Studies on the spread of H5N1 influenza viruses in Egypt

(エジプトにおける H5N1 インフルエンザウイルスの伝播に関する研究)

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Abbreviations

AIC	Akaike information criteria
AICM	Akaike information criteria in Bayesian Monte Carlo
CI	confidence interval
EMEA	European-Middle Eastern-African
GMRF	Gaussian Markov random field
HA	hemagglutinin
HKY	Hasegawa-Kishino-Yano
HPAI	highly pathogenic avian influenza
HPD	highest posterior density
MCC	maximum clade credibility
MCMC	Markov chain Monte Carlo
NA	neuraminidase
NCBI	National Center for Biotechnology Information
NNIs	Nearest-Neighbor-Interchanges
OIE	Office International des Epizooties (World Organisation for Animal Health)
R_0	Basic reproduction number
TMRCA	time to the most recent common ancestor
WHO	World Health Organization

Preface

Influenza A virus is a zoonotic pathogen that infects various mammalian and avian species (Kida, Shortridge, & Webster, 1988; Sonnberg, Webby, & Webster, 2013; Webster, Bean, Gorman, Chambers, & Kawaoka, 1992). The natural host of the influenza A virus are the aquatic birds, like wildfowl and shorebirds (Kida & Yanagawa, 1979; Olsen et al., 2006). Influenza A viruses in aquatic birds are classified according to the antigenicity of hemagglutinin (HA) and neuraminidase (NA) into 16 H (H1-H16) and 9 N (1-9) subtypes. In human population, H1N1 and H3N2 influenza viruses are circulating as seasonal influenza. H5, H7 and H9 subtypes of influenza viruses are frequently identified among domestic poultry (Fusaro et al., 2011; Horwood et al., 2018; Lipatov et al., 2007). Migratory birds play a role in transmitting viruses between countries.

The H5N1 influenza virus is of great concern to the public health in the world. According to the World Health Organization (WHO), more than 860 human cases have been clinically diagnosed as H5N1 infections in 17 countries by the 24th of June 2019 (World Health Organization, 2019). In 2009, the World Organisation for Animal Health (OIE) reported that H5N1 viruses became enzootic in poultry populations in Bangladesh, Cambodia, China, Egypt, India, Indonesia, Laos, Nepal and Vietnam (Tarantola et al., 2010). H5N1 viruses were circulating among poultry in many countries all over the world, South east Asia including, China, Cambodia, Indonesia, Japan, Korea, Laos PDR, Thailand, and Vietnam, and others including, Egypt, Iraq, and Turkey. In 1997, the first human case of H5N1virus infection was reported in Hong Kong. In July 2003, a new outbreak started in poultry in Vietnam, Indonesia, and Thailand and since then the virus spread into Europe and Africa. H5N1 viruses have a destructive effect on the poultry industries. Moreover, H5N1 viruses continued to infect humans with high mortality rates, which raised the concern of the public health.

H5N1 influenza viruses were first identified in Egypt among poultry in 2006 (Aly, Arafa, & Hassan, 2008) and declared to be enzootic in 2008 (G. Kayali et al., 2016). The viruses show high mortality rates among birds. Sporadic infections among humans were reported but they doesn't exceed the first generation of contact (Yang, Halloran, Sugimoto, & Longini, 2007).

Based on the evolution of the Egyptian H5N1 viruses, their classification into circulating clades has changed progressively. Four major clades of H5N1 have been reported since the virus was first introduced, clade 2.2, 2.2.1, 2.2.1.1, and 2.2.1.2. From 2007, clade 2.2.1 became endemic in poultry in Egypt. Genetic drift occurred in clade 2.2.1 led to split of the new subclade 2.2.1.1 of H5N1 viruses circulating in Egyptian poultry (El-Shesheny et al., 2014; G. Kayali et al., 2011) (Abdelwhab et al., 2011). During 2010-2011, clade 2.2.1 and 2.2.1.1 of viruses were cocirculating among poultry in Egypt (Smith, Donis, & Working, 2012).In 2015 a new clade 2.2.1.2 evolved of these clades (A. S. Arafa et al., 2015; Smith, Donis, & World, 2015)

Estimation of epidemiological parameters is important for conducting the proper interventions of infectious diseases. Basic reproduction number (R_0) is one of the important parameters for monitoring transmission of infectious diseases. R_0 is defined as the average number of secondary cases originating from a primary infected case in a whole susceptible population (Vynnycky, 2010). Chapter I of this thesis addresses the estimation of R_0 of H5N1viruses among humans by using phylogney, sampling time and sampling place.

Spread of H5N1 influenza viruses in Egypt and its neighboring countries can be understood by combining spatial and temporal epidemiological data and genetic data. Spatio-temporal patterns of viral spread can be studied using phylogeographic analysis. In Chapter II, I conduct phylogeographic analysis of H5N1 viruses to understand spatial and temporal spread of the viruses. I used Bayesian discrete approach to understand the viral spread. I used information of virus isolates from Egypt and its neighboring countries, Palestine (Gaza and

Jenin), Israel, and Syria (Qatana) to identify the geographic origin of virus' introductions at different time points.

Chapter I

Estimating Transmission Potential of H5N1 Viruses among Humans by Using Phylogney, Sampling Time, and Sampling Place.

Introduction

The H5N1 avian influenza viruses raised the concern to the public health in the world. As the WHO reported more than 50% case fatality rate from clinically diagnosed as H5N1 infections by the 24th of June 2019 (World Health Organization, 2019). Sporadic human infections of H5N1 viruses causing severe respiratory disorders leading to death have been reported (Yuen et al., 1998). Herfst et al. and Imai et al. addressed airborne transmission of H5N1 viruses between ferrets (Herfst et al., 2012; Imai et al., 2012). Although the human-to-human transmission of the viruses is limited, family case clusters of H5N1 infections were reported from Sumatra (Yang et al., 2007), Cambodia (Chea et al., 2014), Thailand (Ungchusak et al., 2005), China, (Wang et al., 2008) and Pakistan (World Health Orgnization, 2008).

In 2006 H5N1 influenza viruses were first isolated from poultry in Egypt (Aly et al., 2008) and declared to be enzootic in 2008 (G. Kayali et al., 2016). The number of human cases in Egypt has been increasing dramatically since 2014 (Refaey et al., 2015). Two-thirds of the human H5N1 cases were reported in the world by 2019 were from Egypt (World Health Organization, 2019). The increase in 2014 might be related to either increase of the number of outbreaks among poultry or due to increase in the transmission potential of the H5N1 viruses among human populations. Arafa et al. found that H5N1 viruses isolated in Egypt during 2014–2015 have transmitted between ferrets via respiratory droplets (A. S. Arafa et al., 2016) and identification of the transmission potential of H5N1 viruses in humans to improve the control measures for the viral spread in Egypt.

One way to estimate transmissibility of infectious diseases is to measure R_0, which is defined as the average number of secondary cases originating from a primary infected case in a whole susceptible population (Vynnycky, 2010). To estimate R_0 of avian influenza virus infections in a human population, the number of human cases and/or cases with history of bird contact are frequently used (Nishiura, Mizumoto, & Ejima, 2013). However, the data of number of people contacted with poultry may not be accurate, because the data are biased by the recall bias or missing data. Lack of epidemiological data is an obstacle for the estimation of R_0 of avian influenza virus infections into a human population.

Recently, various types of epidemiological information have been used to estimate R_0. Chong et al. used travel data, i.e. arrival times of infected cases in different countries (Chong, Zee, & Wang, 2017). Farrington et al. used age-stratified serological survey data to estimate R_0 of hepatitis A, mumps, rubella, parvovirus infections, Haemophilus influenzae, and measles infection (Farrington & Kanaan, 2001). On the other hand, Pybus et al. developed a method to estimate R_0 of an infectious disease using nucleotide sequences of pathogens, showing nucleotide sequences have the ability to infer the magnitude of infectious diseases transmission (Pybus et al., 2001).

In this study, I assess the transmission potential of H5N1 viruses among humans in Egypt. I measure transmission potential by R_0 using nucleotide sequences, sampling time, and sampling location of H5N1 viruses isolated in Egypt during 2006-2016.

Methods

Sequence data

Nucleotide sequences of the HA gene of H5N1 influenza viruses isolated from humans and birds in Egypt were downloaded from the National Center for Biotechnology information (NCBI) Influenza Virus Database (Bao et al., 2008). I selected full-length and nearly full-length HA sequences in the database, and nucleotide sequences of HA of 73 human isolates and 531 avian isolates from 2006 to 2016 were obtained. For each nucleotide sequence, I recorded the city and the date where and when the virus was sampled (Appendix, Table S 1). Thirteen human sequences that lacking sampling date information were excluded from subsequent analyses. For the clustering analysis described below, *p*-distance (Nei, 2000) among all pairs of sequences were calculated. For each city where viruses were sampled, the latitude and longitude of the city were obtained from Egypt Cities Database in SimpleMaps.com (SimpleMaps.com, 2010-2019). Then, geographical distances between cities were calculated using the “geosphere” library in R software.

Detection of human case cluster using phylogenetic tree

To find possible human-to-human transmissions, I first identified clusters of human isolates using a phylogenetic tree. I constructed a phylogenetic tree of HA sequences of avian and human using maximum composite likelihood with general time reversible substitution model in MEGA version 6.06 software (Tamura, 2013). Clusters of human isolates were identified as follows. Each human isolate is considered to belong to a cluster. There may be a cluster with a single virus, and I call such a cluster a singleton cluster. Two human isolates are considered to belong to the same cluster if they are connecting with one or two internal nodes in the phylogenetic tree. Applying this criterion for all pairs of human isolates, I get clusters of human isolates.

Estimation of human-to-human transmission potential

To estimate the number of human-to-human transmission events in infection chains, I employ a mathematical model describing human-to-human transmission. I hypothesized all human index cases of H5N1 viruses are avian-to-human transmission. Figure 1 illustrates the infection chains in our model. In the model the number of avian-to-human transmissions is denoted by n. The total number of human cases is denoted by S. I defined the length x_i of an infectious chain i as the number of individuals in the infectious chain, which starts from an individual infected from a bird and ends with a person who have not transmitted virus to another person. I assume the probability of observing the "i"-th chains with length x_i follows a geometric distribution with the "success" probability p, which is considered as the probability of a human-to-human transmission. The likelihood function L of human-to-human transmission probability p can be written as follow:

$$L(p; x_1 \dots \dots, x_n) = \prod_{i=1}^{n} p^{x_i - 1}(1-p)$$

Since the summation of x_i over i is equal to the total number of human cases S, the maximum likelihood estimate of p is given by

$$\hat{p} = \frac{\sum_{i=1}^{n} x_i - n}{\sum_{i=1}^{n} x_i} = 1 - \frac{n}{S}.$$

R_0 is the expected number of secondary cases from single case in the entire susceptible population. Assuming that R_0 is smaller than or equal to 1, the representative value for the estimate of R_0 can be given by

$$R_0 = \hat{p} = 1 - \frac{n}{S}.$$

I calculate the confidence interval (CI) for the R_0 estimate using a likelihood ratio test. All the analysis was done using the statistical software R.

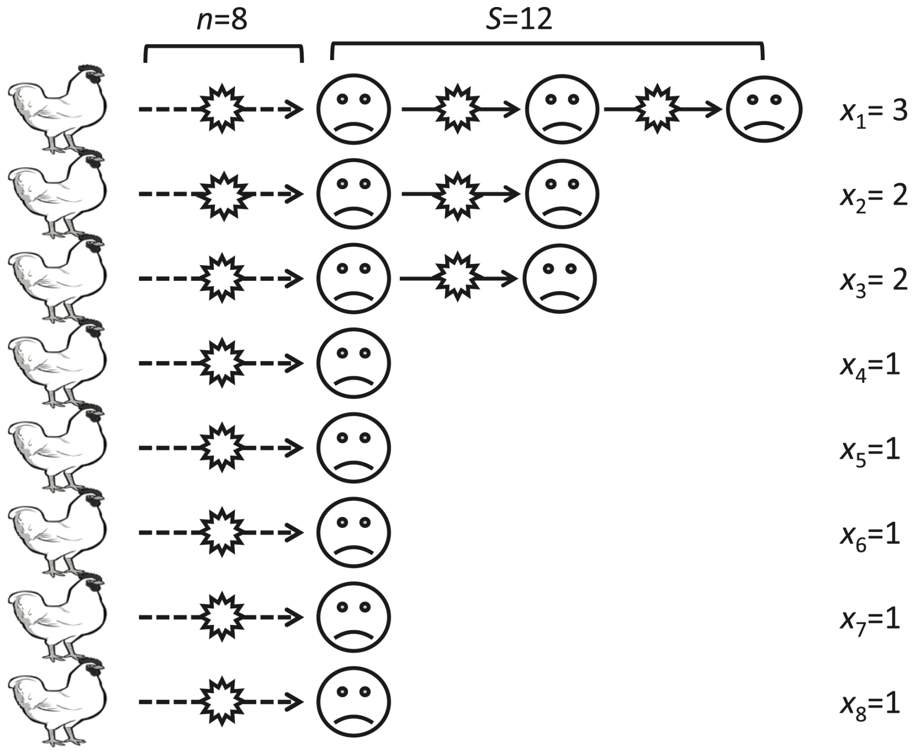


Figure 1. An illustrative example of infection chains in our model.

A virus transmits from a bird to a human (broken lines) then transmits from a human to another human and so on (solid lines). The x_i represent the length of the ith transmission chain.

Clustering analysis using genetic distance, sampling time interval, and geographical distance

Possible human-to-human transmissions were identified using criteria of genetic distance, sampling time interval, and geographical distance. Figure 2 illustrates how our clustering algorithm works with genetic distance and sampling time interval. In this example, there are 4 viruses were isolated from humans. The d_g on edges connecting two viruses represents the genetic distance between corresponding viruses. The d_t on edges represents the sampling time interval between the corresponding viruses. If I set genetic distance threshold to 0.02 and use only genetic distance as a criterion, then edges of A–B, B–C, and C–D satisfy the criterion and A, B, C, and D are considered as a cluster. The clustered sequences were sorted by their sampling time and transmission chains were reconstructed. I consider adjacent pairs in the transmission chain as candidate transmission pairs. In this case, I have 4 human cases and one transmission chain, and R_0 is calculated to be 1–1/4=0.75. If I set the sampling time interval threshold to 7 days and use sampling time as another criterion in addition to the genetic distance criterion, then edges of A–B and B–C satisfy these two criteria, grouping A, B, and C to the same cluster and making D to be a singleton cluster. Then R_0 is calculated to be 1–2/4=0.5. I can extend this to work with geographical distance in the same manner.

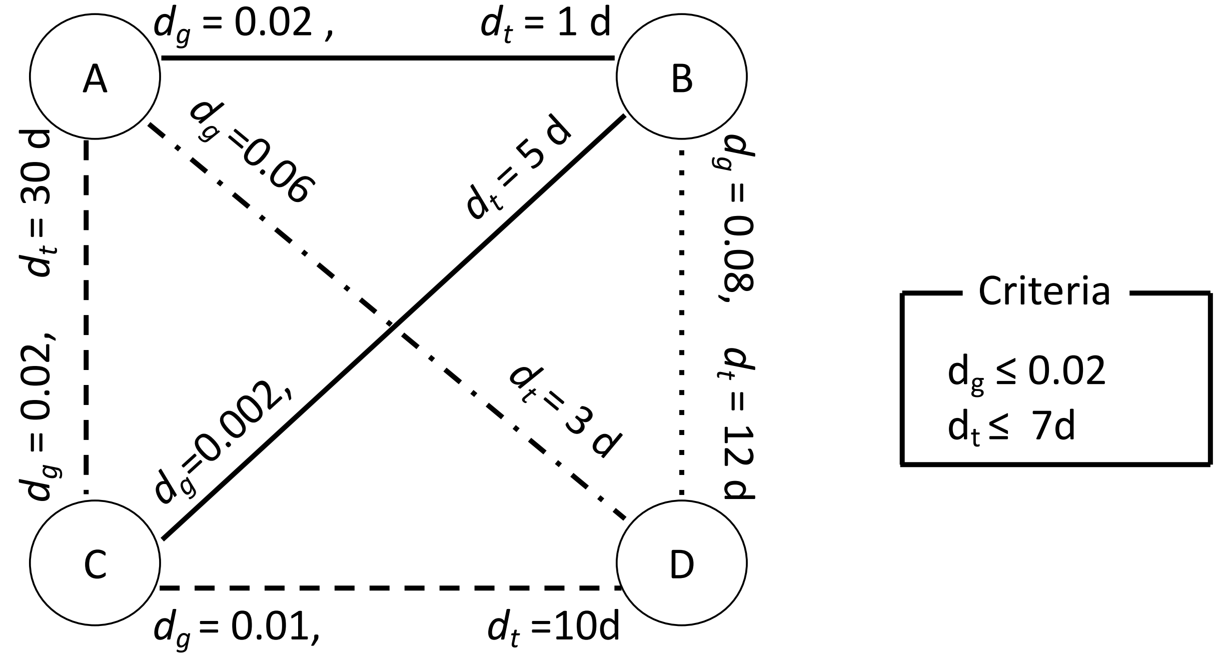


Figure 2. An illustrative example of clustering analysis using two criteria.

The nodes A, B, C, and D represent viruses isolated from humans. The d_g on each edge connecting two nodes represents the genetic distance between corresponding viruses. The d_t on each edge represents the sampling time interval between the corresponding viruses. This example uses 0.02 as clustering threshold for genetic distance and 7 days for sampling time interval. A solid line represents a pair of viruses satisfying both criteria. A dashed line represents a pair of viruses satisfying only the criteria for genetic distance. A dash-dot line represents a pair of viruses satisfying only the criteria for sampling time interval. A dotted line represents a pair of viruses which does not satisfy with any of the criteria.

Sensitivity analysis

To assess the robustness of the R_0 estimate, I conducted sensitivity analyses with respect to combinations of threshold values for the genetic distance, sampling time interval, and geographical distance. First, I varied genetic distance from 0 to 0.01 and calculated R_0 and its 95% CI. The 95% CI was calculated using the likelihood ratio test method. To obtain the distribution of sampling time interval and geographical distance between candidate transmission pairs, I used a fixed threshold for genetic distance between human viruses at a *p*-distance of 0.004488. This *p*-distance value is the between-households genetic variation, which is calculated by adding the mean value of between-households genetic distance and 1.96 times its standard deviation according to a previous study (Thai et al., 2014). Sequences in the clusters identified by phylogenetic analysis were also analyzed in the same manner.

To investigate the effect of sampling time interval threshold on the R_0 estimate, I fixed the genetic distance threshold at the between-households genetic variation and varied the sampling time threshold from 0 to 60 days, which is a sufficient time for the infectious period of human influenza. For the sensitivity analysis using geographical distance, I fixed the genetic distance threshold at the between-households genetic variation and varied the geographical distance threshold from 0 to 700 km, which is the maximum distance within human clusters identified from genetic distance. I also conducted sensitivity analyses of sequences in the clusters identified by phylogenetic analysis in the same manner. Table S2 in appendix shows the estimates of R_0 with respect to combinations of threshold values for the genetic distance, sampling time interval, and geographical distance.

Results

Phylogenetic analysis

A phylogenetic tree was constructed from HA sequences of avian and human viruses isolated in Egypt from 2006 to 2016 (Figure 3). From 60 sequences of human isolates, a total of 26 human clusters were found in the phylogenetic tree. Of these clusters, 12 were singleton clusters and 14 have more than one human sequence. These 14 clusters are candidates of possible human-to-human transmissions. The phylogenetic tree has 4 major clades of clade 2.2, 2.2.1, 2.2.1.1, and 2.2.1.2 (A. Arafa et al., 2016). The clade 2.2.1 has 9 candidate clusters of human-to-human transmissions, clade 2.2.1.2 has 4, and clade 2.2 has 1. Clade 2.2.1.1 has no candidate clusters for human-to-human transmissions. In total, 34 human-to-human transmission events were suggested from the phylogenetic tree. R_0 was estimated to be 1–26/60=0.57 with its 95% confidence interval from 0.44 to 0.69.

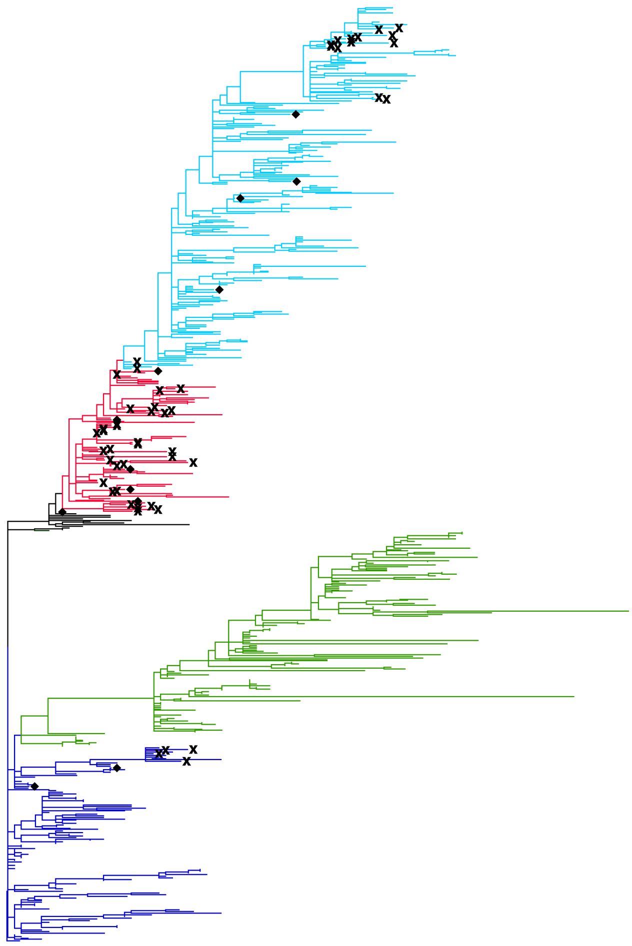


Figure 3. Phylogenetic tree of the HA gene of H5N1 avian influenza A viruses isolated in Egypt.

The tree was constructed with the maximum composite likelihood with general time reversible substitution model in MEGA software version 6.06. Tips of the tree represent reported viral sequences. The genetic distance between two viruses are depicted to be proportional to the summation of horizontal distances of branches connecting them. Human viruses are emphasized by marks; human viruses identified in a human cluster containing more than one human isolate were represented by cross marks. Human viruses in a singleton cluster were represented by diamonds. Clade information of H5N1 viruses are shown using different colors; clade 2.2 are shown in blue, clade 2.2.1.1 in green, clade 2.2.1 in red, and clade 2.2.1.2 in light blue.

Estimation of R_0 from genetic distance

Human isolates were clustered by genetic distances, and R_0 and its CI were calculated from the clustering results. Figure 4 shows the sensitivity of R_0 estimate with respect to genetic distance. In Figure 4 (A) clusters were identified using only genetic distances among human viruses without using the phylogenetic tree. R_0 was estimated to be 0.00 with its 95% CI from 0.00 to 0.032 when the genetic distance threshold was 0.00. R_0 increased as the genetic distance threshold increased, and R_0 was estimated to be 0.883 with its 95% confidence interval from 0.79 to 0.95 when the genetic distance threshold was 0.01. R_0 was estimated to be 0.55 with its 95% CI from 0.42 to 0.67 when the genetic distance threshold was 0.004488, which is the between-household genetic variation. In Figure 4(B) clusters were identified using phylogenetic tree of human and avian viruses and genetic distances among viruses clustered together. R_0 was estimated to be 0.30 with its 95% confidence interval from 0.19 to 0.42 when the genetic distance threshold was the between-household genetic variation. R_0 was estimated to be 0.53 with its 95% CI from 0.41 to 0.66 when the genetic distance threshold was 0.01.

