	0
88	0	0	0	0
Location: Pollinatarium (606 W Windsor, Urbana IL)				
89	0	0	0	0
90	0	0	0	0
91	2	0	0	0
92	0	0	0	0
93	1	1	0	1
94	1	0	0	0
95	0	0	0	0
96	0	0	0	0
97	0	0	0	0
98	1	0	0	0
99	0	0	0	0
100	2	0	0	0
101	0	0	0	0
102	0	0	0	0
103	3	1	1	0
104	0	0	0	0
105	0	0	0	0
106	0	0	0	0
107	1	0	0	0
108	0	0	0	0
109	1	1	0	0
110	0	0	0	0
111	1	0	0	0
112	1	1	0	0
113	0	0	0	0
114	2	1	0	1
Location: Apple orchard (~corner of Country Rd 1400 N and Race St)				
115	2	0	0	0
116	0	0	0	0
117	1	1	0	1
118	0	0	0	0
119	3	1	0	0
120	1	0	0	0

121	1	1	0	0
122	2	1	0	1
123	1	1	0	0
124	1	0	0	0
125	0	0	0	0
126	2	1	0	0
127	0	0	0	0
128	1	0	0	0
129	0	0	0	0
130	0	0	0	0
131	0	0	0	0
132	0	0	0	0
133	2	0	0	0
134	0	0	0	0
135	1	1	0	0
136	0	0	0	0
137	1	0	0	0
138	0	0	0	0
139	0	0	0	0
140	0	0	0	0
141	6	2	0	1
142	2	0	0	0
143	0	0	0	0
144	0	0	0	0
145	0	0	0	0
146	3	0	0	0
147	0	0	0	0
148	0	0	0	0
149	2	1	0	0
150	0	0	0	0
151	0	0	0	0
Location: Race Street between Windsor and Old Church, Urbana IL				
152	2	0	0	0
153	1	0	0	0
154	0	0	0	0
155	1	0	0	0
156	0	0	0	0
157	1	1	0	1
158	0	0	0	0
159	0	0	0	0
160	2	0	0	0
161	0	0	0	0
162	0	0	0	0

163	0	0	0	0
164	3	1	0	1
165	1	1	0	0
166	0	0	0	0
167	0	0	0	0
168	1	0	0	0
169	0	0	0	0
170	0	0	0	0
171	0	0	0	0
172	3	1	0	0
173	0	0	0	0
174	0	0	0	0
175	2	1	0	0
176	0	0	0	0
177	0	0	0	0
178	1	0	0	0
179	0	0	0	0
180	0	0	0	0
181	0	0	0	0
182	1	0	0	0
183	0	0	0	0
184	1	1	0	0
185	0	0	0	0
186	0	0	0	0
187	3	1	0	1
188	0	0	0	0
189	0	0	0	0
190	1	0	0	0
191	0	0	0	0
192	1	1	0	1
193	0	0	0	0
194	0	0	0	0
195	2	0	0	0
196	0	0	0	0
197	0	0	0	0
198	1	1	0	0
199	4	1	0	1
200	0	0	0	0
201	0	0	0	0
202	0	0	0	0
203	1	0	0	0
204	1	1	0	0

Location: E Perkins Rd (~2277 E Perkins Rd to Saline Ditch bridge), Urbana IL				
205	0	0	0	0
206	1	0	0	0
207	0	0	0	0
208	0	0	0	0
209	0	0	0	0
210	0	0	0	0
211	3	1	0	1
212	0	0	0	0
213	0	0	0	0
214	1	0	0	0
215	0	0	0	0
216	0	0	0	0
217	0	0	0	0
218	0	0	0	0
219	0	0	0	0
220	1	1	0	0
221	0	0	0	0
222	2	0	0	0
223	0	0	0	0
224	0	0	0	0
225	2	0	0	0
226	0	0	0	0
227	0	0	0	0
228	2	1	0	0
229	1	1	0	1
230	0	0	0	0
231	0	0	0	0
232	0	0	0	0
233	1	0	0	0
234	0	0	0	0
235	0	0	0	0
236	0	0	0	0
237	0	0	0	0
238	0	0	0	0
239	2	0	0	0
Location: Phillips Tract/Trelease Prairie (1725 N Cottonwood Rd, Urbana IL)				
240	0	0	0	0
241	2	1	0	1
242	1	0	0	0
243	0	0	0	0