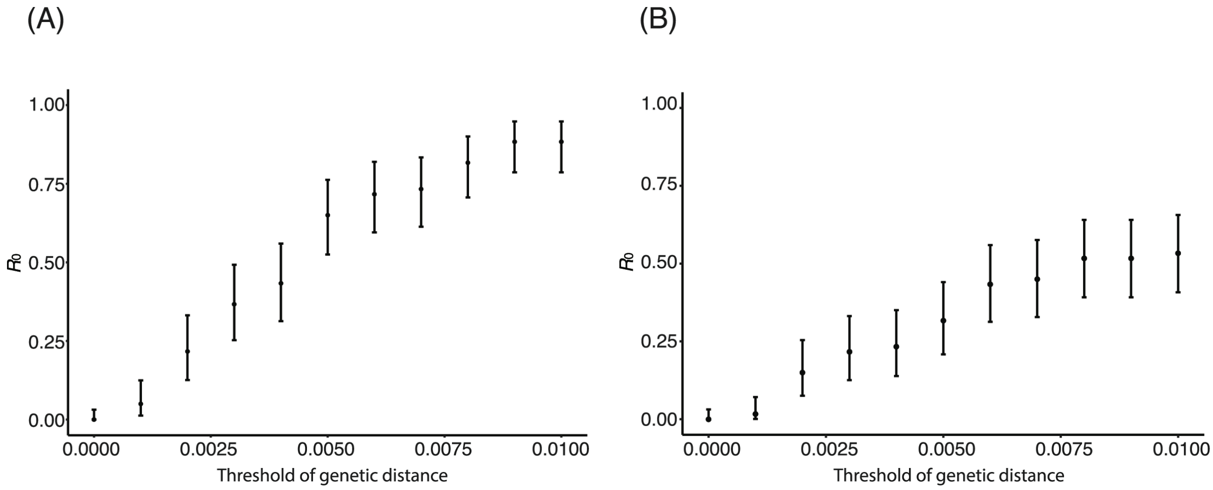


Figure 4. Effect of genetic distance threshold on the estimate of R_0 using genetic distance.

(A) Human viruses were clustered by genetic distances. (B) Human viruses were clustered by phylogeny and genetic distances.

Distribution of sampling time interval and geographical distance among human viruses

To determine the range of parameter values explored in the sensitivity analysis of R_0 estimate against sampling time interval and geographical distance, I analyze the distribution of sampling time intervals and geographical distances. The distribution of sampling time intervals and geographical distances among candidate transmission pairs were obtained by fixing the threshold for genetic distance between human viruses at the between-households genetic variation (Figure 5). Figure 5 (A) shows histogram of time intervals among candidate transmission pairs in the cluster obtained using the between-households genetic distance among human sequences. Figure 5 (B) uses phylogeny and the between-households genetic distance to obtain clusters of human sequences. The time intervals of candidate transmission pairs range from 0 to 149 days in clusters identified using genetic distance and from 1 to 170 days in clusters identified using phylogeny and genetic distance. In both panels of Figure 5 (A) and 5 (B) the bins from 0 to 10 days show the highest. Figure 5 (C) shows histogram of geographical distances among candidate transmission pairs in the cluster obtained using the between-households genetic distance. Figure 5 (D) uses phylogeny and the between-households genetic distance to obtain clusters of human sequences. The geographical distances of candidate transmission pairs ranges from 0 to 682.2 km in clusters identified using genetic distance and ranges from 0 to 383.3 km in clusters identified using phylogeny and genetic distance. In both panels of Figure 5 (C) and 5 (D) the bins from 0 to 25 km show the highest.

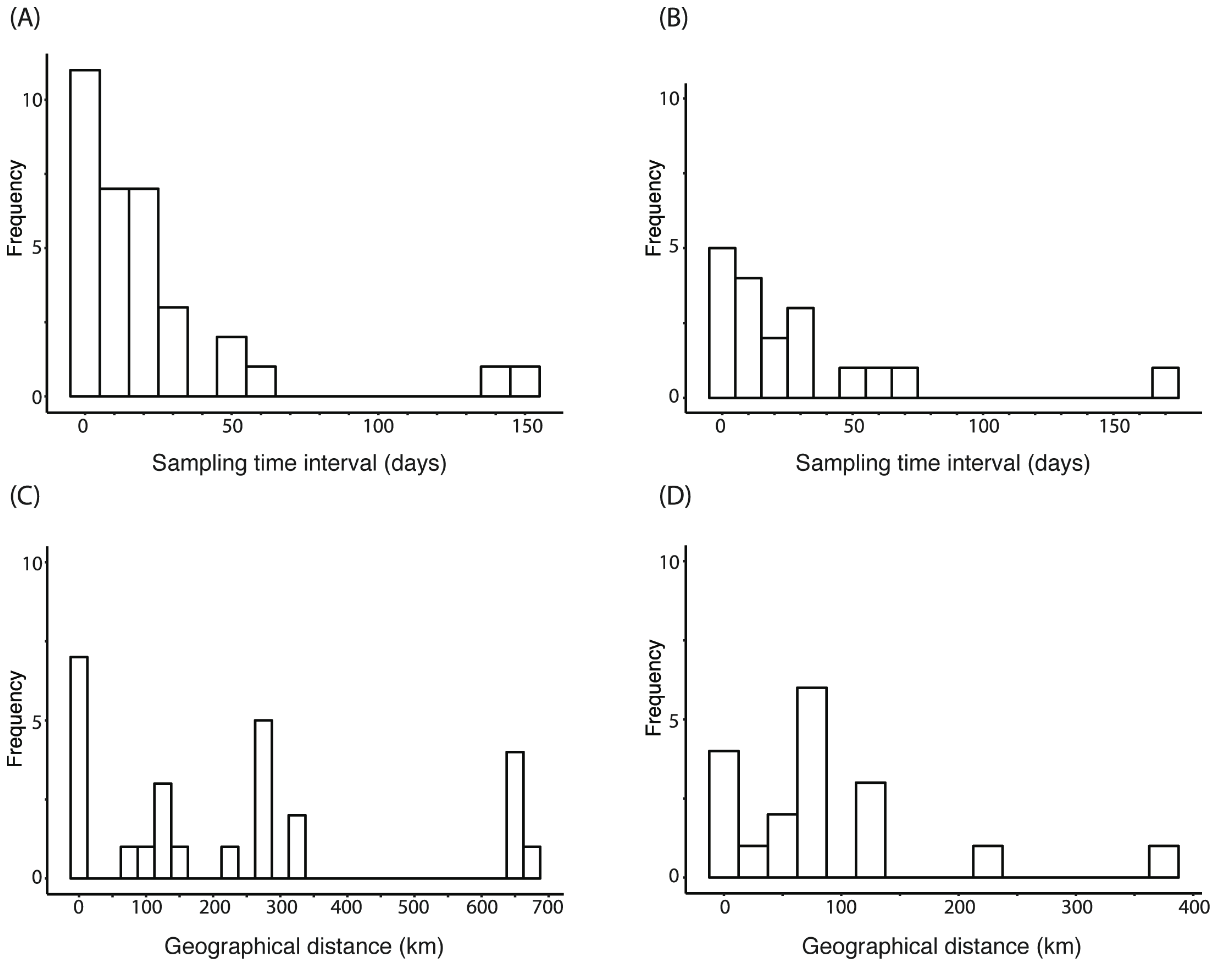


Figure 5. Distribution of sampling time interval and geographical distance among human viruses.

(A) Histogram of sampling time intervals between human viruses clustered by genetic distances threshold at the between-household genetic variation. (B) Histogram of sampling time intervals between human viruses clustered by phylogeny and genetic distances threshold at the between-household genetic variation. (C) Histogram of geographical distances between human viruses clustered by genetic distances threshold at the between-household genetic variation. (D) Histogram of geographical distances between human viruses clustered by phylogeny and genetic distances threshold at the between-household genetic variation.

Estimation of R_0 from genetic distance and sampling time interval

Human viruses were clustered by genetic distances and sampling time interval, and R_0 and its CI were calculated from the clustering results. Figure 6 shows sensitivity of R_0 estimate with respect to sampling time interval threshold when genetic distance threshold was fixed at the between-household distance. Figure 6 (A) uses genetic distances and sampling time intervals, and Figure 6 (B) uses phylogeny and genetic distances and sampling time interval among human sequence clusters. R_0 was estimated to be 0.55 (95% CI:0.42,0.67) without phylogeny and 0.30 (95% CI:0.19,0.42) with phylogeny when the sampling time interval threshold was 220 days, and these values decreased as sampling time interval threshold decreased. R_0 was estimated to be 0.42 (95% CI: 0.30, 0.54) without phylogeny and 0.23 (95% CI: 0.14, 0.35) with phylogeny when the sampling time interval threshold was 30 days, which is the upper bound of sampling time interval between-household transmissions (Loeb & Neupane, 2012; Ng et al., 2016).

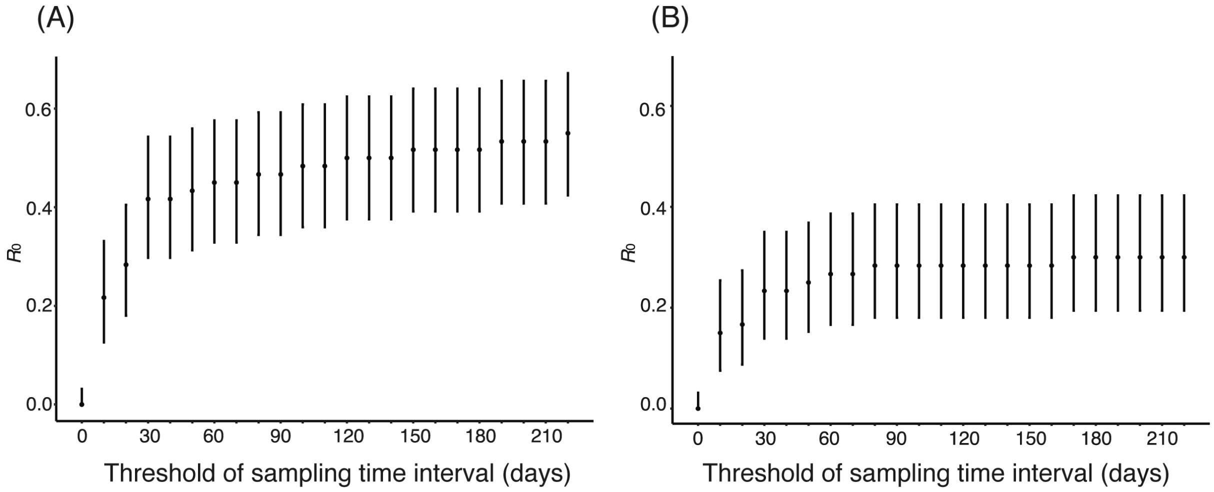


Figure 6. Estimation of R_0 from genetic distance and sampling time interval.

The effect of time interval threshold on the estimate of R_0 is shown when genetic distance threshold fixed at the between-household variation. (A) Genetic distances and sampling time intervals were used to obtain candidate transmission pairs. (B) Phylogeny, genetic distances, and sampling time interval were used to obtain candidate transmission pairs.

Estimation of R_0 from genetic distance and geographical distance

Human viruses were clustered by genetic distances and geographical distances, and R_0 and its CI were calculated from the clustering results. Figure 7 shows sensitivity of R_0 estimate with respect to geographical distance threshold when genetic distance threshold was fixed at the between-household distance. Figure 7 (A) uses genetic and geographical distances, and Figure 7 (B) uses phylogeny and genetic distances and geographical distances among human sequence clusters. R_0 was estimated to be 0.55 (95% CI:0.42,0.67) without phylogeny and 0.30 (95% CI:0.19,0.42) with phylogeny when the geographical distance threshold was 700 km, and these values decreased as geographical distance threshold decreased. R_0 was estimated to be 0.15 (95% CI: 0.0751, 0.254) without phylogeny and 0.1 (95% CI: 0.041, 0.1923) with phylogeny when the geographical distance threshold was 0 km, which is the geographical distance between the same city.

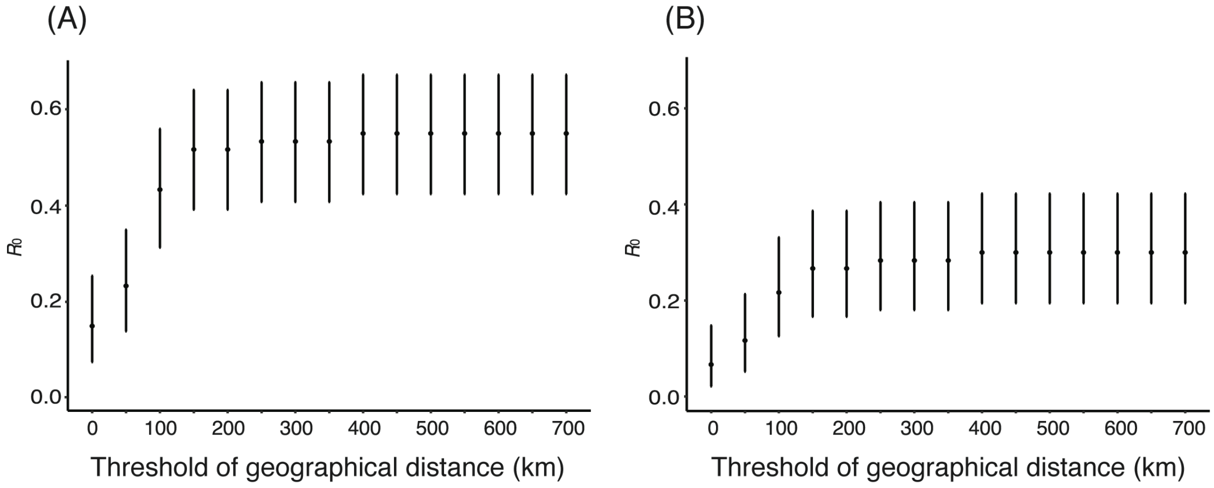


Figure 7. Estimation of R_0 from genetic distance and geographical distance.

The effect of geographical distance threshold on the estimate of R_0 is shown when genetic distance threshold fixed at the between-household variation. (A) Genetic distances and geographical distance were used to obtain candidate transmission pairs. (B) Phylogeny, genetic distances, and geographical distance were used to obtain candidate transmission pairs.

Estimation of R_0 from genetic distance, sampling time interval, and geographical distance

Human viruses were clustered by genetic distances, sampling time interval, and geographical distances, and R_0 and its CI were calculated from the clustering results. I set threshold values for genetic distance = 0.004488 which is the genetic distance observed in the between-household transmissions of H1N1 viruses (Thai et al., 2014). I specified threshold for time interval at 30 days according to Loeb et al. and Ng, et al. (Loeb & Neupane, 2012; Ng et al., 2016). If it is assumed that human-to-human transmissions occurred only within household and I set the geographical distance threshold was 0 km (within a city), which is the geographical distance between the same city, 3 human-to-human transmissions were detected. Based on this result, R_0 was estimated to be 0.05 (95% CI:0.01,0.13). Table S2 appendix shows the estimates of R_0 for different combinations of genetic distance threshold, sampling time interval threshold, and geographical distance threshold. The upper bounds of 95% CI of our estimates of R_0 using various thresholds were below unity.

Discussion

In this study, to elucidate the cause of the rapid increase in human cases of H5N1 influenza virus infections had increased from 2014 to 2015 in Egypt, I have estimated the R_0 of H5N1 infections in human population in Egypt using candidate transmission pairs identified from the nucleotide sequences, infection time, and geographic location of viruses. Sensitivity analysis shows that R_0 is below unity, suggesting that major outbreak will not occur, with broad range of threshold values of genetic distance, sampling time interval, and geographical distance. Using genetic distance, sampling time interval, and geographical distance, I estimated R_0 of 0.05 (95% CI; 0.01, 0.13) assuming that human-to-human transmissions occurred within a city, 0.23 (95% CI; 0.14, 0.35) assuming human-to-human transmissions among cities, suggesting that human-to-human transmission of H5N1 viruses is rare in Egypt.

I have estimated the R_0 of H5N1 infections in human population in Egypt using candidate transmission pairs identified from the nucleotide sequences, infection time, and geographic location of viruses. The nucleotide sequences of H5N1 influenza viruses were used to obtain candidate transmission pairs in two different ways. The first approach makes clusters of human viruses using genetic distances with respect to a given threshold value. This approach does not use nucleotide sequences of avian viruses. The second approach use a phylogenetic tree of influenza viruses constructed from nucleotide sequences of humans and birds and use genetic distance to divide clusters into transmission chains. The second approach reduces a possibility that two avian-to-human transmissions are clustered together. In fact, the estimated values of R_0 were smaller when I analyzed sequences with phylogeny than when without phylogeny (Figure 4 (A) (B), Figure 6 (A) (B), and Figure 7 (A) (B)). There is a possibility that the R_0 would further decrease if I had more avian sequences similar to human viruses. In sensitivity analysis, the effect of threshold values on R_0 were smaller when with a phylogenetic tree (Figure 4 (B)) than without a phylogenetic tree (Figure 4 (A)).

Sensitivity analysis of sampling time interval showed a large effect on R_0 between 0 days and 30 days (Figure 6 (A) (B)). R_0 was estimated as 0.22, 0.28, and 0.42 when the sampling time interval threshold was 10, 20, and 30 days, respectively. It is known that the sampling time interval of transmission period is less than 30 days. Sensitivity analysis of geographical distance showed a large effect on R_0 between 0 km and 150 km (Figure 7 (A) (B)). R_0 was estimated as 0.067, 0.12, 0.22, 0.27 when the geographical distance threshold was 0, 50, 100, and 150 km, respectively. These results indicate that the threshold of sampling time interval and geographical distance are important variables to estimate R_0 using our data. I estimated R_0 with combinations of different threshold values for genetic distance, sampling time difference and spatial difference as sensitivity analyses. In all analyses, the upper bound of the 95% CI of R_0 was below unity.

Although sensitivity of R_0 against geographical distance is also high, the setting of geographical distance to detect clusters of human cases is not straightforward. Since several studies reported that most human-to-human transmissions of H5N1 occurred within their household (Centers for Disease Control and Prevention, 2015; Ungchusak et al., 2005; Wang et al., 2008), the threshold of geographical distance might be suitable to set 0 km, i.e., human-to-human transmissions occurred only within the same city. If this is the case, the R_0 estimate is 0.05 (95% CI: 0.01, 0.13). However, the human cases of H5N1 in Egypt have not been well-understood whether they occur within or between household so far, and this assumption may underestimate R_0. If I do not set any threshold of geographical distance, the R_0 estimate is 0.23 (95% CI: 0.14, 0.35). However, this setting may overestimate R_0. This setting assumes that genetic distance and sampling time difference are enough to determine the cluster of human cases formed by only human-to-human transmission. If multiple introductions of H5N1 viruses from avian to human occur, this setting may lead to misinterpret them as human-to-human transmission events. To estimate an accurate R_0, a detailed surveillance, e.g., contact tracing, is required. Regardless of the settings for threshold of geographical distance, the upper bound of the 95% CI of R_0 was below unity.

Several studies have estimated R_0 of H5N1 influenza viruses in human populations. Ferguson et al. estimated R_0 of H5N1 viruses as 0.06 (95% CI: 0.01, 0.2) using exposure history to birds of 33 reported cases in Viet Nam in 2004 (Ferguson & Donnelly, 2004). Yang et al. estimated the lower bound of the local R_0 of H5N1 viruses to be 1.14 (95% CI: 0.61–2.14) using data of family case clusters from Sumatra, Indonesia (Yang et al., 2007). From time series data of human cases of H5N1 influenza, Bettencourt and Ribeiro estimated R_0 in Vietnam and Indonesia as 0.53 (95% CI: 0.26, 0.77) and 0.56 (95% CI: 0.16, 0.89), respectively (Bettencourt, 2008). Aditama et al. used data of the household with a cluster of cases and estimated R_0 of H5N1 virus in households in Indonesia between 0.1 and 0.25 with upper confidence bounds below 0.4 in the period from 2005 to 2009 (Aditama, Kusriastuti, Santoso, & Maruf, 2012). Saucedo et al. used family cluster data of H5N1 cases worldwide from 2003 to 2006 and estimated R_0 to be 0.2 (Saucedo, Martcheva , & Annor, 2019). Our estimate of R_0 is 0.05 (95% CI; 0.01, 0.13) assuming that human-to-human transmissions occurred within a city, 0.23 (95% CI; 0.14, 0.35) assuming human-to-human transmissions among cities. The estimate of R_0 for among cities setting is comparable with most of estimates from these studies.

Human cases of the highly pathogenic avian influenza (HPAI) H5N1 had increased in 2014–2015. Naguib et al. showed that human infections of H5N1 in Egypt in 2014–2015 are statistically linked to the increased outbreaks in poultry (Naguib, 2016). The upper bounds of 95% CI of our estimates of R_0 using various methods were below unity, suggesting that major outbreak will not occur shortly. Using genetic distance and sampling time, R_0 was estimated to be 0.23 with 95% CI from 0.14 to 0.35. Furthermore, the distribution of geographical distance between human cases show unclear trend (Figure 5(C) (D)), meanwhile, the distribution should be right-skewed if most human cases are attributed to human-to-human transmission.

Sensitivity of R_0 against geographical distance suggests that the outbreak of H5N1 among birds in Egypt occurs widely (diameter of the area is 200 km hypothesized from the saturation of R_0 estimate in Figure 7 (A) and (B) with assuming that human-to-human transmission is rare). Our results supported that most human cases should be attributed to avian-to-human transmissions. The dramatic increase in human cases in Egypt would be attributed to the high prevalence of H5N1 among avian species, and avian-to-human transmissions in wide regions of Egypt may explain the unclear trend in the distribution of geographical distance between human cases.

Vaccines against H5N1 viruses have been used in Egypt since 2006 (Domenech, Rushton, & Lubroth, 2009). Kandeil et al. showed that vaccination can be efficient in back yard settings in Egypt (Kandeil et al., 2018). Despite the intensive use of H5N1vaccines, the virus became endemic in 2008 and the number of human cases has increased (Abdelwhab et al., 2016; Peyre et al., 2009). Savill et al. shows that vaccination of poultry makes it difficult to monitor the spread of viruses (Savill, St Rose, Keeling, & Woolhouse, 2006). Moreover, the immune pressure of the vaccinated poultry accelerated the virus evolution in Egypt (Abdelwhab et al., 2010; A. Arafa, Suarez, Hassan, & Aly, 2010; Artois et al., 2018). Therefore, to reduce the risk of H5N1 infections in humans I need to implement a more effective control measures other than vaccinations in poultry, because the control of avian influenza using vaccination is difficult.

This study proposed a method to estimate human-to-human transmissibility of zoonotic pathogens using nucleotide sequences as well as temporal and geographic information of infections. The integration of multiple types of data to the analyses can lead a more accurate estimation than analysis using a single type of data. However, there are some limitations in this study. First, I did not include exposure history to birds in our analysis. The World Health Organization reported exposure history of 37 laboratory-confirmed human cases of avian influenza A (H5N1) virus infection in Egypt during the period from the 3rd of March to the 31st of March 2015. Of these, 36 cases had a history of contact with poultry or visiting poultry markets. One case was under investigation (World Health Organization, 2015). The inclusion of bird contact information may reduce the estimates of R_0. There is no link between the sequence data used in this study and exposure history data so far, the improvement of surveillance system that can link them is required to estimate an accurate R_0. Second, the number of available sequences in the database is limited. There would be difference in the sampling probability between human and avian sequences. Assuming that the sampling probability in human sequences is higher than that of avian sequences, I may have overestimated the R_0. Surveillance of both human and avian viruses is important to correctly estimate R_0 by our method.

In this study, I estimated R_0 of H5N1 viruses in human population using nucleotide sequences, sampling date, and sampling location of viruses. Taking into account the phylogeny, genetic distance, sampling time difference among viruses, R_0 was estimated to be 0.05 (95% CI; 0.01, 0.13) assuming that human-to-human transmissions occurred within a city, 0.23 (95% CI; 0.14, 0.35) assuming human-to-human transmissions among cities. Sensitivity analysis confirmed that R_0 is below unity (appendix, Table S2), suggesting that major outbreak will not occur, with broad range of threshold values of genetic distance, sampling time interval, and geographical distance. In conclusion human-to-human transmission of H5N1 viruses in Egypt is still limited. The large increase in human cases is most probably attributed to the increase in avian cases. Monitoring both avian and human populations is required to prevent major outbreaks of H5N1 infections among the human population.

Summary

Control of H5N1 in both avian and human is of great concern. To control the virus, we have to understand the evolutionary and epidemiological dynamics of the virus. In this Chapter, I investigated the transmissibility of H5N1 viruses among humans via estimating the basic reproduction number R0 using nucleotide sequences and sampling dates of viruses. To this end, full-length hemagglutinin gene sequences of human and avian H5N1 influenza viruses isolated from 2006 to 2016 in Egypt were obtained from the NCBI influenza virus resource. Taking into account the phylogeny, genetic distance, sampling time difference among viruses, R0 was estimated to be 0.05 (95% CI: 0.01, 0.13) assuming that human-to-human transmissions occurred within a city, 0.23(95% CI: 0.14, 0.35) assuming human-to-human transmissions among cities. These results indicate that human-to-human transmission of H5N1 viruses in Egypt is limited, and the large increase in human cases is likely attributed to other factor than increase in human-to-human transmission potential.

Chapter II

Phylogeographic analyses of H5N1 viruses in Egypt

Introduction

Millions of migratory birds pass through Egypt due to its geographic location in the West Asian–East African and Mediterranean–Black Sea flyways, increasing the chances of viral transmission to and from Egypt (Abdelwhab & Hafez, 2011; Baha el Din, 2001). In December 2005, The US Naval Medical Research Unit No. 3 and the Ministry of Environment of Egypt have declared the first highly pathogenic A/H5N1 from common teal sampled from the Damietta region (Saad et al., 2007). This virus showed 99.4% similarity to an H5N1 virus isolated from domestic poultry in 2006 in Egypt. Egypt became the second African country, after Nigeria, to report the HPAI H5N1 infection in poultry on 16 February 2006 (Aly et al., 2008). From 2003 to 2015 Egypt was reported as the country with the highest number of reported cases worldwide and the case fatality rate was 0.33 (116/342) (World Health Organization, 2015).

Based on the evolution of the Egyptian H5N1 viruses, clades of circulating viruses have changed progressively. From late 2005 to 2006 H5N1 virus European-Middle Eastern-African (EMEA) lineage (Clade 2.2) have been diversified into three subclades according to their geographic origin, European, Middle East, and African. Clade 2.2 is distinct from other contemporary Asian clades, which share common ancestry with the original 1997 Hong Kong strain (Salzberg et al., 2007). In other study, the African subclade diversified into three subclades A, B, C, and the Egyptian isolates clustered with the sublineage B (Ducatez et al., 2007). By 2009, the Egyptian H5N1 viruses were classified in the unified nomenclature system as clade 2.2.1, which have further diversified into subclades (Brown et al., 2009). Clade 2.2.1 became endemic in poultry from 2007 in Egypt, which has reported to have the highest number of human infections worldwide. Clade 2.2.1.1 viruses appeared as vaccine escape mutants after the genetic drift occurred in clade 2.2.1. This split of the new subclade 2.2.1.1, indicated further divergence of H5N1 viruses circulating in Egyptian poultry (El-Shesheny et al., 2014; G. Kayali et al., 2011) (Abdelwhab et al., 2011). During 2010-2011, viruses of clade 2.2.1 and 2.2.1.1 were cocirculating among poultry in Egypt (Smith et al., 2012). Further evolution of these clades resulted in the new clade 2.2.1.2 (A. S. Arafa et al., 2015; Smith et al., 2015).

Early work analyzed phylogenetic evolution of H5N1 viruses without considering geographic distribution within the country (Saad et al., 2007; Salzberg et al., 2007). Later on, Aly et al. included the geographic distribution of the initial Egyptian isolates (Aly et al., 2008). The Egyptian isolates were distributed over country's main regions: Cairo, Nile delta, Canal, and Upper Egypt. The Nile Delta had the highest reported (G. Kayali et al., 2011).

In recent years more attention has been turned to understand the epidemiology of H5N1 viruses, including; incidence, transmission, and possible control measures and other factors (Qin et al., 2015; Yee, Carpenter, & Cardona, 2009). Spatio-temporal distribution of diseases is crucial for understanding their evolution, transmission, spread, and dynamics (Lopez-Quilez, 2019). Combination of the geospatial data with mathematical and statistical techniques provide powerful tools for analyzing spatio-temporal distribution and incidence of infectious diseases (Pybus, Tatem, & Lemey, 2015).

In this study, phylogeographic models present a framework for getting insight on H5N1 viruses' diffusion. In order to achieve better understanding of the H5N1 virus dynamics I aim to analyze the spatio-temporal distribution of H5N1 viruses in Egypt and its neighboring countries from 2006 to 2016 by using time-stamped, geographically referenced sequences.

Materials and methods

Genetic epidemiological data

I identified the H5N1 influenza virus outbreaks from 2006 to 2016 using the real-time tracking of influenza A/H5N1 virus evolution in Nextstrain (Hadfield et al., 2018; Moncla). Nucleotide sequences of the HA gene of H5N1 influenza viruses isolated from humans and birds in Egypt, Palestine, Israel, and Syria were downloaded from the NCBI Influenza Virus Database (Bao et al., 2008). I selected full-length and nearly full-length HA sequences in the database, and nucleotide sequences of HA of 73 human isolates, and 557 avian isolates from 2006 to 2016 from Egypt and middle eastern countries, Palestine, Israel, and Syria were obtained (Figure 8). For each nucleotide sequence I recorded the sampling city and date from the GeneBank record for each sequence. One hundred seventy-four sequences that lacked either sampling date and/or sampling place information were excluded from subsequent analyses. The GenBank accession numbers, strain names, sampling dates, and sampling locations of nucleotide sequences from Egypt used in this study can be found in the appendix Table S 1 and those from other countries are listed in appendix Table S 3. For calculating the genetic distance among all pairs of sequences, *p*-distance (Nei, 2000) were used. For each city where viruses were sampled, the latitude and longitude of the city were obtained from SimpleMaps.com and latitude.it (SimpleMaps.com, 2010-2019) (Latitude.to(v1.51beta), 2019)

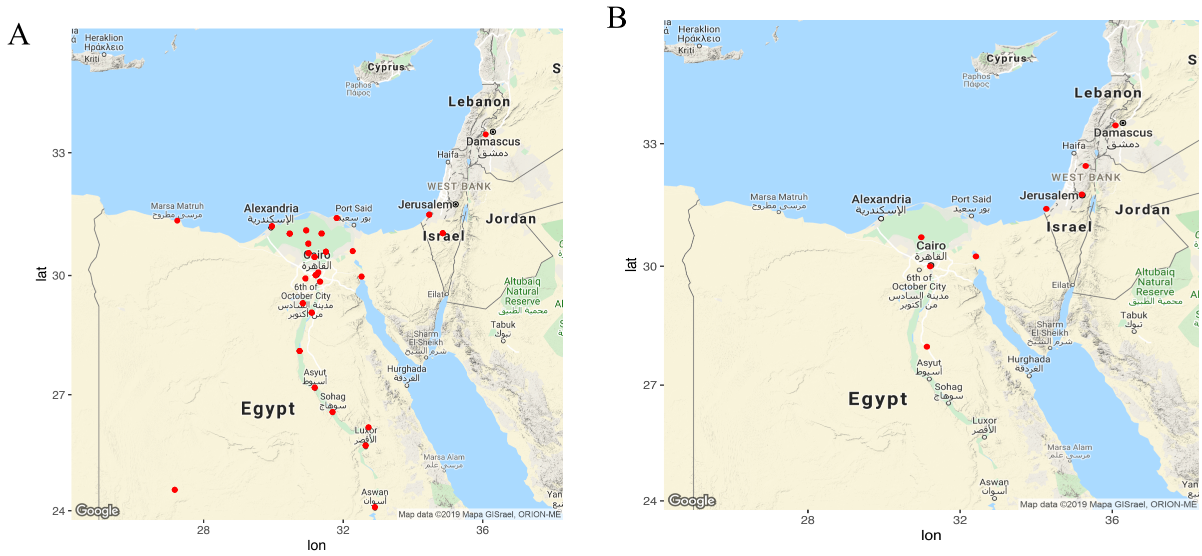


Figure 8. Spatial distribution of the H5N1 samples.

A) Cities where the 456 virus were sampled B) Discretized spatial distribution. Red dots represent the sampling cities on the map was downloaded from google maps.

Sequence alignment and phylogenetic analysis.

Sequences were aligned via the ClustalW in the MEGAX program. I used PhyML software version 3.0 to test the substitution models and estimate the maximum likelihood phylogenies using the fast algorism to perform Nearest Neighbor Interchanges (NNIs). Trees were re-rooted to the sequence with earliest sampling date using the FigTree v1.4.4.

Molecular clock analysis

I computed the distance of a set of tips to the root by using the Phylogenetic Variance-covariance “vcv.phylo” function in R software. Distances from the tip to the root were plotted against the sampling year to show the molecular clock evolution.

Phylogeography

I modeled the phylogeography of H5N1 after the work done by Lemy et al. for studying the phylogeography of H5N1viruses (Lemey, Rambaut, Drummond, & Suchard, 2009). I used BEAST version 1.8, program as a cross-platform program for Bayesian analysis of molecular sequences using Markov chain Monte Carlo (MCMC) to create the Bayesian phylogeographic trees (Drummond & Rambaut, 2007) by using an asymmetric, non-reversable discrete phylogeographic model. Egypt and Palestine were dissected into 4 (Nile delta, Canal, Cairo, and Upper Egypt) and 2 (Gaza and Jenin) regions, respectively and Syria is represented by one region (Qatana). Each region was used as a state in the Bayesian phylogeographic analysis. For the spatial discretization I grouped the samples according to the sampling regions. For each region was identified as the central mean value among the cities that located in the same region. I selected the maximum clade credibility (MCC) by using the TreeAnnotator (Drummond & Rambaut, 2007). The MCC tree was illustrated using FigTree v1.4.4 software.

I considered two scenarios in our Bayesian discrete model analysis. I used either random local or uncorrelated relaxed clock model. For the relaxed model, I used an uncorrelated log-normal scenario. I applied the non-parametric skyride coalescent (Minin, Bloomquist, & Suchard, 2008) model to reconstruct the population dynamics using the Gaussian Markov Random Field (GMRF) prior to obtain a smooth estimates for the effective population size over time. I set the length of the Bayesian MCMC run at 200 million with sampling every 20000 step.

For each Bayesian settings, I ran MCMC for 4 times and log files were combined using logCombiner program in BEAST to increase the sample size. The models were compered by estimating the log marginal likelihood values via the Akaike information criteria for MCMC (AICM) test using the Tracer program.

To identify the origin of each introduction of the virus in the four classified clades of H5N1 virus along the trunk of the phylogeny, I analyzed trunk of the MCC tree. I defined the trunk lineage of the phylogeny as the lineage that originating from the root of the tree to the most recently sampled isolate in the clusters (Cheng et al., 2013). I calculated the frequency of each geographic region to be located at the trunk of the tree at different time point as the number of introductions of the virus sampled from certain regions at certain yearly time period. Proportion of introductions for each regional was calculated yearly to be as the yearly frequency of each region over the total number of introductions from different regions. Percentage of total introduction of each region in the phylogeny was also calculated as the summation of the proportions of introductions from one region over the sum of proportions of total introductions in the phylogeny.

Results

I examined the evolution and spatial dispersion of H5N1 viruses by using available HA gene sequences. I assume that the number of available genetic sequences can be indicator for the outbreaks. Figure 9 (A) shows the yearly time series of the number of H5N1 influenza virus available in the NCBI influenza virus resources. From 2006 to 2016 the number of available sequences varies either corresponding to the virus evolution and outbreak occurrence or as a result of recalling bias. In 2006-2007, the virus was first introduced into Egypt causing outbreak among poultry with a certain number avian to human transmissions. 2008 showed epidemic of the H5N1 virus among poultry with increased number of cases, but fewer human cases were reported. 2009 showed increase in the human cases reported and lower avian cases. In late 2009 and 2010, the number of avian sequences reported increased dramatically with lower human cases reported, same as the situation in 2008 where the virus became enzootic. Effective population size analysis showed that there is change in virus evolution from 2007 to 2011, which is the period when the split variant viruses of clade 2.2.1.1 was co-circulating with clade 2.2.1 viruses. From 2011 to 2013 both avian and human cases were decreased as there were no reports about new virus strains. By late 2014, further evolution of these clades resulted in the new clade 2.2.1.2, which was circulating in 2015 and caused increase in the number of avian cases, but interestingly the human cases reported were low.

Population size analysis using GMRF showed increase in the genetic diversity and virus evolution between 2007 and 2011. This increase could be revealed to the co-circulation of clade 2.2.1 and clade 2.2.1.1 of H5N1 influenza viruses (Figure 9 (B)).

To construct the spatio-temporal patterns of distribution, I analyzed HA gene sequences sampled from Egypt and other countries that were affected with the same outbreak at the same time; Palestine (Gaza and Jenin), Israel, and Syria (Qatana). Plotting root-to-tip distances against the sampling times from maximum likelihood phylogenies reconstructed with the root position selected to optimize the temporal signal in PhyML suggested a linear trend of coevolution. Interestingly, a parallel diversion happened in 2008 (Figure 10 (A)). To verify either this diversion happened as a deviation of the human viruses from the avian viruses or it is caused by diversion that happened within the avian viruses, I separately plotted the root-to-tip distances in human viruses against the sampling times distances as well as the avian viruses. From this analysis I confirmed that there is a linear relationship between the human and avian viruses and the dispersion occurred among the avian viruses (Figure 10 (B) and (C)).

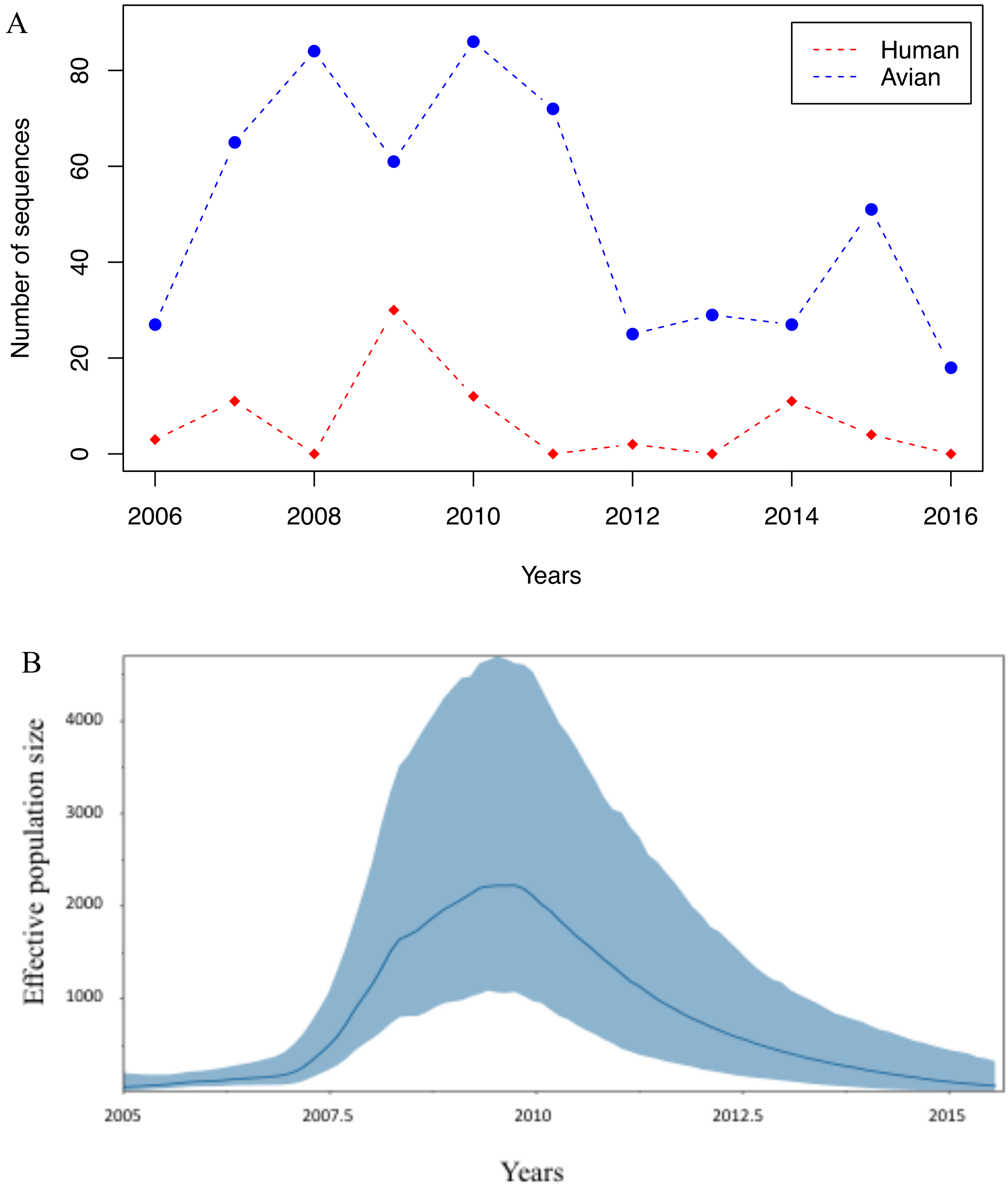


Figure 9. Yearly changes in H5N1 viruses from 2006 to 2016.

A) Number of HA gene sequences of H5N1 viruses. B) Change in Effective population size of H5N1. Number of sequences isolated from humans and avian species are shown in red and blue color, respectively.

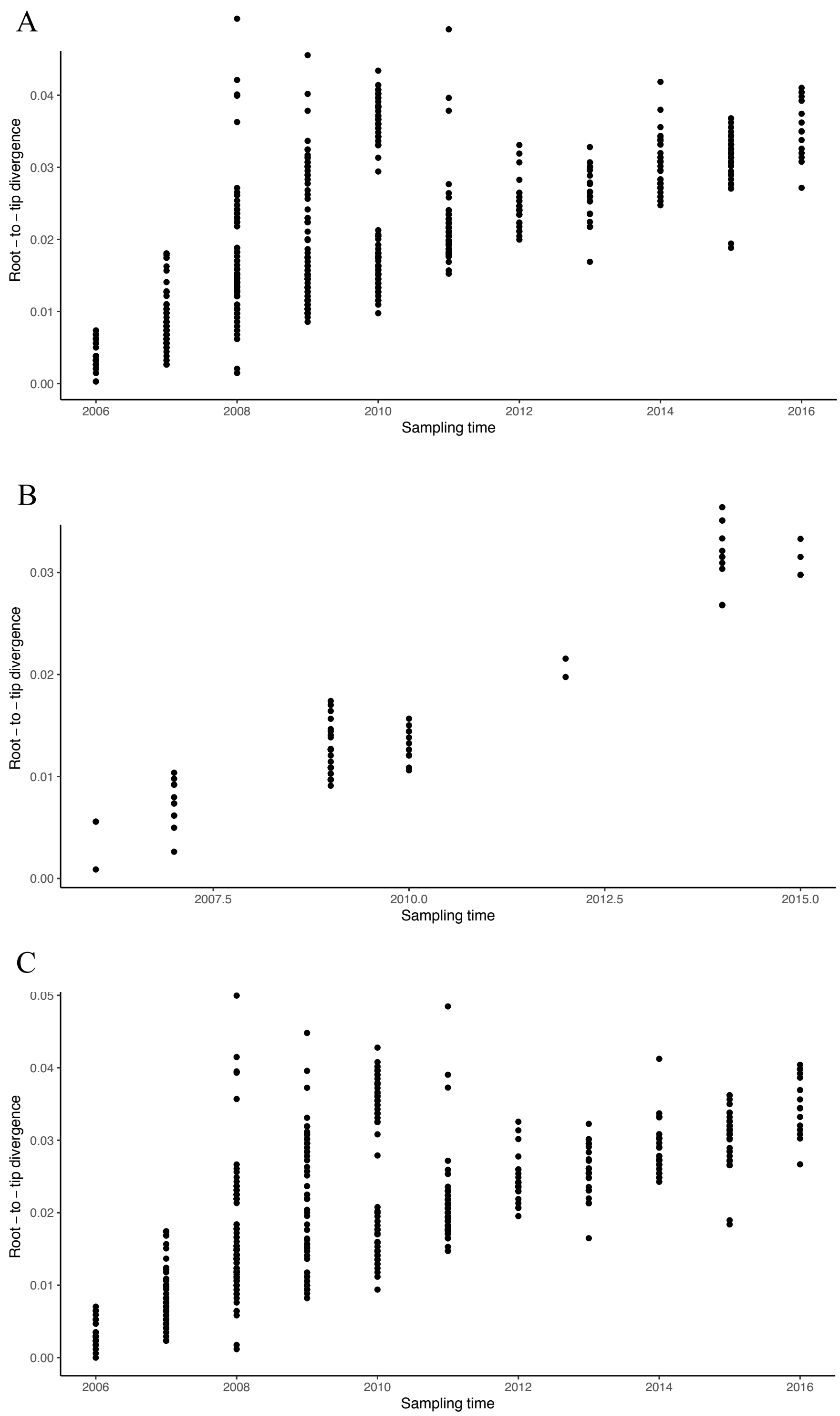


Figure 10. Temporal distribution of the root-to-tip distances among A) avian and human sequences, B) human sequences, and C) avian sequences.

X-axis represents sampling time of the virus and Y-axis represent the root-to-tip linear regression.

Phylogeography

I reconstruct phylogenies of genotypes in accordance to discrete states in a Bayesian statistical framework which ends with time scaled rooted phylogenies. I modeled the sequence evolution by using the Hasegawa-Kishino-Yano (HKY) nucleotide substitution model with discrete gamma-distributed rate variation. I assume the GMRF as a demographic model that achieve temporal smoothing of the effective population size in a Bayesian framework. The Bayesian analysis indicated increase in the genetic diversity and virus evolution from 2006 to 2016.

Figure 11 illustrates the estimated MCC of H5N1. This MCC tree represents the tree topology with the highest product of individual clade probabilities in their posterior sample and the posterior median estimate represents the branch length. The time to most recent common ancestor (tMRCA) is estimated at 2005 (95% HPD: 2005.1-2005.9) using the lognormal uncorrelated relaxed clock model and the tree root height is estimated to be 10.04 (95% HPD: 9.8-10.5). By using the local random molecular clock model, the tMRCA is estimated at 2005 (95% HPD: 2004.3-2005.6) with tree root height estimated at 10.5 (95% HPD: 10.0-11.2).

Through the tree H5N1 viruses that were sampled from humans were distributed into three clades 2.2, 2.2.1, and 2.2.l.2 leaving clade 2.2.1.1 without showing any human viruses.