244	0	0	0	0
245	0	0	0	0
246	1	0	0	0
247	1	0	0	0
248	1	1	0	0
249	0	0	0	0
250	0	0	0	0
251	0	0	0	0
252	0	0	0	0
253	0	0	0	0
254	2	0	0	0
255	0	0	0	0
256	2	0	0	0
257	0	0	0	0
258	0	0	0	0
259	0	0	0	0
260	3	1	0	1
261	0	0	0	0
262	0	0	0	0
263	2	0	0	0
264	0	0	0	0
265	0	0	0	0
266	0	0	0	0
267	0	0	0	0
268	1	1	0	1
269	0	0	0	0
270	1	0	0	0
271	0	0	0	0
272	3	0	0	0
273	0	0	0	0
274	0	0	0	0
275	1	0	0	0
276	2	1	0	1
277	0	0	0	0
278	3	0	0	0
279	0	0	0	0
280	1	0	0	0
281	1	0	0	0
282	0	0	0	0
283	0	0	0	0
284	0	0	0	0
285	0	0	0	0
286	0	0	0	0

287	2	0	0	0
288	0	0	0	0
289	0	0	0	0
290	0	0	0	0
291	0	0	0	0
292	0	0	0	0
293	1	1	0	1
294	0	0	0	0
295	0	0	0	0
296	2	0	0	0
297	0	0	0	0
298	1	0	0	0
299	3	0	0	0
300	0	0	0	0
301	0	0	0	0
302	0	0	0	0
303	0	0	0	0
304	0	0	0	0
305	5	1	0	0
306	0	0	0	0
307	0	0	0	0
308	3	0	0	0
309	0	0	0	0
310	1	0	0	0
311	0	0	0	0
312	0	0	0	0
313	0	0	0	0
314	3	0	0	0
315	0	0	0	0
316	0	0	0	0
317	0	0	0	0
318	1	1	0	0
319	0	0	0	0
320	0	0	0	0
321	0	0	0	0
322	0	0	0	0
323	2	0	0	0
324	1	1	0	1
325	0	0	0	0
326	2	1	1	0
327	0	0	0	0
328	2	0	0	0
329	0	0	0	0

330	1	0	0	0
331	1	0	0	0
332	0	0	0	0
333	2	0	0	0
334	0	0	0	0
335	0	0	0	0
336	0	0	0	0
337	3	1	0	0
338	0	0	0	0
339	1	0	0	0

Number of oviposition marks and eggs/larvae from 10 plants collected in each of the 7 locations used in the primary survey**.**

Location	Fruit	OviMarks	Eggs/Larvae
1	A	2	1
1	B	1	0
1	C	1	1
1	D	3	1
1	E	1	0
1	F	1	0
1	G	2	0
1	H	6	2
1	I	1	0
1	J	1	0
2	A	3	1
2	B	1	1
2	C	3	0
2	D	2	0
2	E	1	0
2	F	5	3
2	G	1	0
2	H	1	1
2	I	3	0
2	J	1	1
3	A	1	0
3	B	1	0
3	C	3	1
3	D	1	1
3	E	2	0
3	F	4	1
3	G	1	0
3	H	1	0
3	I	2	0
3	J	1	1
4	A	1	1
4	B	1	0
4	C	2	0
4	D	1	1
4	E	1	0
4	F	1	0
4	G	2	2
4	H	1	0
4	I	1	1
4	J	1	0

5	A	1	0
5	B	2	2
5	C	2	1
5	D	1	1
5	E	1	0
5	F	1	0
5	G	4	3
5	H	1	0
5	I	1	0
5	J	1	0
6	A	3	1
6	B	1	0
6	C	1	0
6	D	1	1
6	E	2	1
6	F	1	0
6	G	1	0
6	H	2	1
6	I	1	0
6	J	2	1
7	A	4	1
7	B	1	0
7	C	1	1
7	D	2	1
7	E	2	0
7	F	1	1
7	G	1	0
7	H	2	1
7	I	1	0
7	J	1	0