Phylogeny showed that there is interspersing of the lineages sampled from different countries, indicating cross-border spread of the H5N1virus. Since the root of the tree or in other words the tMRCA is sampled from Egypt in the Nile delta region, it is most probably the virus emerged from the Nile delta region in Egypt to the neighboring countries introduced in this study.

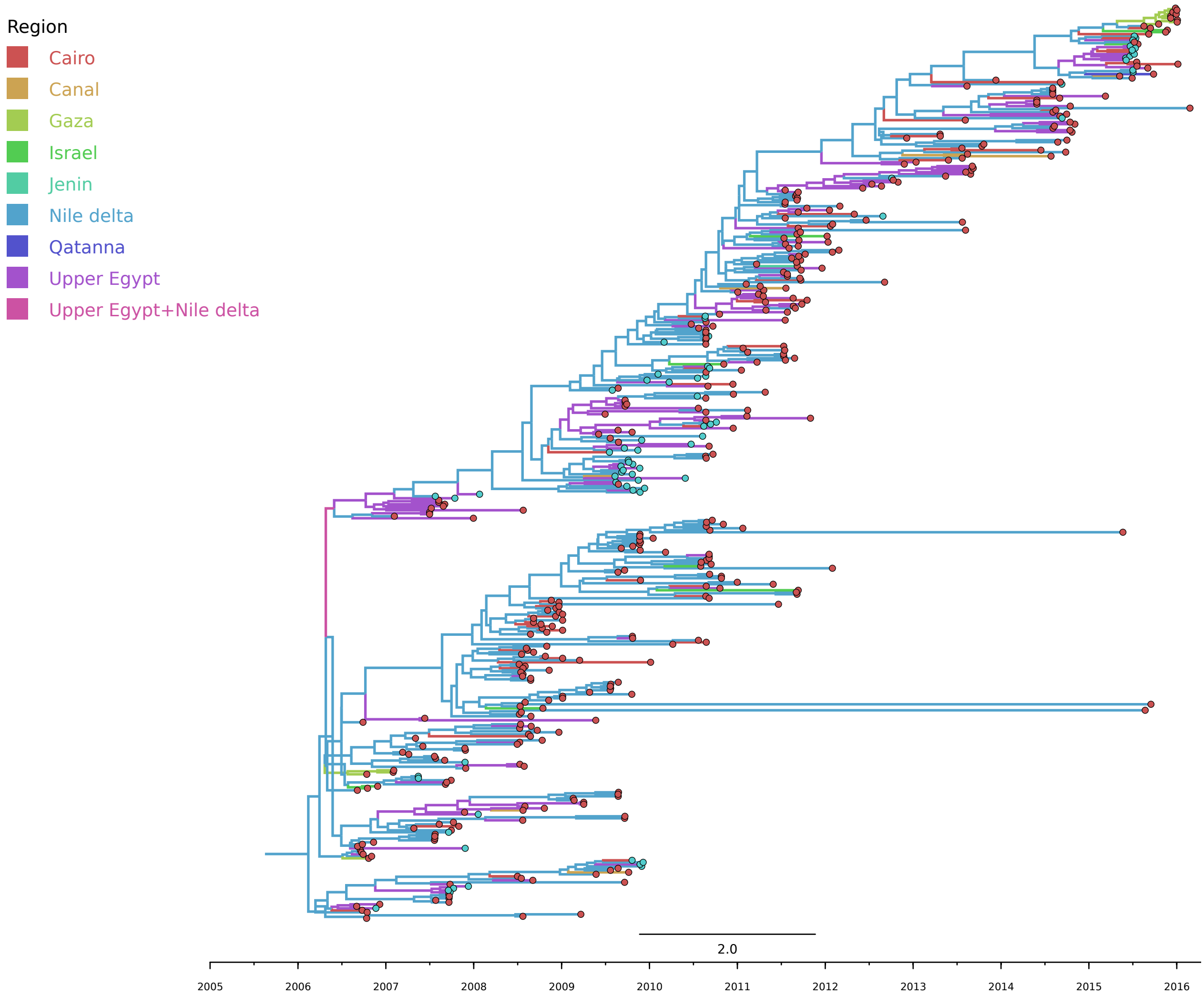


Figure 11. Time scaled phylogenetic MCC trees for H5N1 HA gene sequences from three countries in the period from 2006 to 2016.

Tips were colored according to the host. Human and avian viruses identified with light blue and red fixed size circles, respectively. Branches were colored according to the geographic origin.

Introductions of H5N1 virus in Egypt and neighboring countries

Phylogenetic tree of HA gene of H5N1 virus of Egypt, Gaza, Israel, and Qatana showed that Egyptian viruses ae the main source of the outbreaks occurred in the neighboring countries which affected with the same viruses at the same time. Viruses from Gaza, Israel, and Qatana were interspread with the Egyptian viruses, and subsequently the source of the virus introduction into Egypt is from countries other than those regions. I analyzed the trunk of the tree and found that for clade 2.2, 2.2.1.1, and 2.2.1.2 the Nile delta region represents the sampling location of the common ancestor of the source of the virus introduction, however clade 2.2.1.1 showed that the common ancestor was sampled from the Upper Egypt region (Figure 12). I analyzed yearly origin of virus introductions along the phylogeny's trunk by calculating the frequency of each geographic region to be located at the trunk of the tree at each year from 2005 to 2016. Table 1 shows the yearly origin of the virus depending on the frequency of each region per year, separately. As there might be more than one region located at the trunk of the phylogeny at a certain year, I calculated the proportion of abundance for each region at that specific year (Table 1). From this analysis I found that, in 2006, there were 6 introductions from two regions, 4 from the Nile Delta region and 2 from Upper Egypt. By calculating the proportion of each region in the year, I found that the Nile Delta region represent 60% of the abundance in 2006, more than the Upper Egypt which represents ~30% of the virus abundance. 2007 showed the same situation as 2006, where the virus' introductions from Nile delta region was more abundant than the Upper Egypt. From 2008 to 2014 the was only introductions from the Nile Delta, however in 2015, Gaza showed around 80% of the virus introductions, outperforming the Nile Delta region. Overall analysis of the percentile of abundance along the trunk of phylogenetic tree, we found that most of the viruses were isolated from the Nile delta region in Egypt as in Table 2.

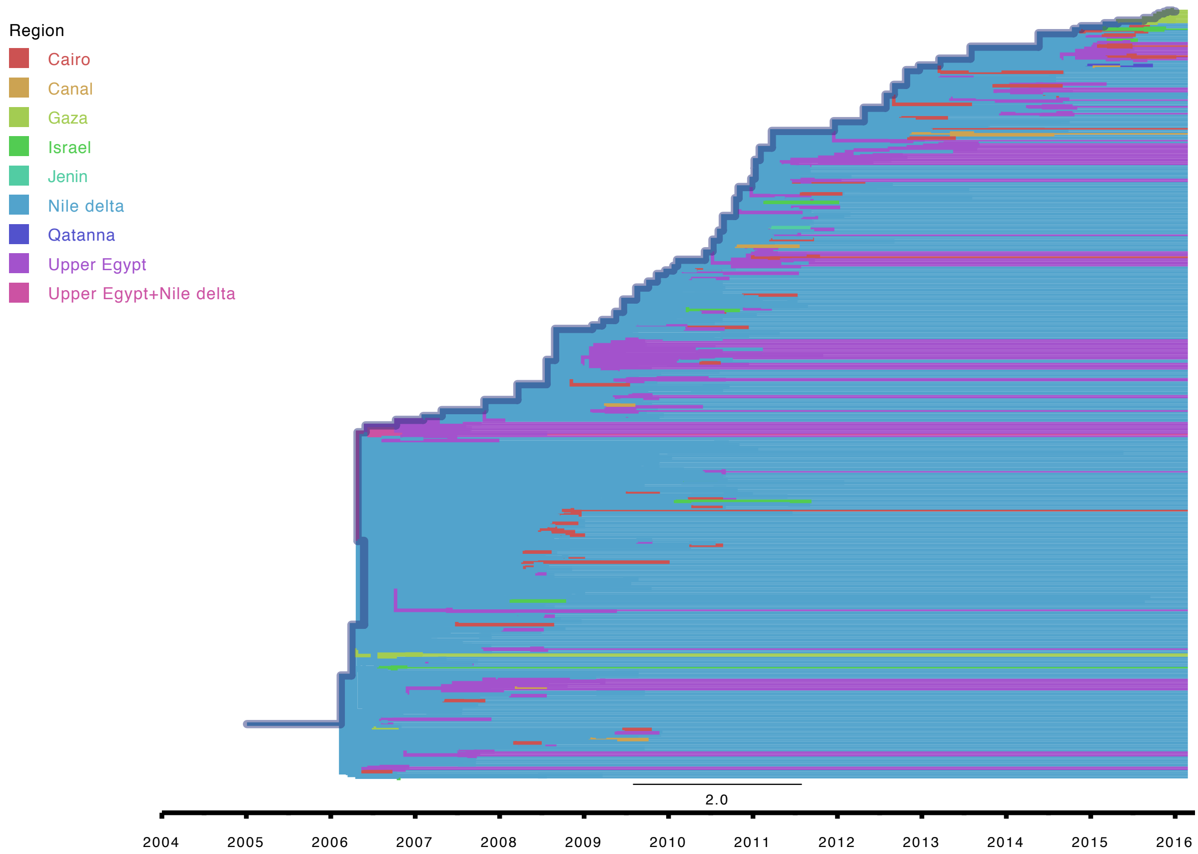


Figure 12. Time scaled MCC tree of H5N1 virus isolated from different regions.

Trunk lineages of the tree is illustrated in dark blue bold lines. Background colors represent regions where the virus isolates were sampled (branches extend to the same level).

Table 1. Spatio-temporal analysis of the origin of H5N1 virus introductions.

Year	Region	No. sequences	Frequency	Proportion
2005	Nile Delta	1	1	1
2006	Nile Delta	6	4	0.67
2006	Upper Egypt	6	2	0.33
2007	Nile Delta	3	2	0.67
2007	Upper Egypt	3	1	0.33
2008	Nile Delta	4	4	1
2009	Nile Delta	7	7	1
2010	Nile Delta	8	8	1
2011	Nile Delta	4	4	1
2012	Nile Delta	5	5	1
2013	Nile Delta	3	3	1
2014	Nile Delta	3	3	1
2015	Gaza	9	7	0.78
2015	Nile Delta	9	2	0.22

Table 2. Percentile proportion of total introductions of the virus from each region along the trunk of the phylogeny.

Region	% Total introductions
Nile Delta	86.7684478
Upper Egypt	6.10687023
Gaza	7.12468193

Model comparison

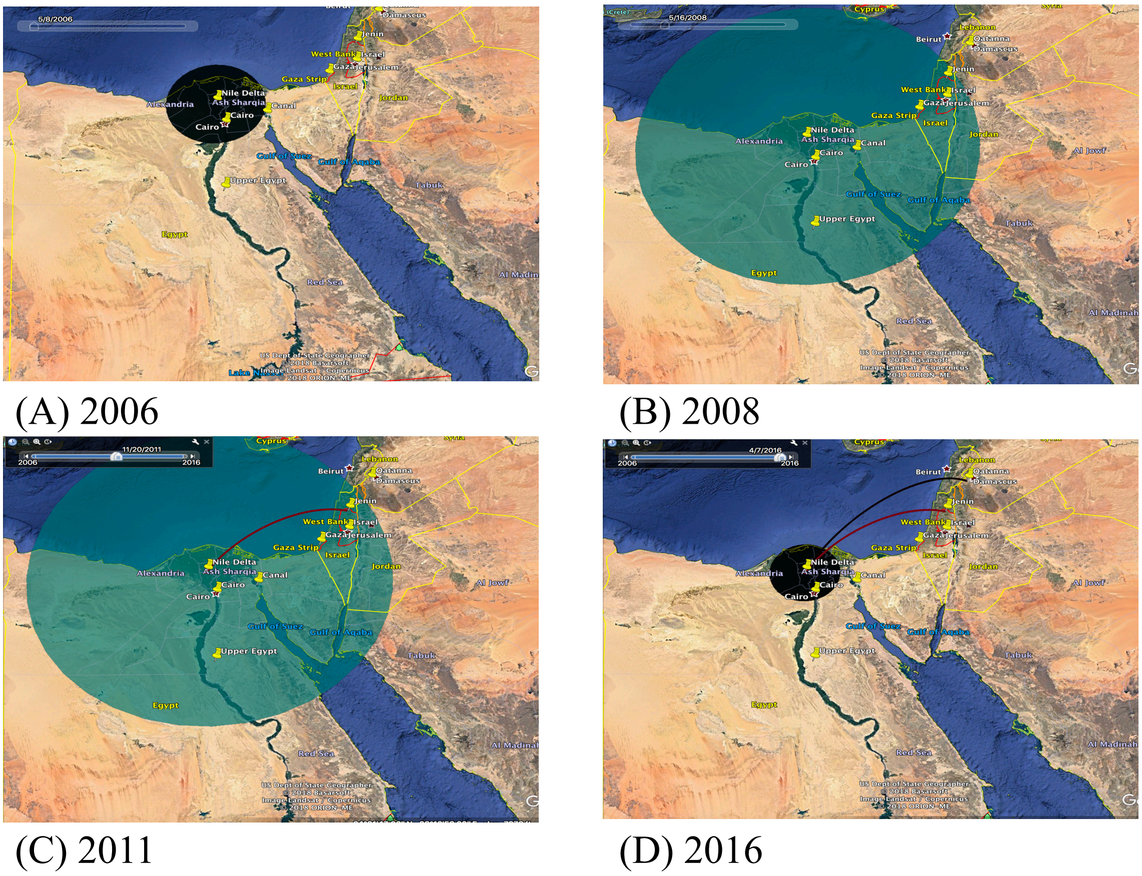
I used the Tracer software to compare molecular clock models by calculating the log likelihood values using Akaike information criteria (AIC) in a Bayesian Monte Carlo (AICM). Table 3 shows the computed AICM values for two models, lognormal-uncorrelated relaxed molecular clock and the random local molecular clock model. In this analysis, lognormal-uncorrelated relaxed molecular clock model shows lower estimates for the AICM than the random local clock model.

Table 3. Model comparison using AICM estimation.

Trace	AICM	Lognormal-uncorrelated relaxed	Random local clock
Lognormal-uncorrelated relaxed	38562.809	0	-1422.207
Random local clock	39755.05	-1422.207	0

Spatial spread of H5N1 in Middle Eastern countries.

Spatial projection in Figure 13 shows that there is a strong connection between the Nile delta region in Egypt and the virus introductions in Gaza, Jenin, Israel, and Qatana. A Long-range migration event was observed between the Nile delta region in Egypt and Jenin in the northern West bank, Palestine since 2011 (Figure 13 (C)). Another long transition took place in 2015 from Egypt, Nile delta region to Qatana in Syria. Spatio-temporal magnitude of genetic diversity was illustrated in Figure 13 through the circle radius, and node height values of the MCC tree are represented by colors changing from black (minimum) to red (maximum). The period from 2011 to 2016 showed no increase in the viral dispersal movements.



(A) 2006 (B) 2008

(C) 2011 (D) 2016

Figure 13. Spatio-temporal spread of H5N1 in Egypt and other Middle Eastern countries.

Circle radiuses are proportional to lineage diversity. Long-range migration event was displayed as long branch between Egypt and Jenin, and Egypt and Qatana.

Discussion

Understanding the spread of H5N1 influenza virus is a crucial for surveillance and vaccine strain selection. I analyzed the geographic spread of the virus using epidemiological and virological data over a period of 10 years from Egypt and some other Mediterranean countries. This study analyzed the spatial dynamics of H5N1 virus spread and transmission. I identified the evolutionary tempo and mode among Egypt and the other countries that were affected by the same outbreak between 2006 and 2016 (Figure 10).

This study highlighted the complex history of the H5N1 virus and the countrywide spread during a small time period. The introduction of the virus into Egypt seems to be happened in 2005, while the virus was introduced into Gaza and Israel in 2006, Jenin in late 2010, and Qatana in late 2014. The spread of the virus seems to be started from Egypt towards the Other 4 regions in the neighboring countries near by the eastern borders of Egypt. Clade 2.2.1.1 appeared in 2007 in Egypt and circulated in Egypt, Gaza, Israel.

Phylogeographic analysis suggested that human viruses in the phylogenetic tree were distributed into clades 2.2, 2.2.1, and 2.2.1.2, However clade 2.2.1.1 which hypothesized to be a vaccine skip mutant does not show any human viruses (G. Kayali et al., 2016). Clade 2.2.1.1 evolved from clade 2.2.1 in 2008 as shown in the phylogeographic tree in figure 11. Molecular clock analysis confirmed this deviation in the avian virus' signal in 2008 (figure 10).

I used HA gene sequences of H5N1 viruses sampled from Egypt, Palestine, and Syria to examine the evolution and spatial dispersion of H5N1 virus. Assuming the number of genetic sequences is indicator for H5N1 viruses' evolution, I analyzed the yearly change in the number of H5N1 influenza virus available in the NCBI influenza virus resources (Figure 9). From 2006 to 2016 the number of available sequences appears as waives of increases and decreases either due to virus evolution, outbreak occurrence or missing bias. In 2006, the virus was first introduced into Egypt causing outbreak among poultry with a certain number of avian to human transmissions in 2006-2007 (Aly et al., 2008). In 2008 the H5N1 virus became enzootic among poultry represented as increased number of avian sequences (cases), but fewer human cases were reported. 2009 showed increase in the human cases and avian cases, and this could be related to either increased human susceptibility to the virus or increased viruses evolution in avian population. Between 2009 and 2011, the number of avian sequences increased as clade 2.2.1.1. The large increase in poultry cases was due to the mass vaccination strategies that had started since late 2006 and three years on, their efficiency became limited (Peyre et al., 2016). From 2011 to 2013 both avian and human cases were decreased as there were no reports about new virus strains. By late 2014, further evolution of these clades resulted in the new clade 2.2.1.2, which was circulating in 2015 and caused increase in the number of avian cases, but interestingly the human cases reported were low (A. S. Arafa et al., 2015). This decrease in human cases could be revealed to the lower pathogenicity of the new virus strain toward humans.

Analysis of the introductions of H5N1 virus in Egypt and neighboring countries supported that the Nile Delta region in Egypt is the origin of the outbreak since it represents the first introduction of the virus in 2005. Yearly analysis of the virus introductions supported that the Nile Delta regions represents the origin of the introductions across the years from 2005 to 2014. In 2015, Gaza showed the largest number of virus introductions across the year, and the virus could be transmitted from there to Egypt at a certain time point in 2015.

I found well-supported migration paths between Egypt and Jenin in 2011 and Egypt and Qatana in 2015 as shown in Figure 13. Such long distances transitions most probably occurred because of either the migratory birds or due to poultry trade between countries.

Model comparison using AICM indicated that lognormal uncorrelated relaxed clock model is better fitting with our data, showing lower estimates for AICM = 38562.809.

Our analysis agree with the previous study by Scotch et al., about phylogeography of influenza A H5N1 clade 2.2.1.1 in Egypt (Scotch et al., 2013), where we confirmed that the most of the introduction of the H5N1 virus in Egypt were from the most populated Nile Delta region. By including more data from the countries that were affected by the same outbreak, Gaza, Israel, Syrian, I also confirmed that the Nile Delta region was the origin of the virus introductions from 2005 to 2014. 2015 showed higher abundance of virus introductions from Gaza, and there still remains uncertainty about the virus spread from to this region and further research is needed.

Summary

Rapidly evolving viruses can accumulate genetic variation while spreading in time and space. Virus genes become a good source for understanding the virus dynamics, epidemics, spread, and evolution. I applied phylogeography to investigate H5N1 avian influenza viruses in Egypt and its neighboring countries, Gaza, Israel, and Qatana. In this study I found that the Nile Delta region was the origin of the virus introductions from 2005 to 2014. 2015 showed higher abundance of virus introductions from Gaza, however, it still remains uncertainty about the direction of virus transmission between these regions, and further research is needed.

Conclusion

In conclusion human-to-human transmission of H5N1 viruses in Egypt is limited. The large increase in human cases is most probably attributed to other factor than increase in human-to-human transmission potential. Nile Delta region is the major origin of the virus introductions in poultry population from 2005 to 2014, and Egyptian viruses in poultry are the main source of the outbreaks that occurred in the neighboring countries including Gaza, Israel, and Qatana. These results suggested that a strategy containing virus transmissions in avian populations in Egypt, especially in Nile delta region is a key to control H5N1 infections among both human and avian populations in Egypt and its neighboring countries.

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Appendix

Table S 1. The GenBank accession numbers, strain names, sampling dates, and sampling locations of nucleotide sequences from Egypt.

Accession number	Host	Strain name	Sampling date	Sampling location
EF535822	Human	A/Egypt/2321-NAMRU3/2007(H5N1)	3/13/07	Aswan
CY062439	Human	A/Egypt/7021-NAMRU3/2006(H5N1)	5/16/06	Menia
KP702165	Human	A/Egypt/MOH-NRC-7271/2014(H5N1)	11/26/14	Menia
KP702173	Human	A/Egypt/MOH-NRC-7305/2014(H5N1)	11/28/14	Menia
KR063683	Human	A/Egypt/MOH-NRC-8434/2014(H5N1)	12/27/14	Menoufiya
CY041908	Human	A/Egypt/N00001/2009(H5N1)	1/11/09	Giza
KP864432	Human	A/Egypt/N0001/2015(H5N1)	1/1/15	Menoufiya
KP864433	Human	A/Egypt/N0002/2015(H5N1)	1/1/15	Menia
KP864434	Human	A/Egypt/N0004/2015(H5N1)	1/5/15	Aswan
KP864435	Human	A/Egypt/N0005/2015(H5N1)	1/7/15	Cairo
CY062464	Human	A/Egypt/N00269/2010(H5N1)	1/11/10	Beni Suef
CY062466	Human	A/Egypt/N00270/2010(H5N1)	1/12/10	Daqahlia
CY041910	Human	A/Egypt/N00585/2009(H5N1)	1/23/09	Menoufiya
CY041912	Human	A/Egypt/N00605/2009(H5N1)	2/3/09	Suez
CY041914	Human	A/Egypt/N00606/2009(H5N1)	2/7/09	Menia
JX456101	Human	A/Egypt/N00951/2012(H5N1)	2/21/12	Behaira
CY041916	Human	A/Egypt/N01310/2009(H5N1)	2/28/09	Fayoum
CY062468	Human	A/Egypt/N01360/2010(H5N1)	2/2/10	Qalubiya
CY062470	Human	A/Egypt/N01644/2010(H5N1)	2/7/10	Helwan

KM392416	Human	A/Egypt/N01753/2014(H5N1)	3/6/14	Behaira
KM392417	Human	A/Egypt/N01754/2014(H5N1)	3/7/14	Demiatta
CY062474	Human	A/Egypt/N02038/2010(H5N1)	2/15/10	Daqahlia
CY041918	Human	A/Egypt/N02039/2009(H5N1)	3/3/09	Alexandria
CY062476	Human	A/Egypt/N02127/2010(H5N1)	2/13/10	Kafr el sheikh
JX456104	Human	A/Egypt/N02137/2012(H5N1)	3/29/12	Giza
CY041920	Human	A/Egypt/N02407/2009(H5N1)	3/9/09	Menoufiya
CY062478	Human	A/Egypt/N02554/2010(H5N1)	2/23/10	Qalubiya
CY041922	Human	A/Egypt/N02563/2009(H5N1)	3/14/09	Assuit
CY041924	Human	A/Egypt/N02752/2009(H5N1)	3/24/09	Qena
CY062480	Human	A/Egypt/N02770/2010(H5N1)	2/27/10	Qalubiya
CY062482	Human	A/Egypt/N03071/2010(H5N1)	3/3/10	Kafr el sheikh
CY062484	Human	A/Egypt/N03072/2010(H5N1)	3/7/10	Cairo
CY041926	Human	A/Egypt/N03228/2009(H5N1)	3/30/09	Menoufiya
CY041928	Human	A/Egypt/N03272/2009(H5N1)	4/1/09	Behaira
CY041930	Human	A/Egypt/N03434/2009(H5N1)	4/15/09	Kafr el sheikh
CY041932	Human	A/Egypt/N03438/2009(H5N1)	4/16/09	Cairo
CY041934	Human	A/Egypt/N03439/2009(H5N1)	4/18/09	Kafr el sheikh
CY041936	Human	A/Egypt/N03450/2009(H5N1)	4/19/09	Sohag
CY041938	Human	A/Egypt/N04316/2009(H5N1)	5/9/09	Sohag
CY041940	Human	A/Egypt/N04394/2009(H5N1)	5/11/09	Sharqiya
CY041943	Human	A/Egypt/N04396/2009(H5N1)	5/17/09	Daqahlia
CY062486	Human	A/Egypt/N04434/2010(H5N1)	3/31/10	Fayoum
CY041945	Human	A/Egypt/N04526/2009(H5N1)	5/18/09	Daqahlia
CY041947	Human	A/Egypt/N04527/2009(H5N1)	5/18/09	Sohag

CY041949	Human	A/Egypt/N04822/2009(H5N1)	5/25/09	Sharqiya
CY041951	Human	A/Egypt/N04823/2009(H5N1)	5/25/09	Sharqiya
CY041953	Human	A/Egypt/N04979/2009(H5N1)	5/31/09	Kafr el sheikh
CY041955	Human	A/Egypt/N05056/2009(H5N1)	6/6/09	Daqahlia
CY062447	Human	A/Egypt/N05912/2009(H5N1)	6/16/09	Kafr el sheikh
CY062453	Human	A/Egypt/N08835/2009(H5N1)	8/1/09	Menoufiya
CY062455	Human	A/Egypt/N09174/2009(H5N1)	8/26/09	Menoufiya
CY062457	Human	A/Egypt/N09539/2009(H5N1)	9/16/09	Alexandria
CY062459	Human	A/Egypt/N11981/2009(H5N1)	11/22/09	Menia
KP864426	Human	A/Egypt/N5560/2014(H5N1)	12/15/14	Assuit
KP864427	Human	A/Egypt/N5561/2014(H5N1)	12/14/14	Menia
KP864428	Human	A/Egypt/N5563/2014(H5N1)	12/23/14	Menia
KP864429	Human	A/Egypt/N5564/2014(H5N1)	12/26/14	Helwan
KP864430	Human	A/Egypt/N5565/2014(H5N1)	12/24/14	Assuit
KP864431	Human	A/Egypt/N5566/2014(H5N1)	12/26/14	Giza
CY062472	Human	A/Egypt/N01982/2010(H5N1)	2/12/10	Menoufiya
LC106066	Avian	A/chicken/Ismailia/144CA/2014	11/1/14	Ismailia
LC106067	Avian	A/chicken/Sharkeya/14209SS/2014	12/23/14	Sharkeya
LC106068	Avian	A/chicken/Kafr_Elsheikh/UT-151CAD/2015	1/1/15	Kafr_Elsheikh
LC106069	Avian	A/duck/Cairo/157CA/2015	1/11/15	Cairo
LC106070	Avian	A/duck/Menia/1543S/2015	1/12/15	Menia
LC106071	Avian	A/turkey/Menia/15248S/2015	2/26/15	Menia
LC106072	Avian	A/duck/Cairo/1578CA/2015	3/2/15	Cairo
LC106073	Avian	A/duck/Dakahlia/1536CAG/2015	2/10/15	Dakahlia

LC106074	Avian	A/duck/Giza/15292S/2015	3/9/15	Giza
LC093071	Avian	A/Pigeon/Egypt/RIMD18/2009	1/1/09	Egypt
LC093079	Avian	A/Pigeon/Egypt/RIMD20/2009	1/1/09	Alexandria
KY951986	Avian	A/chicken/Behera/1/2015	3/11/15	Behaira
KY951987	Avian	A/chicken/Dakahlia/2/2015	8/20/15	Dakahlia
KF178948	Avian	A/chicken/Egypt/0626/2006	2/28/06	Alexandria
EU372944	Avian	A/chicken/Egypt/06459-3-NLQP/2006	3/13/06	Menoufiya
EU372945	Avian	A/chicken/Egypt/06495-NLQP/2006	3/17/06	Sharkia
EU372946	Avian	A/chicken/Egypt/06541-NLQP/2006	3/20/06	Cairo
EU496383	Avian	A/chicken/Egypt/06553-NLQP/2006	3/21/06	Damitta
KR732525	Avian	A/chicken/Egypt/06553-NLQP/2006	1/1/06	Egypt
EU496384	Avian	A/chicken/Egypt/06612-NLQP/2006	3/24/06	Sohag
EU372947	Avian	A/chicken/Egypt/06959-NLQP/2006	11/27/06	Gharbia
GQ184214	Avian	A/chicken/Egypt/07118-NLQP/2007	3/1/07	Qalyobia
KR732539	Avian	A/chicken/Egypt/07118-NLQP/2007	1/1/07	Egypt
EU496386	Avian	A/chicken/Egypt/07125-NLQP/2007	4/3/07	Behaira
EU496389	Avian	A/chicken/Egypt/07202-NLQP/2007	12/19/07	Quena
GQ184216	Avian	A/chicken/Egypt/07480S-NLQP/2007	6/25/07	Luxor
EU496396	Avian	A/chicken/Egypt/07665S-NLQP/2007	12/24/07	Sharkia
GQ184219	Avian	A/chicken/Egypt/0811-NLQP/2008	1/4/08	Luxor
GQ184246	Avian	A/chicken/Egypt/08124S-NLQP/2008	1/10/08	Behaira
KR732574	Avian	A/chicken/Egypt/0813-NLQP/2008	1/1/08	Egypt
GQ184247	Avian	A/chicken/Egypt/08139S-NLQP/2008	1/11/08	Qalyobia
GQ184221	Avian	A/chicken/Egypt/0815-NLQP/2008	1/5/08	Qalyobia
GQ184222	Avian	A/chicken/Egypt/0823-NLQP/2008	1/7/08	Gharbia

JF746739	Avian	A/chicken/Egypt/0827-NLQP/2008	1/1/08	Egypt
JF746737	Avian	A/chicken/Egypt/083-NLQP/2008	1/1/08	Egypt
CY044032	Avian	A/chicken/Egypt/083/2008	1/2/08	Gharbia
GQ184223	Avian	A/chicken/Egypt/0831-NLQP/2008	1/10/08	Qalyobia
CY041290	Avian	A/chicken/Egypt/0836/2008	1/15/08	Luxor
GQ184224	Avian	A/chicken/Egypt/0837-NLQP/2008	1/17/08	Qalyobia
GQ184249	Avian	A/chicken/Egypt/08371S-NLQP/2008	2/9/08	Menoufiya
GQ184225	Avian	A/chicken/Egypt/0838-NLQP/2008	1/16/08	Menia
GQ184226	Avian	A/chicken/Egypt/0841-NLQP/2008	1/17/08	Suez
GQ184228	Avian	A/chicken/Egypt/0847-NLQP/2008	1/18/08	Fayoum
GQ184218	Avian	A/chicken/Egypt/085-NLQP/2008	1/3/08	Alexandria
GQ184229	Avian	A/chicken/Egypt/0850-NLQP/2008	1/22/08	Luxor
GQ184230	Avian	A/chicken/Egypt/0855-NLQP/2008	1/26/08	Qalyobia
GQ184231	Avian	A/chicken/Egypt/0859-NLQP/2008	1/31/08	Qalyobia
GQ184232	Avian	A/chicken/Egypt/0865-NLQP/2008	2/6/08	Giza
GQ184233	Avian	A/chicken/Egypt/0869h3-NLQP/2008	2/19/08	Sharkia
GQ184234	Avian	A/chicken/Egypt/0870-NLQP/2008	2/17/08	Cairo
GQ184236	Avian	A/chicken/Egypt/0876-NLQP/2008	4/6/08	Qalyobia
GQ184238	Avian	A/chicken/Egypt/0879-NLQP/2008	5/14/08	6th of October
GQ184239	Avian	A/chicken/Egypt/0880-NLQP/2008	5/18/08	Giza
EU496399	Avian	A/chicken/Egypt/088S-NLQP/2008	1/1/08	Dakahlia
CY041298	Avian	A/chicken/Egypt/0891/2008	9/26/08	Fayoum
GQ184241	Avian	A/chicken/Egypt/0894-NLQP/2008	11/27/08	Menia
GQ184242	Avian	A/chicken/Egypt/0896-NLQP/2008	12/24/08	Menia
GU002703	Avian	A/chicken/Egypt/0910QL-NLQP/2009	4/1/09	Luxor

HQ198254	Avian	A/chicken/Egypt/091317s/2009	12/1/09	Menoufiya
JF746741	Avian	A/chicken/Egypt/0918-NLQP/2009	2/1/09	Egypt
GU002687	Avian	A/chicken/Egypt/0918Q-NLQP/2009	3/1/09	Qalyobia
GU002672	Avian	A/chicken/Egypt/092-NLQP/2009	1/1/09	Menoufiya
GU002700	Avian	A/chicken/Egypt/0920-NLQP/2009	2/1/09	Menoufiya
GU002690	Avian	A/chicken/Egypt/09279S-NLQP/2009	4/1/09	Egypt
GU002692	Avian	A/chicken/Egypt/09359S-NLQP/2009	4/1/09	Sharkia
GU002693	Avian	A/chicken/Egypt/09519S-NLQP/2009	5/1/09	Qalyobia
GU002695	Avian	A/chicken/Egypt/09568S-NLQP/2009	5/1/09	Egypt
HQ198252	Avian	A/chicken/Egypt/095941v/2009	5/1/09	Qalyobia
GU002680	Avian	A/chicken/Egypt/0960-NLQP/2009	3/1/09	Behaira
GU002698	Avian	A/chicken/Egypt/096293V-NLQP/2009	5/1/09	Qalyobia
GU002688	Avian	A/chicken/Egypt/0962S-NLQP/2009	2/1/09	Behaira
GU002689	Avian	A/chicken/Egypt/0963S-NLQP/2009	2/1/09	Sharkia
GU002705	Avian	A/chicken/Egypt/096767V-NLQP/2009	5/1/09	Qalyobia
KR732527	Avian	A/chicken/Egypt/096L-NLQP/2009	1/1/09	Egypt
GU002683	Avian	A/chicken/Egypt/0975-NLQP/2009	4/1/09	Kafr-Elshikh
GU366078	Avian	A/chicken/Egypt/0987-NLQP/2009	5/12/09	Egpt
CY061552	Avian	A/chicken/Egypt/1/2008	1/1/08	Qalubiya
FR687255	Avian	A/chicken/Egypt/1/2009	1/1/09	Qalubiya
JN807782	Avian	A/chicken/Egypt/10112SG/2010	6/26/10	Dakahlia
HQ198281	Avian	A/chicken/Egypt/10116s/2010	2/1/10	Qalyobia
HQ198274	Avian	A/chicken/Egypt/10127s/2010	2/1/10	Helwan
HQ198275	Avian	A/chicken/Egypt/1012sf/2010	2/1/10	Fayoum
JN807801	Avian	A/chicken/Egypt/10132/2010	10/21/10	6th of October

JN807777	Avian	A/chicken/Egypt/10158SF/2010	4/29/10	Beni Suif
HQ198295	Avian	A/chicken/Egypt/10159s/2010	3/1/10	Qalyobia
HQ198277	Avian	A/chicken/Egypt/101604v/2010	2/1/10	New valley
HQ198290	Avian	A/chicken/Egypt/1020d/2010	3/1/10	Alexandria
JN807775	Avian	A/chicken/Egypt/1021AD/2010	4/13/10	Alexandria
HQ198292	Avian	A/chicken/Egypt/1021L/2010	2010/03/	Luxor
JN807788	Avian	A/chicken/Egypt/10250SF/2010	8/2/10	Beni Suif
JN807792	Avian	A/chicken/Egypt/10259SF/2010	8/8/10	Beni Suif
HQ198296	Avian	A/chicken/Egypt/10265s/2010	4/1/10	Menia
HQ198261	Avian	A/chicken/Egypt/1029/2010	1/1/10	Menoufiya
HQ198270	Avian	A/chicken/Egypt/102d/2010	2/1/10	Behaira
KR732445	Avian	A/chicken/Egypt/102d/2010	1/1/10	Egypt
HQ198263	Avian	A/chicken/Egypt/1034/2010	2/1/10	Menoufiya
JN807802	Avian	A/chicken/Egypt/10347SF/2010	10/23/10	Fayoum
HQ198280	Avian	A/chicken/Egypt/1034qd/2010	2/1/10	Alexandria
HQ198264	Avian	A/chicken/Egypt/1035/2010	2/1/10	Egypt
JN807790	Avian	A/chicken/Egypt/1038AL/2010	8/5/10	Luxor
JN807804	Avian	A/chicken/Egypt/10413SF/2010	12/10/10	Egypt
JN807772	Avian	A/chicken/Egypt/1041AG/2010	1/27/10	Dakahlia
HQ198266	Avian	A/chicken/Egypt/1042/2010	2/1/10	Helwan
JN807784	Avian	A/chicken/Egypt/10432S/2010	7/13/10	Qalyobia
HQ198255	Avian	A/chicken/Egypt/1050ss/2010	1/1/10	Sharkia
JN807803	Avian	A/chicken/Egypt/10512AG/2010	11/22/10	Dakahlia
JN807797	Avian	A/chicken/Egypt/10513S/2010	9/29/10	Menoufiya
HQ198284	Avian	A/chicken/Egypt/1052g/2010	2/1/10	Qalyobia

HQ198269	Avian	A/chicken/Egypt/1063/2010	2/1/10	Qalyobia
KR732550	Avian	A/chicken/Egypt/1063/2010	1/1/10	Egypt
HQ198278	Avian	A/chicken/Egypt/1071g/2010	2/1/10	Dakahlia
EF441276	Avian	A/chicken/Egypt/1078-NAMRU3/2006	6/28/05	Menoufiya
EF441277	Avian	A/chicken/Egypt/1079-NAMRU3/2007	1/1/06	Beni suif
EF441278	Avian	A/chicken/Egypt/1080-NAMRU3/2006	1/1/06	Damietta
EF441279	Avian	A/chicken/Egypt/1081-NAMRU3/2006	1/1/06	Gharbiya
JN807778	Avian	A/chicken/Egypt/1090/2010	6/8/10	6th of October
JN807785	Avian	A/chicken/Egypt/1098/2010	7/19/10	Qalyobia
FJ686839	Avian	A/chicken/Egypt/10NLQP-CLEVB299/2008	4/19/08	Dakahlya
JN807812	Avian	A/chicken/Egypt/1112/2011	1/10/11	Menoufiya
JN807855	Avian	A/chicken/Egypt/11124SF/2011	3/16/11	Beni Sueif
JN807847	Avian	A/chicken/Egypt/1112AF/2011	3/6/11	Fayoum
JN807813	Avian	A/chicken/Egypt/1113/2011	1/11/11	Qalyobia
JN807808	Avian	A/chicken/Egypt/1115S/2011	1/5/11	Qalyobia
JN807839	Avian	A/chicken/Egypt/111640V/2011	2/23/11	Sharkia
JN807817	Avian	A/chicken/Egypt/1117/2011	1/12/11	Qalyobia
JN807845	Avian	A/chicken/Egypt/111766V/2011	3/1/11	Sharkia
JN807858	Avian	A/chicken/Egypt/1117AF/2011	3/21/11	Fayoum
JN807841	Avian	A/chicken/Egypt/11184S/2011	2/27/11	Menoufiya
JN807852	Avian	A/chicken/Egypt/111945V/2011	3/13/11	Menoufiya
JN807821	Avian	A/chicken/Egypt/111AF/2011	1/20/11	Fayoum
JN807865	Avian	A/chicken/Egypt/1123AL/2011	4/26/11	Luxor
EF469650	Avian	A/chicken/Egypt/1129N3-HK9/2007	1/1/07	Fayoum

JN807822	Avian	A/chicken/Egypt/112AF/2011	1/20/11	Fayoum
JN807807	Avian	A/chicken/Egypt/112SG/2011	1/4/11	Dakahlia
JN807846	Avian	A/chicken/Egypt/1134SD/2011	3/3/11	Gharbia
JQ858472	Avian	A/chicken/Egypt/113Q/2011	7/26/11	Qalyobia
JN807809	Avian	A/chicken/Egypt/115/2011	1/5/11	6th of October
JQ858469	Avian	A/chicken/Egypt/11506SF/2011	7/8/11	Menia
JN807867	Avian	A/chicken/Egypt/11529S/2011	6/13/11	Luxor
JN807856	Avian	A/chicken/Egypt/1155/2011	3/17/11	Helwan
JN807818	Avian	A/chicken/Egypt/1156S/2011	1/12/11	Menoufiya
JN807830	Avian	A/chicken/Egypt/1158SF/2011	1/27/11	Fayoum
JN807840	Avian	A/chicken/Egypt/115AD/2011	2/26/11	Behaira
JN807825	Avian	A/chicken/Egypt/115AF/2011	1/20/11	Fayoum
JQ858475	Avian	A/chicken/Egypt/11667s/2011	7/27/11	Menoufiya
JQ858473	Avian	A/chicken/Egypt/11672s/2011	7/26/11	Menoufiya
JN807843	Avian	A/chicken/Egypt/116AD/2011	3/1/11	Behaira
JN807832	Avian	A/chicken/Egypt/116AF/2011	2/7/11	Beni Suif
JN807819	Avian	A/chicken/Egypt/1174S/2011	1/14/11	Suez
JQ858471	Avian	A/chicken/Egypt/1176/2011	7/18/11	Giza
JQ858482	Avian	A/chicken/Egypt/11765s/2011	12/13/11	Menoufiya
JN807844	Avian	A/chicken/Egypt/117AD/2011	3/1/11	Behaira
JN807834	Avian	A/chicken/Egypt/117AF/2011	2/14/11	Fayoum
JQ858479	Avian	A/chicken/Egypt/1188/2011	10/25/11	Giza
JN807835	Avian	A/chicken/Egypt/118AF/2011	2/16/11	Egypt
JN807836	Avian	A/chicken/Egypt/1197AG/2011	2/19/11	Dakahlia
JN807806	Avian	A/chicken/Egypt/119S/2011	1/4/11	Qalyobia

JQ858483	Avian	A/chicken/Egypt/121/2012	1/6/12	Menia
KJ522716	Avian	A/chicken/Egypt/12107S/2012	10/17/12	Giza
KJ522713	Avian	A/chicken/Egypt/1213CAL/2012	4/24/12	Sohag
JQ858488	Avian	A/chicken/Egypt/12186F-12/2012	2/1/12	Egypt
JQ858487	Avian	A/chicken/Egypt/12186F-9/2012	2/1/12	Egypt
KJ522714	Avian	A/chicken/Egypt/12257CA/2012	5/30/12	Qalubiya
EF469651	Avian	A/chicken/Egypt/12378N3-CLEVB/2006	1/1/06	Gharbiya
EF469652	Avian	A/chicken/Egypt/12379N3-CLEVB/2006	1/1/06	Sharqiya
KJ522708	Avian	A/chicken/Egypt/123AS/2012	2/28/12	Dakahlia
KJ522712	Avian	A/chicken/Egypt/1273CA/2012	4/12/12	Kafr Elsheikh
EF441280	Avian	A/chicken/Egypt/1300-NAMRU3/2007	1/1/07	Gharbiya
KJ522745	Avian	A/chicken/Egypt/13153S/2013	12/9/13	Giza
KJ522728	Avian	A/chicken/Egypt/1320S/2013	2/7/13	Suez
KJ522734	Avian	A/chicken/Egypt/1335S/2013	2/23/13	New valley
KJ522726	Avian	A/chicken/Egypt/134AD/2013	1/30/13	Behaira
KJ522739	Avian	A/chicken/Egypt/13639V/2013	4/16/13	Menoufiya
KP209296	Avian	A/chicken/Egypt/1411CAL/2014	3/26/14	Qena
KP209299	Avian	A/chicken/Egypt/14126S/2014	4/9/14	Assuit
KP209288	Avian	A/chicken/Egypt/1412SD/2014	1/28/14	Behaira
KP209301	Avian	A/chicken/Egypt/141VI/2014	4/14/14	Egypt
KP209287	Avian	A/chicken/Egypt/1422S/2014	1/28/14	Beni Sueif
KR002633	Avian	A/chicken/Egypt/1427AF/2014	9/3/14	Fayoum
KP209295	Avian	A/chicken/Egypt/1429AD/2014	3/22/14	Behaira
KP209289	Avian	A/chicken/Egypt/1429S/2014	2/3/14	Qalyobia
KP209292	Avian	A/chicken/Egypt/1460S/2014	2/25/14	Giza

KP209293	Avian	A/chicken/Egypt/1461S/2014	2/26/14	Assuit
KP209302	Avian	A/chicken/Egypt/147CA/2014	4/17/14	Assuit
FJ686841	Avian	A/chicken/Egypt/14NLQP-CLEVB255/2008	3/1/08	Dakahlya
KP035010	Avian	A/chicken/Egypt/14VIR784-10-136A/2013	2013//1/1/13	Egypt
KP035012	Avian	A/chicken/Egypt/14VIR784-11-133AL/2013	1/1/13	Egypt
KP035022	Avian	A/chicken/Egypt/14VIR784-5-1318S/2013	1/1/13	Egypt
FJ686843	Avian	A/chicken/Egypt/16NLQP-CLEVB242/2008	2/18/08	Dakahlya
EU717849	Avian	A/chicken/Egypt/1709-1VIR08/2007	2/25/07	Egypt
EU717853	Avian	A/chicken/Egypt/1709-4VIR08/2007	3/4/07	Egypt
EU717855	Avian	A/chicken/Egypt/1709-5/2008	1/8/08	Egypt
EU717857	Avian	A/chicken/Egypt/1709-6/2008	1/3/08	Egypt
FJ686844	Avian	A/chicken/Egypt/17NLQP-CLEVB241/2008	2/18/08	Sharkia
CY062601	Avian	A/chicken/Egypt/18-H/2009	6/1/09	Egypt
EF469653	Avian	A/chicken/Egypt/1889N3-SM26/2007	1/1/07	Giza
EF469654	Avian	A/chicken/Egypt/1890N3-HK45/2007	1/1/07	Gharbiya
EF469659	Avian	A/chicken/Egypt/1891N3-CLEVB/2007	1/1/07	Gharbiya
EF469660	Avian	A/chicken/Egypt/1892N3-HK49/2007	1/1/07	Gharbiya
FJ686831	Avian	A/chicken/Egypt/1NLQP-CLEVB331/2008	6/15/08	Giza

CY062602	Avian	A/chicken/Egypt/20-16/2009	6/1/09	Egypt
KP869097	Avian	A/chicken/Egypt/2010	12/14/10	Sharkia
FJ686846	Avian	A/chicken/Egypt/20NLQP-CLEVB238/2008	1/26/08	Sharkia
DQ862001	Avian	A/chicken/Egypt/2253-1/2006	6/1/06	Egypt
CY020645	Avian	A/chicken/Egypt/2253-1/2006	1/1/06	Egypt
FJ686847	Avian	A/chicken/Egypt/22NLQP-CLEVB232/2008	1/25/08	Fayoum
FJ686848	Avian	A/chicken/Egypt/23NLQP-CLEVB231/2008	1/17/08	Cairo
FJ686849	Avian	A/chicken/Egypt/24NLQP-CLEVB227/2008	1/8/08	Sharkia
EU373736	Avian	A/chicken/Egypt/2628-1/2007	1/1/07	Egypt
FJ686832	Avian	A/chicken/Egypt/2NLQP-CLEVB330/2008	6/15/08	Cairo
EU371898	Avian	A/chicken/Egypt/3044NAMRU3-CLEVB59/2007	1/1/07	Egypt
EU371899	Avian	A/chicken/Egypt/3045NAMRU3-CLEVB60/2007	1/2/07	Egypt
EU371900	Avian	A/chicken/Egypt/3046NAMRU3-CLEVB62/2007	1/3/07	Egypt
EU371903	Avian	A/chicken/Egypt/3049NAMRU3-CLEVB75/2007	1/4/07	Egypt
EU371905	Avian	A/chicken/Egypt/3051NAMRU3-CLEVB78/2007	1/5/07	Egypt

EU371906	Avian	A/chicken/Egypt/3052NAMRU3-CLEVB104/2007	1/6/07	Egypt
CY062603	Avian	A/chicken/Egypt/33-1/2008	7/2/08	Egypt
CY062604	Avian	A/chicken/Egypt/34-2/2008	7/2/08	Egypt
CY062605	Avian	A/chicken/Egypt/35-3/2008	7/2/08	Egypt
CY062606	Avian	A/chicken/Egypt/36-4/2008	7/2/08	Egypt
CY062607	Avian	A/chicken/Egypt/37-1/2008	7/2/08	Egypt
CY062608	Avian	A/chicken/Egypt/38-2/2008	7/2/08	Egypt
FJ686833	Avian	A/chicken/Egypt/3NLQP-CLEVB325/2008	6/2/08	Sharkia
FJ686834	Avian	A/chicken/Egypt/4NLQP-CLEVB308/2008	5/5/08	Dakahlya
FJ686835	Avian	A/chicken/Egypt/5NLQP-CLEVB307/2008	5/3/08	Qaliobia
CY062609	Avian	A/chicken/Egypt/6-A/2010	3/20/10	Egypt
FJ686836	Avian	A/chicken/Egypt/6NLQP-CLEVB306/2008	4/29/08	Dakahlya
FJ686837	Avian	A/chicken/Egypt/7NLQP-CLEVB305/2008	4/25/08	Qaliobia
CY062610	Avian	A/chicken/Egypt/8-C/2010	3/20/10	Egypt
FJ686838	Avian	A/chicken/Egypt/8NLQP-CLEVB304/2008	4/25/08	Qaliobia
EU371908	Avian	A/chicken/Egypt/9383NAMRU3-CLEVB112/2007	1/1/07	Egypt

EU371910	Avian	A/chicken/Egypt/9385NAMRU3-CLEVB125/2007	1/2/07	Egypt
EU371911	Avian	A/chicken/Egypt/9386NAMRU3-CLEVB136/2007	1/3/07	Egypt
EU371912	Avian	A/chicken/Egypt/9387NAMRU3-CLEVB148/2007	1/4/07	Egypt
EU371913	Avian	A/chicken/Egypt/9388NAMRU3-CLEVB149/2007	1/5/07	Egypt
EU371914	Avian	A/chicken/Egypt/9389NAMRU3-CLEVB150/2007	1/6/07	Egypt
EU371915	Avian	A/chicken/Egypt/9390NAMRU3-CLEVB157/2007	1/7/07	Egypt
EU371916	Avian	A/chicken/Egypt/9391NAMRU3-CLEVB158/2007	1/8/07	Egypt
EU371917	Avian	A/chicken/Egypt/9392NAMRU3-CLEVB167/2007	1/9/07	Egypt
EU371918	Avian	A/chicken/Egypt/9396NAMRU3-CLEVB187/2007	1/10/07	Egypt
EU371919	Avian	A/chicken/Egypt/9397NAMRU3-CLEVB188/2007	1/11/07	Egypt
EU371922	Avian	A/chicken/Egypt/9400NAMRU3-CLEVB211/2007	1/12/07	Egypt
KR063678	Avian	A/chicken/Egypt/A10351A/2014	11/23/14	Egypt
KU715927	Avian	A/chicken/Egypt/A10537B/2015	1/26/15	Egypt
KU715896	Avian	A/chicken/Egypt/A10540A/2015	1/26/15	Egypt

KU715873	Avian	A/chicken/Egypt/A10540D/2015	1/26/15	Egypt
KU715878	Avian	A/chicken/Egypt/A10540E/2015	1/26/15	Egypt
KU715922	Avian	A/chicken/Egypt/A10542C/2015	1/26/15	Egypt
KU715881	Avian	A/chicken/Egypt/A10543A/2015	1/26/15	Egypt
KU715899	Avian	A/chicken/Egypt/A10543B/2015	1/26/15	Egypt
KU715945	Avian	A/chicken/Egypt/A10544C/2015	1/26/15	Egypt
KU715893	Avian	A/chicken/Egypt/A10544D/2015	1/26/15	Egypt
KU715934	Avian	A/chicken/Egypt/A10758D/2015	7/3/15	Egypt
KU715917	Avian	A/chicken/Egypt/A10759B/2015	7/3/15	Egypt
KU715930	Avian	A/chicken/Egypt/A10759E/2015	7/3/15	Egypt
KT220528	Avian	A/chicken/Egypt/B9039A/2013	11/22/13	Beni-Sueif
KT220544	Avian	A/chicken/Egypt/B9040C/2013	11/22/13	Beni Suef
KT220560	Avian	A/chicken/Egypt/B9040D/2013	11/22/13	Beni Suef
KJ147497	Avian	A/chicken/Egypt/BSU-BS-F27/2012	5/20/12	Beni Suef
KJ147498	Avian	A/chicken/Egypt/BSU-BS-R24/2012	7/8/12	Beni Suef
KJ147493	Avian	A/chicken/Egypt/BSU-BS-R8/2009	3/17/09	Beni Suef
AB497020	Avian	A/chicken/Egypt/C1Li9/2007	3/1/07	Alexandria
AB497019	Avian	A/chicken/Egypt/C1Lu2/2007	3/1/07	Alexandria
AB551132	Avian	A/chicken/Egypt/C3Br11/2007	3/1/07	Alexandria
AB465592	Avian	A/chicken/Egypt/CL6/2007	3/1/07	Alexandria
KU715895	Avian	A/chicken/Egypt/D10547C/2015	1/27/15	Egypt
KU715969	Avian	A/chicken/Egypt/D10547E/2015	1/27/15	Egypt
KU715954	Avian	A/chicken/Egypt/D10548B/2015	1/27/15	Egypt
KU715939	Avian	A/chicken/Egypt/D10548D/2015	1/27/15	Egypt
KU715921	Avian	A/chicken/Egypt/D10551C/2015	1/27/15	Egypt

KU715926	Avian	A/chicken/Egypt/D10551D/2015	1/27/15	Egypt
KU715965	Avian	A/chicken/Egypt/D10552B/2015	1/27/15	Egypt
KU715968	Avian	A/chicken/Egypt/D10565A/2015	1/27/15	Egypt
KU715910	Avian	A/chicken/Egypt/D10566A/2015	1/27/15	Egypt
KU715937	Avian	A/chicken/Egypt/D10566C/2015	1/27/15	Egypt
KU715924	Avian	A/chicken/Egypt/D10566D/2015	1/27/15	Egypt
KU715918	Avian	A/chicken/Egypt/D10658E/2015	2/21/15	Egypt
JF357723	Avian	A/chicken/Egypt/F10/2009	6/10/09	Egypt
KY558844	Avian	A/chicken/Egypt/F12505E/2016	1/23/16	Egypt
EU183323	Avian	A/chicken/Egypt/F3/2006	6/1/06	Fayoum
EU183324	Avian	A/chicken/Egypt/F4/2006	12/5/06	Beni Suef
EU183326	Avian	A/chicken/Egypt/F6/2007	3/6/07	Beni Suef
JF357720	Avian	A/chicken/Egypt/F7/2009	3/17/09	Fayoum
JF357721	Avian	A/chicken/Egypt/F8/2009	3/24/09	Fayoum
JF357722	Avian	A/chicken/Egypt/F9/2009	4/1/09	Ismailia
KT220539	Avian	A/chicken/Egypt/F9514A/2014	1/27/14	Dakahliya
KT220549	Avian	A/chicken/Egypt/F9514B/2014	1/27/14	Dakahliya
KT220555	Avian	A/chicken/Egypt/F9514E/2014	1/27/14	Dakahliya
KT220534	Avian	A/chicken/Egypt/F9519D/2014	1/27/14	Dakahliya
KP326324	Avian	A/chicken/Egypt/Fadllah-7/2014	11/1/14	Menoufiya
JF746740	Avian	A/chicken/Egypt/G3H4-NLQP/2008	3/1/08	Egypt
CY099582	Avian	A/chicken/Egypt/M2773A/2011	1/19/11	Egypt
KF258179	Avian	A/chicken/Egypt/M7217A/2013	1/31/13	Egypt
KF732012	Avian	A/chicken/Egypt/M7217B/2013	1/31/13	Egypt

KP322737	Avian	A/chicken/Egypt/N05807-CLEVB459/2009	3/1/09	Qalyubia
KP322738	Avian	A/chicken/Egypt/N05811-CLEVB521/2009	4/18/09	Qalyubia
KP322739	Avian	A/chicken/Egypt/N05832-CLEVB754/2011	3/6/11	Fayoum
KY558870	Avian	A/chicken/Egypt/N12638D/2016	5/8/16	Egypt
KY558852	Avian	A/chicken/Egypt/N12642E/2016	5/8/16	Egypt
KY558850	Avian	A/chicken/Egypt/N12643B/2016	5/8/16	Egypt
FR687256	Avian	A/chicken/Egypt/Q1011/2010	1/1/10	Qalubiya
KU715900	Avian	A/chicken/Egypt/Q10574B/2015	1/31/15	Egypt
KU715915	Avian	A/chicken/Egypt/Q10646A/2015	2/16/15	Egypt
KU715864	Avian	A/chicken/Egypt/Q10777B/2015	11/3/15	Egypt
KU715888	Avian	A/chicken/Egypt/Q10781B/2015	11/3/15	Egypt
KF881632	Avian	A/chicken/Egypt/Q1089E/2010	1/13/10	Egypt
KF881531	Avian	A/chicken/Egypt/Q1090E/2010	1/13/10	Egypt
KU715944	Avian	A/chicken/Egypt/Q10920C/2015	4/15/15	Egypt
KF881582	Avian	A/chicken/Egypt/Q1112E/2010	1/27/10	Egypt
KF881362	Avian	A/chicken/Egypt/Q1118D/2010	1/27/10	Egypt
FR687258	Avian	A/chicken/Egypt/Q1182/2010	1/1/10	Qalubiya
KF881467	Avian	A/chicken/Egypt/Q1182E/2010	2/3/10	Egypt
KF881438	Avian	A/chicken/Egypt/Q1184B/2010	2/15/10	Egypt
KF881690	Avian	A/chicken/Egypt/Q1397D/2010	3/20/10	Egypt
KF881416	Avian	A/chicken/Egypt/Q1769B/2010	5/30/10	Egypt
KF881711	Avian	A/chicken/Egypt/Q1995A/2010	7/23/10	Egypt

CY099579	Avian	A/chicken/Egypt/Q1995D/2010	8/23/10	Egypt
KF881491	Avian	A/chicken/Egypt/Q2247A/2010	9/29/10	Egypt
KF881719	Avian	A/chicken/Egypt/Q2247B/2010	9/29/10	Egypt
KF258176	Avian	A/chicken/Egypt/Q5283C/2012	5/6/12	Egypt
KT220551	Avian	A/chicken/Egypt/Q7630D/2013	4/8/13	Qalubiya
EU183327	Avian	A/chicken/Egypt/R1/2006	12/25/06	Beni Suef
EU183328	Avian	A/chicken/Egypt/R2/2007	1/1/07	Beni Suef
EU183329	Avian	A/chicken/Egypt/R3/2007	2/1/07	Beni Suef
EU183332	Avian	A/chicken/Egypt/R6/2007	2/26/07	Beni Suef
AB601121	Avian	A/chicken/Egypt/RIMD1-5/2008	8/1/08	Behaira
AB601129	Avian	A/chicken/Egypt/RIMD10-6/2008	8/1/08	Behaira
AB601130	Avian	A/chicken/Egypt/RIMD11-1/2008	6/1/08	Gharbia
AB601123	Avian	A/chicken/Egypt/RIMD12-3/2008	1/1/08	Behaira
AB601131	Avian	A/chicken/Egypt/RIMD13-1/2008	1/1/08	Behaira
AB601122	Avian	A/chicken/Egypt/RIMD2-6/2008	1/1/08	Alexandria
AB601132	Avian	A/chicken/Egypt/RIMD21-2/2009	1/1/09	Behaira
AB601133	Avian	A/chicken/Egypt/RIMD25-1/2009	1/1/09	Behaira
AB601134	Avian	A/chicken/Egypt/RIMD26-3/2009	1/1/09	Behaira
AB601135	Avian	A/chicken/Egypt/RIMD27-2/2009	1/2/09	Alexandria
AB601124	Avian	A/chicken/Egypt/RIMD4-3/2008	1/2/08	Behaira
AB601125	Avian	A/chicken/Egypt/RIMD5-3/2008	1/6/08	Alexandria
AB601126	Avian	A/chicken/Egypt/RIMD7-1/2008	1/3/08	Behaira
AB601127	Avian	A/chicken/Egypt/RIMD8-14/2008	1/9/08	Behaira
KU715919	Avian	A/chicken/Egypt/S10738B/2015	4/3/15	Egypt
KU715884	Avian	A/chicken/Egypt/S10739C/2015	4/3/15	Egypt

KU715871	Avian	A/chicken/Egypt/S10937B/2015	2/20/15	Egypt
CY099592	Avian	A/chicken/Egypt/S2938A/2011	2/28/11	Egypt
KF881655	Avian	A/chicken/Egypt/S2938D/2011	2/28/11	Egypt
CY099593	Avian	A/chicken/Egypt/S3093A/2011	3/30/11	Egypt
CY099587	Avian	A/chicken/Egypt/S3280B/2011	5/12/11	Egypt
CY099588	Avian	A/chicken/Egypt/S3280D/2011	5/12/11	Egypt
KF881603	Avian	A/chicken/Egypt/S3280E/2011	5/12/11	Egypt
JX912986	Avian	A/chicken/Egypt/S3806A/2011	9/4/11	Egypt
JN714467	Avian	A/chicken/Egypt/VSVRI/2009	1/9/09	Egypt
KY029063	Avian	A/chicken/Egypt/ZU103/2016	2/20/16	Egypt
KY029064	Avian	A/chicken/Egypt/ZU105/2016	2/20/16	Egypt
KY029066	Avian	A/chicken/Egypt/ZU116/2016	2/20/16	Egypt
KY029069	Avian	A/chicken/Egypt/ZU120/2016	2/26/16	Egypt
KY029054	Avian	A/chicken/Egypt/ZU2/2016	2/15/16	Egypt
KY029056	Avian	A/chicken/Egypt/ZU28/2016	2/15/16	Egypt
KY029057	Avian	A/chicken/Egypt/ZU29/2016	2/15/16	Egypt
KY029059	Avian	A/chicken/Egypt/ZU34/2016	2/15/16	Egypt
KY029060	Avian	A/chicken/Egypt/ZU46/2016	2/15/16	Egypt
KY029061	Avian	A/chicken/Egypt/ZU47/2016	2/15/16	Egypt
KY029062	Avian	A/chicken/Egypt/ZU53/2016	2/15/16	Egypt
KY951988	Avian	A/chicken/Giza/3/2015	7/1/15	Giza
CY126168	Avian	A/chicken/Giza/CAI15/2008	6/1/08	Giza
CY126176	Avian	A/chicken/Giza/CAI17/2009	7/1/09	Giza
CY126208	Avian	A/chicken/Giza/CAI22/2008	6/30/08	Giza
CY126216	Avian	A/chicken/Giza/CAI23/2008	6/30/08	Giza

CY126058	Avian	A/chicken/Giza/CAI37/2009	5/20/09	Giza
CY126128	Avian	A/chicken/Giza/CAI7/2008	3/1/08	Giza
CY126136	Avian	A/chicken/Giza/CAI8/2008	4/1/08	Giza
CY126026	Avian	A/chicken/Menofia/CAI29/2009	10/1/09	Menoufiya
CY126034	Avian	A/chicken/Menofia/CAI30/2010	3/1/10	Menoufiya
CY126240	Avian	A/chicken/Menofia/CAI35/2010	4/21/10	Menoufiya
CY126248	Avian	A/chicken/Menofia/CAI36/2010	4/21/10	Menoufiya
CY126264	Avian	A/chicken/Menofia/CAI39/2010	3/3/10	Menoufiya
CY126152	Avian	A/chicken/Qalubia/CAI12/2008	6/30/08	Qalubiya
CY126160	Avian	A/chicken/Qalubia/CAI14/2008	3/1/08	Qalubiya
CY126192	Avian	A/chicken/Qalubia/CAI20/2008	6/30/08	Qalubiya
CY126200	Avian	A/chicken/Qalubia/CAI21/2008	6/30/08	Qalubiya
CY126112	Avian	A/chicken/Qalubia/CAI5/2008	6/30/08	Qalubiya
KY951989	Avian	A/chicken/Sharkia/4/2015	2/15/15	Sharkia
CY126104	Avian	A/chicken/Sharkia/CAI3/2009	9/1/09	Sharkia
CY126256	Avian	A/chicken/Sharkia/CAI38/2009	5/20/09	Sharkia
EU371907	Avian	A/crow/Egypt/9382NAMRU3-CLEVB111/2007	1/1/07	Egypt
EU496392	Avian	A/duck/Egypt/07322S-NLQP/2007	3/20/07	Menia
GQ184250	Avian	A/duck/Egypt/08425S-NLQP/2008	2/27/08	Menia
GQ184244	Avian	A/duck/Egypt/0845S-NLQP/2008	1/3/08	Menoufiya
CY044040	Avian	A/duck/Egypt/0871/2008	2/20/08	Gharbia
GQ184235	Avian	A/duck/Egypt/0875-NLQP/2008	4/6/08	Matrouh
GQ184237	Avian	A/duck/Egypt/0877-NLQP/2008	4/15/08	Luxor
GQ184240	Avian	A/duck/Egypt/0891-NLQP/2008	9/26/08	Fayoum

JF746738	Avian	A/duck/Egypt/0897-NLQP/2008	12/1/08	Egypt
GU002674	Avian	A/duck/Egypt/0918-NLQP/2009	2/1/09	Egypt
GU002686	Avian	A/duck/Egypt/09224F-NLQP/2009	5/1/09	Qalyobia
GU002675	Avian	A/duck/Egypt/0923-NLQP/2009	2/1/09	Gharbia
GU002676	Avian	A/duck/Egypt/0926-NLQP/2009	2/1/09	Egypt
GU002685	Avian	A/duck/Egypt/093L-NLQP/2009	2/1/09	Aswan
GU002678	Avian	A/duck/Egypt/0955-NLQP/2009	3/1/09	Sharkia
GU002681	Avian	A/duck/Egypt/0964-NLQP/2009	3/1/09	Gharbia
GU002697	Avian	A/duck/Egypt/0971SM-NLQP/2009	2/1/09	Menoufiya
GU002682	Avian	A/duck/Egypt/0972-NLQP/2009	4/1/09	Menia
GU002673	Avian	A/duck/Egypt/099-NLQP/2009	1/1/09	Alexandria
GU002696	Avian	A/duck/Egypt/0990SM-NLQP/2009	2/1/09	Sharkia
JN807794	Avian	A/duck/Egypt/10118/2010	9/14/10	Menoufiya
HQ198271	Avian	A/duck/Egypt/1011d/2010	2/1/10	Alexandria
JN807800	Avian	A/duck/Egypt/10131/2010	10/20/10	Menoufiya
HQ198272	Avian	A/duck/Egypt/101565v/2010	2/1/10	Qalyobia
HQ198259	Avian	A/duck/Egypt/1017/2010	1/1/10	Egypt
JN807780	Avian	A/duck/Egypt/10185SS/2010	6/10/10	Sharkia
HQ198279	Avian	A/duck/Egypt/1020sd/2010	2/1/10	Kafr-Elshekh
JN807783	Avian	A/duck/Egypt/10228SF/2010	6/28/10	Beni Suif
JN807786	Avian	A/duck/Egypt/10255AG/2010	7/20/10	Dakahlia
JN807795	Avian	A/duck/Egypt/10283SF/2010	9/16/10	Fayoum
JN807796	Avian	A/duck/Egypt/10290SF/2010	9/22/10	Fayoum
JN807798	Avian	A/duck/Egypt/10331SF/2010	10/12/10	Beni-suif
JN807799	Avian	A/duck/Egypt/10336SF/2010	10/14/10	Beni-suif

HQ198256	Avian	A/duck/Egypt/103swf/2010	1/1/10	Fayoum
JN807774	Avian	A/duck/Egypt/1046SF/2010	2/24/10	Menia
HQ198293	Avian	A/duck/Egypt/1063s/2010	2/1/10	Gharbia
HQ198285	Avian	A/duck/Egypt/1068s/2010	2/1/10	Gharbia
HQ198287	Avian	A/duck/Egypt/106d/2010	2/1/10	Gharbia
JN807850	Avian	A/duck/Egypt/11106SF/2011	3/8/11	Behaira
JN807842	Avian	A/duck/Egypt/1110AF/2011	2/28/11	Behaira
JN807857	Avian	A/duck/Egypt/11117SS/2011	3/18/11	Sharkia
JX576786	Avian	A/duck/Egypt/1111sg-NLQP/2011	8/26/11	Behaira
JN807814	Avian	A/duck/Egypt/1113SD/2011	1/11/11	Gharbia
JN807854	Avian	A/duck/Egypt/1116AF/2011	3/15/11	Fayoum
JN807860	Avian	A/duck/Egypt/11175SF/2011	4/4/11	Fayoum
JN807861	Avian	A/duck/Egypt/11193SF/2011	4/11/11	Fayoum
JQ858470	Avian	A/duck/Egypt/1120SMF/2011	7/14/11	Fayoum
JN807848	Avian	A/duck/Egypt/11211S/2011	3/6/11	Fayoum
JN807851	Avian	A/duck/Egypt/11221S/2011	3/9/11	Sharkia
JN807816	Avian	A/duck/Egypt/1123SF/2011	1/11/11	Menia
JN807810	Avian	A/duck/Egypt/1125S/2011	1/6/11	Menoufiya
JN807811	Avian	A/duck/Egypt/1130AG/2011	1/9/11	Dakahlia
JN807849	Avian	A/duck/Egypt/1153/2011	3/6/11	Qalyobia
JQ858476	Avian	A/duck/Egypt/11685s/2011	8/22/11	Qalyobia
JN807833	Avian	A/duck/Egypt/1174SF/2011	2/13/11	Fayoum
JQ858480	Avian	A/duck/Egypt/11762s/2011	11/29/11	Menia
KJ522715	Avian	A/duck/Egypt/12106S/2012	10/16/12	Menoufiya
KJ522717	Avian	A/duck/Egypt/12133S/2012	11/8/12	Menoufiya

KJ522718	Avian	A/duck/Egypt/12143S/2012	11/20/12	Giza
EF469655	Avian	A/duck/Egypt/12380N3-CLEVB/2006	1/1/06	Gharbiya
EF441281	Avian	A/duck/Egypt/1301-NAMRU3/2007	1/1/07	Gharbiya
EF469656	Avian	A/duck/Egypt/13010N3-CLEVB/2006	1/1/06	Menoufiya
KJ522721	Avian	A/duck/Egypt/1310SD/2013	1/16/13	Behaira
KJ522725	Avian	A/duck/Egypt/1313S/2013	1/29/13	Giza
KJ522727	Avian	A/duck/Egypt/131AL/2013	1/31/13	Luxor
KJ522731	Avian	A/duck/Egypt/132AL/2013	2/20/13	Luxor
KJ522735	Avian	A/duck/Egypt/1338S/2013	2/27/13	New valley
KP209286	Avian	A/duck/Egypt/141AI/2014	1/20/14	Ismailia
KP209291	Avian	A/duck/Egypt/1435CAS/2014	2/17/14	Sharkia
KP209294	Avian	A/duck/Egypt/1468S/2014	2/28/14	Giza
KP209297	Avian	A/duck/Egypt/1471SG/2014	3/27/14	Damiatt
KP035030	Avian	A/duck/Egypt/14VIR784-4-133AD/2013	11/22/14	Behaira
KP035038	Avian	A/duck/Egypt/14VIR784-6-1328S/2013	11/23/14	Egypt
KP035046	Avian	A/duck/Egypt/14VIR784-8-1339S/2013	1/3/13	Egypt
EU717851	Avian	A/duck/Egypt/1709-3VIR08/2007	5/25/08	Egypt
KU357036	Avian	A/duck/Egypt/2/2015	4/6/15	Egypt
DQ862002	Avian	A/duck/Egypt/2253-3/2006	6/1/06	Egypt
CY016899	Avian	A/duck/Egypt/2253-3/2006	1/1/06	Egypt
KU357037	Avian	A/duck/Egypt/3/2015	4/6/15	Egypt
EU371897	Avian	A/duck/Egypt/3043NAMRU3-CLEVB56/2007	1/1/07	Egypt
EU371901	Avian	A/duck/Egypt/3047NAMRU3-CLEVB63/2007	1/1/07	Egypt

KU357038	Avian	A/duck/Egypt/4/2015	4/6/15	Egypt
KU357039	Avian	A/duck/Egypt/5/2015	4/6/15	Egypt
EU373737	Avian	A/duck/Egypt/5169-1/2007	1/1/07	Egypt
EU371921	Avian	A/duck/Egypt/9399NAMRU3-CLEVB202/2007	1/1/07	Egypt
KJ147492	Avian	A/duck/Egypt/BSU-BS-R7/2008	11/15/08	Beni Suef
KJ147494	Avian	A/duck/Egypt/BSU-BS-R9/2009	3/17/09	Beni Suef
KJ147496	Avian	A/duck/Egypt/BSU-FA-1D/2012	2/15/12	Beni Suef
AB497012	Avian	A/duck/Egypt/D1Br12/2007	1/1/07	Damanhur
AB497013	Avian	A/duck/Egypt/D1Li4/2007	1/1/07	Damanhur
AB497011	Avian	A/duck/Egypt/D1Tr335/2007	1/1/07	Damanhur
AB497014	Avian	A/duck/Egypt/D2Br210/2007	1/1/07	Damanhur
AB497015	Avian	A/duck/Egypt/D2Li234/2007	1/1/07	Damanhur
AB497017	Avian	A/duck/Egypt/D3Li12/2007	1/1/07	Damanhur
AB497016	Avian	A/duck/Egypt/D3Lu6/2007	1/1/07	Damanhur
EU183325	Avian	A/duck/Egypt/F5/2006	12/25/06	Minia
KT220533	Avian	A/duck/Egypt/F7289E/2013	2/5/13	Fayoum
CY099578	Avian	A/duck/Egypt/M2583A/2010	12/22/10	Egypt
CY099589	Avian	A/duck/Egypt/M2583B/2010	12/22/10	Egypt
CY099580	Avian	A/duck/Egypt/M2583D/2010	12/22/10	Egypt
CY099586	Avian	A/duck/Egypt/M3075B/2011	2/20/11	Egypt
KF258185	Avian	A/duck/Egypt/M7218B/2013	1/31/13	Egypt
CY099581	Avian	A/duck/Egypt/Q2645C/2010	12/26/10	Egypt
KF258175	Avian	A/duck/Egypt/Q4596A/2012	1/19/12	Egypt
KF881408	Avian	A/duck/Egypt/Q4596B/2012	1/19/12	Egypt

JX912988	Avian	A/duck/Egypt/Q4596C/2012	1/19/12	Egypt
JX912994	Avian	A/duck/Egypt/Q4596D/2012	1/19/12	Egypt
EU183331	Avian	A/duck/Egypt/R5/2007	2/20/07	Beni Suef
KF258189	Avian	A/duck/Egypt/S6419C/2012	10/7/12	Egypt
KF258188	Avian	A/duck/Egypt/S6419E/2012	10/7/12	Egypt
CY126096	Avian	A/duck/El Fayoum/CAI1/2010	2/4/13	Fayoum
CY125961	Avian	A/duck/El Fayoum/CAI9/2010	2/4/13	Fayoum
CY125969	Avian	A/duck/Qalubia/CAI11/2010	3/1/10	Qalubiya
HQ198253	Avian	A/goose/Egypt/09134sml/2009	/09/2009	Sohag
GU002677	Avian	A/goose/Egypt/0929-NLQP/2009	/02/2009	Fayoum
JN807779	Avian	A/goose/Egypt/10209SF/2010	6/9/10	Fayoum
HQ198283	Avian	A/goose/Egypt/1057/2010	2010/02/	Menoufiya
JN807838	Avian	A/goose/Egypt/11162S/2011	2/22/11	Menoufiya
JN807815	Avian	A/goose/Egypt/1117SF/2011	10/24/11	Fayoum
JN807862	Avian	A/goose/Egypt/11350S/2011	4/12/11	Giza
EF469658	Avian	A/goose/Egypt/13009N3-SM2/2006	1/1/06	Menoufiya
KJ522723	Avian	A/goose/Egypt/135S/2013	1/17/13	Menoufiya
KP209303	Avian	A/goose/Egypt/1439FAOS/2014	4/29/14	Assuit
CY099583	Avian	A/goose/Egypt/M2788A/2011	1/20/11	Egypt
KF258180	Avian	A/goose/Egypt/M7221D/2013	1/31/13	Egypt
EU183330	Avian	A/goose/Egypt/R4/2007	2/1/07	Beni Suef
GQ184217	Avian	A/peacock/Egypt/07667S-NLQP/2007	12/25/07	Giza
EU496385	Avian	A/quail/Egypt/07120-NLQP/2007	2/3/07	Alexandria
JN807866	Avian	A/quail/Egypt/1171SG/2011	5/8/11	Egypt

EU371904	Avian	A/quail/Egypt/3050NAMRU3-CLEVB77/2007	1/1/07	Egypt
EU496394	Avian	A/turkey/Egypt/07444S-NLQP/2007	5/24/07	Damitta
GU002701	Avian	A/turkey/Egypt/0935-NLQP/2009	2009/02/	Egypt
GU002679	Avian	A/turkey/Egypt/0959-NLQP/2009	2009/02/	Behaira
HQ198276	Avian	A/turkey/Egypt/101474v/2010	2010/02/	Giza
JN807791	Avian	A/turkey/Egypt/10453F/2010	8/8/10	Kafr-ElShikh
KJ522709	Avian	A/turkey/Egypt/1248CA/2012	4/4/12	Assiut
KJ522720	Avian	A/turkey/Egypt/134S/2013	1/15/13	Giza
KJ522737	Avian	A/turkey/Egypt/137/2013	3/3/13	New valley
KP209298	Avian	A/turkey/Egypt/14125S/2014	4/9/14	Assuit
KP209300	Avian	A/turkey/Egypt/1414CAL/2014	4/10/14	Qena
KP209290	Avian	A/turkey/Egypt/1438S/2014	2/9/14	Giza
CY020653	Avian	A/turkey/Egypt/2253-2/2006	1/1/06	Egypt
CY055191	Avian	A/turkey/Egypt/7/2007	1/1/07	Egypt
EU371920	Avian	A/turkey/Egypt/9398NAMRU3-CLEVB195/2007	1/1/07	Egypt
EU183321	Avian	A/turkey/Egypt/F1/2006	2/25/06	Minia
EU183322	Avian	A/turkey/Egypt/F2/2006	3/1/06	Qalubiya
KF258178	Avian	A/turkey/Egypt/S6405A/2012	10/7/12	Egypt
KF258182	Avian	A/turkey/Egypt/S6405D/2012	10/7/12	Egypt
KF258181	Avian	A/turkey/Egypt/S6405E/2012	10/7/12	Egypt
EF535822	Human	A/Egypt/2321-NAMRU3/2007(H5N1)	3/13/07	Aswan
CY062439	Human	A/Egypt/7021-NAMRU3/2006(H5N1)	5/16/06	Menia
KP702165	Human	A/Egypt/MOH-NRC-7271/2014(H5N1)	11/26/14	Menia

KP702173	Human	A/Egypt/MOH-NRC-7305/2014(H5N1)	11/28/14	Menia
KR063683	Human	A/Egypt/MOH-NRC-8434/2014(H5N1)	12/27/14	Menoufiya
CY041908	Human	A/Egypt/N00001/2009(H5N1)	1/11/09	Giza
KP864432	Human	A/Egypt/N0001/2015(H5N1)	1/1/15	Menoufiya
KP864433	Human	A/Egypt/N0002/2015(H5N1)	1/1/15	Menia
KP864434	Human	A/Egypt/N0004/2015(H5N1)	1/5/15	Aswan
KP864435	Human	A/Egypt/N0005/2015(H5N1)	1/7/15	Cairo
CY062464	Human	A/Egypt/N00269/2010(H5N1)	1/11/10	Beni Suef
CY062466	Human	A/Egypt/N00270/2010(H5N1)	1/12/10	Daqahlia
CY041910	Human	A/Egypt/N00585/2009(H5N1)	1/23/09	Menoufiya
CY041912	Human	A/Egypt/N00605/2009(H5N1)	2/3/09	Suez
CY041914	Human	A/Egypt/N00606/2009(H5N1)	2/7/09	Menia
JX456101	Human	A/Egypt/N00951/2012(H5N1)	2/21/12	Behaira
CY041916	Human	A/Egypt/N01310/2009(H5N1)	2/28/09	Fayoum
CY062468	Human	A/Egypt/N01360/2010(H5N1)	2/2/10	Qalubiya
CY062470	Human	A/Egypt/N01644/2010(H5N1)	2/7/10	Helwan
KM392416	Human	A/Egypt/N01753/2014(H5N1)	3/6/14	Behaira
KM392417	Human	A/Egypt/N01754/2014(H5N1)	3/7/14	Demiatta
CY062474	Human	A/Egypt/N02038/2010(H5N1)	2/15/10	Daqahlia
CY041918	Human	A/Egypt/N02039/2009(H5N1)	3/3/09	Alexandria
CY062476	Human	A/Egypt/N02127/2010(H5N1)	2/13/10	Kafr el sheikh
JX456104	Human	A/Egypt/N02137/2012(H5N1)	3/29/12	Giza
CY041920	Human	A/Egypt/N02407/2009(H5N1)	3/9/09	Menoufiya
CY062478	Human	A/Egypt/N02554/2010(H5N1)	2/23/10	Qalubiya
CY041922	Human	A/Egypt/N02563/2009(H5N1)	3/14/09	Assuit

CY041924	Human	A/Egypt/N02752/2009(H5N1)	3/24/09	Qena
CY062480	Human	A/Egypt/N02770/2010(H5N1)	2/27/10	Qalubiya
CY062482	Human	A/Egypt/N03071/2010(H5N1)	3/3/10	Kafr el sheikh
CY062484	Human	A/Egypt/N03072/2010(H5N1)	3/7/10	Cairo
CY041926	Human	A/Egypt/N03228/2009(H5N1)	3/30/09	Menoufiya
CY041928	Human	A/Egypt/N03272/2009(H5N1)	4/1/09	Behaira
CY041930	Human	A/Egypt/N03434/2009(H5N1)	4/15/09	Kafr el sheikh
CY041932	Human	A/Egypt/N03438/2009(H5N1)	4/16/09	Cairo
CY041934	Human	A/Egypt/N03439/2009(H5N1)	4/18/09	Kafr el sheikh
CY041936	Human	A/Egypt/N03450/2009(H5N1)	4/19/09	Sohag
CY041938	Human	A/Egypt/N04316/2009(H5N1)	5/9/09	Sohag
CY041940	Human	A/Egypt/N04394/2009(H5N1)	5/11/09	Sharqiya
CY041943	Human	A/Egypt/N04396/2009(H5N1)	5/17/09	Daqahlia
CY062486	Human	A/Egypt/N04434/2010(H5N1)	3/31/10	Fayoum
CY041945	Human	A/Egypt/N04526/2009(H5N1)	5/18/09	Daqahlia
CY041947	Human	A/Egypt/N04527/2009(H5N1)	5/18/09	Sohag
CY041949	Human	A/Egypt/N04822/2009(H5N1)	5/25/09	Sharqiya
CY041951	Human	A/Egypt/N04823/2009(H5N1)	5/25/09	Sharqiya
CY041953	Human	A/Egypt/N04979/2009(H5N1)	5/31/09	Kafr el sheikh
CY041955	Human	A/Egypt/N05056/2009(H5N1)	6/6/09	Daqahlia
CY062447	Human	A/Egypt/N05912/2009(H5N1)	6/16/09	Kafr el sheikh
CY062453	Human	A/Egypt/N08835/2009(H5N1)	8/1/09	Menoufiya
CY062455	Human	A/Egypt/N09174/2009(H5N1)	8/26/09	Menoufiya
CY062457	Human	A/Egypt/N09539/2009(H5N1)	9/16/09	Alexandria
CY062459	Human	A/Egypt/N11981/2009(H5N1)	11/22/09	Menia

KP864426	Human	A/Egypt/N5560/2014(H5N1)	12/15/14	Assuit
KP864427	Human	A/Egypt/N5561/2014(H5N1)	12/14/14	Menia
KP864428	Human	A/Egypt/N5563/2014(H5N1)	12/23/14	Menia
KP864429	Human	A/Egypt/N5564/2014(H5N1)	12/26/14	Helwan
KP864430	Human	A/Egypt/N5565/2014(H5N1)	12/24/14	Assuit
KP864431	Human	A/Egypt/N5566/2014(H5N1)	12/26/14	Giza
CY062472	Human	A/Egypt/N01982/2010(H5N1)	2/12/10	Menoufiya

Table S 2. Sensitivity analysis of R_0 against genetic distance, time difference, geographical distance.

Lb and ub are the upper and lower bound of 95% confidence interval for the R_0 estimate.

Genetic distance	Time interval	Geographic distance	Sequence number	Transmission number	R_0	lb	ub
0	0	0	60	0	0	0	0.032
0	0	50	60	0	0	0	0.032
0	0	100	60	0	0	0	0.032
0	0	150	60	0	0	0	0.032
0	0	200	60	0	0	0	0.032
0	0	250	60	0	0	0	0.032
0	0	300	60	0	0	0	0.032
0	0	350	60	0	0	0	0.032
0	0	400	60	0	0	0	0.032

0	0	450	60	0	0	0	0.032
0	0	500	60	0	0	0	0.032
0	0	550	60	0	0	0	0.032
0	0	600	60	0	0	0	0.032
0	0	650	60	0	0	0	0.032
0	0	700	60	0	0	0	0.032
0	0	750	60	0	0	0	0.032
0	0	800	60	0	0	0	0.032
0	6	0	60	0	0	0	0.032
0	6	50	60	0	0	0	0.032
0	6	100	60	0	0	0	0.032
0	6	150	60	0	0	0	0.032

0	6	200	60	0	0	0	0.032
0	6	250	60	0	0	0	0.032
0	6	300	60	0	0	0	0.032
0	6	350	60	0	0	0	0.032
0	6	400	60	0	0	0	0.032
0	6	450	60	0	0	0	0.032
0	6	500	60	0	0	0	0.032
0	6	550	60	0	0	0	0.032
0	6	600	60	0	0	0	0.032
0	6	650	60	0	0	0	0.032
0	6	700	60	0	0	0	0.032
0	6	750	60	0	0	0	0.032

0	6	800	60	0	0	0	0.032
0	12	0	60	0	0	0	0.032
0	12	50	60	0	0	0	0.032
0	12	100	60	0	0	0	0.032
0	12	150	60	0	0	0	0.032
0	12	200	60	0	0	0	0.032
0	12	250	60	0	0	0	0.032
0	12	300	60	0	0	0	0.032
0	12	350	60	0	0	0	0.032
0	12	400	60	0	0	0	0.032
0	12	450	60	0	0	0	0.032
0	12	500	60	0	0	0	0.032

0	12	550	60	0	0	0	0.032
0	12	600	60	0	0	0	0.032
0	12	650	60	0	0	0	0.032
0	12	700	60	0	0	0	0.032
0	12	750	60	0	0	0	0.032
0	12	800	60	0	0	0	0.032
0	18	0	60	0	0	0	0.032
0	18	50	60	0	0	0	0.032
0	18	100	60	0	0	0	0.032
0	18	150	60	0	0	0	0.032
0	18	200	60	0	0	0	0.032
0	18	250	60	0	0	0	0.032

0	18	300	60	0	0	0	0.032
0	18	350	60	0	0	0	0.032
0	18	400	60	0	0	0	0.032
0	18	450	60	0	0	0	0.032
0	18	500	60	0	0	0	0.032
0	18	550	60	0	0	0	0.032
0	18	600	60	0	0	0	0.032
0	18	650	60	0	0	0	0.032
0	18	700	60	0	0	0	0.032
0	18	750	60	0	0	0	0.032
0	18	800	60	0	0	0	0.032
0	24	0	60	0	0	0	0.032

0	24	50	60	0	0	0	0.03 2
0	24	100	60	0	0	0	0.03 2
0	24	150	60	0	0	0	0.03 2
0	24	200	60	0	0	0	0.03 2
0	24	250	60	0	0	0	0.03 2
0	24	300	60	0	0	0	0.03 2
0	24	350	60	0	0	0	0.03 2
0	24	400	60	0	0	0	0.03 2
0	24	450	60	0	0	0	0.03 2
0	24	500	60	0	0	0	0.03 2
0	24	550	60	0	0	0	0.03 2
0	24	600	60	0	0	0	0.03 2

0	24	650	60	0	0	0	0.032
0	24	700	60	0	0	0	0.032
0	24	750	60	0	0	0	0.032
0	24	800	60	0	0	0	0.032
0	30	0	60	0	0	0	0.032
0	30	50	60	0	0	0	0.032
0	30	100	60	0	0	0	0.032
0	30	150	60	0	0	0	0.032
0	30	200	60	0	0	0	0.032
0	30	250	60	0	0	0	0.032
0	30	300	60	0	0	0	0.032
0	30	350	60	0	0	0	0.032

0	30	400	60	0	0	0	0.032
0	30	450	60	0	0	0	0.032
0	30	500	60	0	0	0	0.032
0	30	550	60	0	0	0	0.032
0	30	600	60	0	0	0	0.032
0	30	650	60	0	0	0	0.032
0	30	700	60	0	0	0	0.032
0	30	750	60	0	0	0	0.032
0	30	800	60	0	0	0	0.032
0	36	0	60	0	0	0	0.032
0	36	50	60	0	0	0	0.032
0	36	100	60	0	0	0	0.032

0	36	150	60	0	0	0	0.032
0	36	200	60	0	0	0	0.032
0	36	250	60	0	0	0	0.032
0	36	300	60	0	0	0	0.032
0	36	350	60	0	0	0	0.032
0	36	400	60	0	0	0	0.032
0	36	450	60	0	0	0	0.032
0	36	500	60	0	0	0	0.032
0	36	550	60	0	0	0	0.032
0	36	600	60	0	0	0	0.032
0	36	650	60	0	0	0	0.032
0	36	700	60	0	0	0	0.032

0	36	750	60	0	0	0	0.032
0	36	800	60	0	0	0	0.032
0	42	0	60	0	0	0	0.032
0	42	50	60	0	0	0	0.032
0	42	100	60	0	0	0	0.032
0	42	150	60	0	0	0	0.032
0	42	200	60	0	0	0	0.032
0	42	250	60	0	0	0	0.032
0	42	300	60	0	0	0	0.032
0	42	350	60	0	0	0	0.032
0	42	400	60	0	0	0	0.032
0	42	450	60	0	0	0	0.032

0	42	500	60	0	0	0	0.03 2
0	42	550	60	0	0	0	0.03 2
0	42	600	60	0	0	0	0.03 2
0	42	650	60	0	0	0	0.03 2
0	42	700	60	0	0	0	0.03 2
0	42	750	60	0	0	0	0.03 2
0	42	800	60	0	0	0	0.03 2
0	48	0	60	0	0	0	0.03 2
0	48	50	60	0	0	0	0.03 2
0	48	100	60	0	0	0	0.03 2
0	48	150	60	0	0	0	0.03 2
0	48	200	60	0	0	0	0.03 2

0	48	250	60	0	0	0	0.032
0	48	300	60	0	0	0	0.032
0	48	350	60	0	0	0	0.032
0	48	400	60	0	0	0	0.032
0	48	450	60	0	0	0	0.032
0	48	500	60	0	0	0	0.032
0	48	550	60	0	0	0	0.032
0	48	600	60	0	0	0	0.032
0	48	650	60	0	0	0	0.032
0	48	700	60	0	0	0	0.032
0	48	750	60	0	0	0	0.032
0	48	800	60	0	0	0	0.032

0	54	0	60	0	0	0	0.032
0	54	50	60	0	0	0	0.032
0	54	100	60	0	0	0	0.032
0	54	150	60	0	0	0	0.032
0	54	200	60	0	0	0	0.032
0	54	250	60	0	0	0	0.032
0	54	300	60	0	0	0	0.032
0	54	350	60	0	0	0	0.032
0	54	400	60	0	0	0	0.032
0	54	450	60	0	0	0	0.032
0	54	500	60	0	0	0	0.032
0	54	550	60	0	0	0	0.032

0	54	600	60	0	0	0	0.032
0	54	650	60	0	0	0	0.032
0	54	700	60	0	0	0	0.032
0	54	750	60	0	0	0	0.032
0	54	800	60	0	0	0	0.032
0	60	0	60	0	0	0	0.032
0	60	50	60	0	0	0	0.032
0	60	100	60	0	0	0	0.032
0	60	150	60	0	0	0	0.032
0	60	200	60	0	0	0	0.032
0	60	250	60	0	0	0	0.032
0	60	300	60	0	0	0	0.032

0	60	350	60	0	0	0	0.03 2
0	60	400	60	0	0	0	0.03 2
0	60	450	60	0	0	0	0.03 2
0	60	500	60	0	0	0	0.03 2
0	60	550	60	0	0	0	0.03 2
0	60	600	60	0	0	0	0.03 2
0	60	650	60	0	0	0	0.03 2
0	60	700	60	0	0	0	0.03 2
0	60	750	60	0	0	0	0.03 2
0	60	800	60	0	0	0	0.03 2
0.001	0	0	60	0	0	0	0.03 2
0.001	0	50	60	0	0	0	0.03 2

0.001	0	100	60	0	0	0	0.032
0.001	0	150	60	0	0	0	0.032
0.001	0	200	60	0	0	0	0.032
0.001	0	250	60	0	0	0	0.032
0.001	0	300	60	0	0	0	0.032
0.001	0	350	60	0	0	0	0.032
0.001	0	400	60	0	0	0	0.032
0.001	0	450	60	0	0	0	0.032
0.001	0	500	60	0	0	0	0.032
0.001	0	550	60	0	0	0	0.032
0.001	0	600	60	0	0	0	0.032
0.001	0	650	60	0	0	0	0.032

0.001	0	700	60	0	0	0	0.032
0.001	0	750	60	0	0	0	0.032
0.001	0	800	60	0	0	0	0.032
0.001	6	0	60	0	0	0	0.032
0.001	6	50	60	0	0	0	0.032
0.001	6	100	60	0	0	0	0.032
0.001	6	150	60	0	0	0	0.032
0.001	6	200	60	0	0	0	0.032
0.001	6	250	60	0	0	0	0.032
0.001	6	300	60	0	0	0	0.032
0.001	6	350	60	0	0	0	0.032
0.001	6	400	60	0	0	0	0.032

0.001	6	450	60	0	0	0	0.032
0.001	6	500	60	0	0	0	0.032
0.001	6	550	60	0	0	0	0.032
0.001	6	600	60	0	0	0	0.032
0.001	6	650	60	0	0	0	0.032
0.001	6	700	60	0	0	0	0.032
0.001	6	750	60	0	0	0	0.032
0.001	6	800	60	0	0	0	0.032
0.001	12	0	60	0	0	0	0.032
0.001	12	50	60	0	0	0	0.032
0.001	12	100	60	0	0	0	0.032
0.001	12	150	60	0	0	0	0.032

0.001	12	200	60	0	0	0	0.032
0.001	12	250	60	0	0	0	0.032
0.001	12	300	60	0	0	0	0.032
0.001	12	350	60	0	0	0	0.032
0.001	12	400	60	0	0	0	0.032
0.001	12	450	60	0	0	0	0.032
0.001	12	500	60	0	0	0	0.032
0.001	12	550	60	0	0	0	0.032
0.001	12	600	60	0	0	0	0.032
0.001	12	650	60	0	0	0	0.032
0.001	12	700	60	0	0	0	0.032
0.001	12	750	60	0	0	0	0.032

0.001	12	800	60	0	0	0	0.032
0.001	18	0	60	0	0	0	0.032
0.001	18	50	60	0	0	0	0.032
0.001	18	100	60	0	0	0	0.032
0.001	18	150	60	0	0	0	0.032
0.001	18	200	60	0	0	0	0.032
0.001	18	250	60	0	0	0	0.032
0.001	18	300	60	0	0	0	0.032
0.001	18	350	60	0	0	0	0.032
0.001	18	400	60	0	0	0	0.032
0.001	18	450	60	0	0	0	0.032
0.001	18	500	60	0	0	0	0.032

0.001	18	550	60	0	0	0	0.032
0.001	18	600	60	0	0	0	0.032
0.001	18	650	60	0	0	0	0.032
0.001	18	700	60	0	0	0	0.032
0.001	18	750	60	0	0	0	0.032
0.001	18	800	60	0	0	0	0.032
0.001	24	0	60	0	0	0	0.032
0.001	24	50	60	0	0	0	0.032
0.001	24	100	60	0	0	0	0.032
0.001	24	150	60	0	0	0	0.032
0.001	24	200	60	0	0	0	0.032
0.001	24	250	60	0	0	0	0.032

0.001	24	300	60	0	0	0	0.03 2
0.001	24	350	60	0	0	0	0.03 2
0.001	24	400	60	0	0	0	0.03 2
0.001	24	450	60	0	0	0	0.03 2
0.001	24	500	60	0	0	0	0.03 2
0.001	24	550	60	0	0	0	0.03 2
0.001	24	600	60	0	0	0	0.03 2
0.001	24	650	60	0	0	0	0.03 2
0.001	24	700	60	0	0	0	0.03 2
0.001	24	750	60	0	0	0	0.03 2
0.001	24	800	60	0	0	0	0.03 2
0.001	30	0	60	0	0	0	0.03 2

0.001	30	50	60	1	0.0167	1E-03	0.07 1
0.001	30	100	60	1	0.0167	1E-03	0.07 1
0.001	30	150	60	1	0.0167	1E-03	0.07 1
0.001	30	200	60	1	0.0167	1E-03	0.07 1
0.001	30	250	60	1	0.0167	1E-03	0.07 1
0.001	30	300	60	1	0.0167	1E-03	0.07 1
0.001	30	350	60	1	0.0167	1E-03	0.07 1
0.001	30	400	60	1	0.0167	1E-03	0.07 1
0.001	30	450	60	1	0.0167	1E-03	0.07 1
0.001	30	500	60	1	0.0167	1E-03	0.07 1
0.001	30	550	60	1	0.0167	1E-03	0.07 1
0.001	30	600	60	1	0.0167	1E-03	0.07 1

0.001	30	650	60	1	0.0167	1E-03	0.071
0.001	30	700	60	1	0.0167	1E-03	0.071
0.001	30	750	60	1	0.0167	1E-03	0.071
0.001	30	800	60	1	0.0167	1E-03	0.071
0.001	36	0	60	0	0	0	0.032
0.001	36	50	60	1	0.0167	1E-03	0.071
0.001	36	100	60	1	0.0167	1E-03	0.071
0.001	36	150	60	1	0.0167	1E-03	0.071
0.001	36	200	60	1	0.0167	1E-03	0.071
0.001	36	250	60	1	0.0167	1E-03	0.071
0.001	36	300	60	1	0.0167	1E-03	0.071
0.001	36	350	60	1	0.0167	1E-03	0.071

0.001	36	400	60	1	0.0167	1E-03	0.071
0.001	36	450	60	1	0.0167	1E-03	0.071
0.001	36	500	60	1	0.0167	1E-03	0.071
0.001	36	550	60	1	0.0167	1E-03	0.071
0.001	36	600	60	1	0.0167	1E-03	0.071
0.001	36	650	60	1	0.0167	1E-03	0.071
0.001	36	700	60	1	0.0167	1E-03	0.071
0.001	36	750	60	1	0.0167	1E-03	0.071
0.001	36	800	60	1	0.0167	1E-03	0.071
0.001	42	0	60	0	0	0	0.032
0.001	42	50	60	1	0.0167	1E-03	0.071
0.001	42	100	60	1	0.0167	1E-03	0.071

0.001	42	150	60	1		0.0167	1E-03	0.07 1
0.001	42	200	60	1		0.0167	1E-03	0.07 1
0.001	42	250	60	1		0.0167	1E-03	0.07 1
0.001	42	300	60	1		0.0167	1E-03	0.07 1
0.001	42	350	60	1		0.0167	1E-03	0.07 1
0.001	42	400	60	1		0.0167	1E-03	0.07 1
0.001	42	450	60	1		0.0167	1E-03	0.07 1
0.001	42	500	60	1		0.0167	1E-03	0.07 1
0.001	42	550	60	1		0.0167	1E-03	0.07 1
0.001	42	600	60	1		0.0167	1E-03	0.07 1
0.001	42	650	60	1		0.0167	1E-03	0.07 1
0.001	42	700	60	1		0.0167	1E-03	0.07 1

0.001	42	750	60	1	0.0167	1E-03	0.071
0.001	42	800	60	1	0.0167	1E-03	0.071
0.001	48	0	60	0	0	0	0.032
0.001	48	50	60	1	0.0167	1E-03	0.071
0.001	48	100	60	2	0.0333	0.006	0.099
0.001	48	150	60	2	0.0333	0.006	0.099
0.001	48	200	60	2	0.0333	0.006	0.099
0.001	48	250	60	2	0.0333	0.006	0.099
0.001	48	300	60	2	0.0333	0.006	0.099
0.001	48	350	60	2	0.0333	0.006	0.099
0.001	48	400	60	2	0.0333	0.006	0.099
0.001	48	450	60	2	0.0333	0.006	0.099

0.001	48	500	60	2	0.0333	0.006	0.099
0.001	48	550	60	2	0.0333	0.006	0.099
0.001	48	600	60	2	0.0333	0.006	0.099
0.001	48	650	60	2	0.0333	0.006	0.099
0.001	48	700	60	2	0.0333	0.006	0.099
0.001	48	750	60	2	0.0333	0.006	0.099
0.001	48	800	60	2	0.0333	0.006	0.099
0.001	54	0	60	0	0	0	0.032
0.001	54	50	60	1	0.0167	1E-03	0.071
0.001	54	100	60	2	0.0333	0.006	0.099
0.001	54	150	60	2	0.0333	0.006	0.099
0.001	54	200	60	2	0.0333	0.006	0.099

0.001	54	250	60	3	0.05	0.013	0.125
0.001	54	300	60	3	0.05	0.013	0.125
0.001	54	350	60	3	0.05	0.013	0.125
0.001	54	400	60	3	0.05	0.013	0.125
0.001	54	450	60	3	0.05	0.013	0.125
0.001	54	500	60	3	0.05	0.013	0.125
0.001	54	550	60	3	0.05	0.013	0.125
0.001	54	600	60	3	0.05	0.013	0.125
0.001	54	650	60	3	0.05	0.013	0.125
0.001	54	700	60	3	0.05	0.013	0.125
0.001	54	750	60	3	0.05	0.013	0.125
0.001	54	800	60	3	0.05	0.013	0.125

0.001	60	0	60	0	0	0	0.032
0.001	60	50	60	1	0.0167	1E-03	0.071
0.001	60	100	60	2	0.0333	0.006	0.099
0.001	60	150	60	2	0.0333	0.006	0.099
0.001	60	200	60	2	0.0333	0.006	0.099
0.001	60	250	60	3	0.05	0.013	0.125
0.001	60	300	60	3	0.05	0.013	0.125
0.001	60	350	60	3	0.05	0.013	0.125
0.001	60	400	60	3	0.05	0.013	0.125
0.001	60	450	60	3	0.05	0.013	0.125
0.001	60	500	60	3	0.05	0.013	0.125
0.001	60	550	60	3	0.05	0.013	0.125

0.001	60	600	60	3	0.05	0.013	0.125
0.001	60	650	60	3	0.05	0.013	0.125
0.001	60	700	60	3	0.05	0.013	0.125
0.001	60	750	60	3	0.05	0.013	0.125
0.001	60	800	60	3	0.05	0.013	0.125
0.002	0	0	60	0	0	0	0.032
0.002	0	50	60	0	0	0	0.032
0.002	0	100	60	0	0	0	0.032
0.002	0	150	60	0	0	0	0.032
0.002	0	200	60	0	0	0	0.032
0.002	0	250	60	0	0	0	0.032
0.002	0	300	60	0	0	0	0.032

0.002	0	350	60	0	0	0	0.032
0.002	0	400	60	0	0	0	0.032
0.002	0	450	60	0	0	0	0.032
0.002	0	500	60	0	0	0	0.032
0.002	0	550	60	0	0	0	0.032
0.002	0	600	60	0	0	0	0.032
0.002	0	650	60	0	0	0	0.032
0.002	0	700	60	0	0	0	0.032
0.002	0	750	60	0	0	0	0.032
0.002	0	800	60	0	0	0	0.032
0.002	6	0	60	0	0	0	0.032
0.002	6	50	60	0	0	0	0.032

0.002	6	100	60	2	0.0333	0.006	0.099
0.002	6	150	60	2	0.0333	0.006	0.099
0.002	6	200	60	2	0.0333	0.006	0.099
0.002	6	250	60	3	0.05	0.013	0.125
0.002	6	300	60	3	0.05	0.013	0.125
0.002	6	350	60	3	0.05	0.013	0.125
0.002	6	400	60	3	0.05	0.013	0.125
0.002	6	450	60	3	0.05	0.013	0.125
0.002	6	500	60	3	0.05	0.013	0.125
0.002	6	550	60	3	0.05	0.013	0.125
0.002	6	600	60	3	0.05	0.013	0.125
0.002	6	650	60	3	0.05	0.013	0.125

0.002	6	700	60	3	0.05	0.013	0.125
0.002	6	750	60	3	0.05	0.013	0.125
0.002	6	800	60	3	0.05	0.013	0.125
0.002	12	0	60	0	0	0	0.032
0.002	12	50	60	0	0	0	0.032
0.002	12	100	60	3	0.05	0.013	0.125
0.002	12	150	60	3	0.05	0.013	0.125
0.002	12	200	60	3	0.05	0.013	0.125
0.002	12	250	60	4	0.0667	0.021	0.148
0.002	12	300	60	4	0.0667	0.021	0.148
0.002	12	350	60	4	0.0667	0.021	0.148
0.002	12	400	60	4	0.0667	0.021	0.148

0.002	12	450	60	4	0.0667	0.021	0.148
0.002	12	500	60	4	0.0667	0.021	0.148
0.002	12	550	60	4	0.0667	0.021	0.148
0.002	12	600	60	4	0.0667	0.021	0.148
0.002	12	650	60	4	0.0667	0.021	0.148
0.002	12	700	60	4	0.0667	0.021	0.148
0.002	12	750	60	4	0.0667	0.021	0.148
0.002	12	800	60	4	0.0667	0.021	0.148
0.002	18	0	60	0	0	0	0.032
0.002	18	50	60	0	0	0	0.032
0.002	18	100	60	3	0.05	0.013	0.125
0.002	18	150	60	3	0.05	0.013	0.125

0.002	18	200	60	3	0.05	0.013	0.125
0.002	18	250	60	4	0.0667	0.021	0.148
0.002	18	300	60	4	0.0667	0.021	0.148
0.002	18	350	60	4	0.0667	0.021	0.148
0.002	18	400	60	4	0.0667	0.021	0.148
0.002	18	450	60	4	0.0667	0.021	0.148
0.002	18	500	60	4	0.0667	0.021	0.148
0.002	18	550	60	4	0.0667	0.021	0.148
0.002	18	600	60	4	0.0667	0.021	0.148
0.002	18	650	60	4	0.0667	0.021	0.148
0.002	18	700	60	4	0.0667	0.021	0.148
0.002	18	750	60	4	0.0667	0.021	0.148

0.002	18	800	60	4	0.0667	0.021	0.148
0.002	24	0	60	0	0	0	0.032
0.002	24	50	60	0	0	0	0.032
0.002	24	100	60	4	0.0667	0.021	0.148
0.002	24	150	60	4	0.0667	0.021	0.148
0.002	24	200	60	4	0.0667	0.021	0.148
0.002	24	250	60	5	0.0833	0.031	0.171
0.002	24	300	60	5	0.0833	0.031	0.171
0.002	24	350	60	5	0.0833	0.031	0.171
0.002	24	400	60	6	0.1	0.041	0.192
0.002	24	450	60	6	0.1	0.041	0.192
0.002	24	500	60	6	0.1	0.041	0.192

0.002	24	550	60	6	0.1	0.041	0.192
0.002	24	600	60	6	0.1	0.041	0.192
0.002	24	650	60	6	0.1	0.041	0.192
0.002	24	700	60	6	0.1	0.041	0.192
0.002	24	750	60	6	0.1	0.041	0.192
0.002	24	800	60	6	0.1	0.041	0.192
0.002	30	0	60	0	0	0	0.032
0.002	30	50	60	2	0.0333	0.006	0.099
0.002	30	100	60	6	0.1	0.041	0.192
0.002	30	150	60	6	0.1	0.041	0.192
0.002	30	200	60	6	0.1	0.041	0.192
0.002	30	250	60	7	0.1167	0.052	0.213

0.002	30	300	60	7	0.1167	0.052	0.213
0.002	30	350	60	7	0.1167	0.052	0.213
0.002	30	400	60	8	0.1333	0.063	0.234
0.002	30	450	60	8	0.1333	0.063	0.234
0.002	30	500	60	8	0.1333	0.063	0.234
0.002	30	550	60	8	0.1333	0.063	0.234
0.002	30	600	60	8	0.1333	0.063	0.234
0.002	30	650	60	8	0.1333	0.063	0.234
0.002	30	700	60	8	0.1333	0.063	0.234
0.002	30	750	60	8	0.1333	0.063	0.234
0.002	30	800	60	8	0.1333	0.063	0.234
0.002	36	0	60	0	0	0	0.032

0.002	36	50	60	2		0.0333	0.006	0.099
0.002	36	100	60	6		0.1	0.041	0.192
0.002	36	150	60	6		0.1	0.041	0.192
0.002	36	200	60	6		0.1	0.041	0.192
0.002	36	250	60	7		0.1167	0.052	0.213
0.002	36	300	60	7		0.1167	0.052	0.213
0.002	36	350	60	7		0.1167	0.052	0.213
0.002	36	400	60	8		0.1333	0.063	0.234
0.002	36	450	60	8		0.1333	0.063	0.234
0.002	36	500	60	8		0.1333	0.063	0.234
0.002	36	550	60	8		0.1333	0.063	0.234
0.002	36	600	60	8		0.1333	0.063	0.234

0.002	36	650	60	8	0.1333	0.063	0.234
0.002	36	700	60	8	0.1333	0.063	0.234
0.002	36	750	60	8	0.1333	0.063	0.234
0.002	36	800	60	8	0.1333	0.063	0.234
0.002	42	0	60	0	0	0	0.032
0.002	42	50	60	2	0.0333	0.006	0.099
0.002	42	100	60	7	0.1167	0.052	0.213
0.002	42	150	60	7	0.1167	0.052	0.213
0.002	42	200	60	7	0.1167	0.052	0.213
0.002	42	250	60	8	0.1333	0.063	0.234
0.002	42	300	60	8	0.1333	0.063	0.234
0.002	42	350	60	8	0.1333	0.063	0.234

0.002	42	400	60	9	0.15	0.075	0.254
0.002	42	450	60	9	0.15	0.075	0.254
0.002	42	500	60	9	0.15	0.075	0.254
0.002	42	550	60	9	0.15	0.075	0.254
0.002	42	600	60	9	0.15	0.075	0.254
0.002	42	650	60	9	0.15	0.075	0.254
0.002	42	700	60	9	0.15	0.075	0.254
0.002	42	750	60	9	0.15	0.075	0.254
0.002	42	800	60	9	0.15	0.075	0.254
0.002	48	0	60	0	0	0	0.032
0.002	48	50	60	2	0.0333	0.006	0.099
0.002	48	100	60	8	0.1333	0.063	0.234

0.002	48	150	60	8	0.1333	0.063	0.234
0.002	48	200	60	8	0.1333	0.063	0.234
0.002	48	250	60	9	0.15	0.075	0.254
0.002	48	300	60	9	0.15	0.075	0.254
0.002	48	350	60	9	0.15	0.075	0.254
0.002	48	400	60	10	0.1667	0.087	0.274
0.002	48	450	60	10	0.1667	0.087	0.274
0.002	48	500	60	10	0.1667	0.087	0.274
0.002	48	550	60	10	0.1667	0.087	0.274
0.002	48	600	60	10	0.1667	0.087	0.274
0.002	48	650	60	10	0.1667	0.087	0.274
0.002	48	700	60	10	0.1667	0.087	0.274

0.002	48	750	60	10	0.1667	0.087	0.274
0.002	48	800	60	10	0.1667	0.087	0.274
0.002	54	0	60	0	0	0	0.032
0.002	54	50	60	2	0.0333	0.006	0.099
0.002	54	100	60	8	0.1333	0.063	0.234
0.002	54	150	60	8	0.1333	0.063	0.234
0.002	54	200	60	8	0.1333	0.063	0.234
0.002	54	250	60	9	0.15	0.075	0.254
0.002	54	300	60	9	0.15	0.075	0.254
0.002	54	350	60	9	0.15	0.075	0.254
0.002	54	400	60	10	0.1667	0.087	0.274
0.002	54	450	60	10	0.1667	0.087	0.274

0.002	54	500	60	10	0.1667	0.087	0.274
0.002	54	550	60	10	0.1667	0.087	0.274
0.002	54	600	60	10	0.1667	0.087	0.274
0.002	54	650	60	10	0.1667	0.087	0.274
0.002	54	700	60	10	0.1667	0.087	0.274
0.002	54	750	60	10	0.1667	0.087	0.274
0.002	54	800	60	10	0.1667	0.087	0.274
0.002	60	0	60	0	0	0	0.032
0.002	60	50	60	2	0.0333	0.006	0.099
0.002	60	100	60	9	0.15	0.075	0.254
0.002	60	150	60	9	0.15	0.075	0.254
0.002	60	200	60	9	0.15	0.075	0.254

0.002	60	250	60	10	0.1667	0.087	0.274
0.002	60	300	60	10	0.1667	0.087	0.274
0.002	60	350	60	10	0.1667	0.087	0.274
0.002	60	400	60	11	0.1833	0.1	0.293
0.002	60	450	60	11	0.1833	0.1	0.293
0.002	60	500	60	11	0.1833	0.1	0.293
0.002	60	550	60	11	0.1833	0.1	0.293
0.002	60	600	60	11	0.1833	0.1	0.293
0.002	60	650	60	11	0.1833	0.1	0.293
0.002	60	700	60	11	0.1833	0.1	0.293
0.002	60	750	60	11	0.1833	0.1	0.293
0.002	60	800	60	11	0.1833	0.1	0.293

0.003	0	0	60	0	0	0	0.032
0.003	0	50	60	0	0	0	0.032
0.003	0	100	60	0	0	0	0.032
0.003	0	150	60	0	0	0	0.032
0.003	0	200	60	0	0	0	0.032
0.003	0	250	60	0	0	0	0.032
0.003	0	300	60	0	0	0	0.032
0.003	0	350	60	0	0	0	0.032
0.003	0	400	60	0	0	0	0.032
0.003	0	450	60	0	0	0	0.032
0.003	0	500	60	0	0	0	0.032
0.003	0	550	60	0	0	0	0.032

0.003	0	600	60	0	0	0	0.032
0.003	0	650	60	0	0	0	0.032
0.003	0	700	60	0	0	0	0.032
0.003	0	750	60	0	0	0	0.032
0.003	0	800	60	0	0	0	0.032
0.003	6	0	60	0	0	0	0.032
0.003	6	50	60	0	0	0	0.032
0.003	6	100	60	4	0.0667	0.021	0.148
0.003	6	150	60	6	0.1	0.041	0.192
0.003	6	200	60	6	0.1	0.041	0.192
0.003	6	250	60	7	0.1167	0.052	0.213
0.003	6	300	60	7	0.1167	0.052	0.213

0.003	6	350	60	7	0.1167	0.052	0.213
0.003	6	400	60	7	0.1167	0.052	0.213
0.003	6	450	60	7	0.1167	0.052	0.213
0.003	6	500	60	7	0.1167	0.052	0.213
0.003	6	550	60	7	0.1167	0.052	0.213
0.003	6	600	60	7	0.1167	0.052	0.213
0.003	6	650	60	7	0.1167	0.052	0.213
0.003	6	700	60	7	0.1167	0.052	0.213
0.003	6	750	60	7	0.1167	0.052	0.213
0.003	6	800	60	7	0.1167	0.052	0.213
0.003	12	0	60	1	0.0167	1E-03	0.071
0.003	12	50	60	1	0.0167	1E-03	0.071

0.003	12	100	60	6	0.1	0.041	0.192
0.003	12	150	60	9	0.15	0.075	0.254
0.003	12	200	60	9	0.15	0.075	0.254
0.003	12	250	60	9	0.15	0.075	0.254
0.003	12	300	60	9	0.15	0.075	0.254
0.003	12	350	60	9	0.15	0.075	0.254
0.003	12	400	60	9	0.15	0.075	0.254
0.003	12	450	60	9	0.15	0.075	0.254
0.003	12	500	60	9	0.15	0.075	0.254
0.003	12	550	60	9	0.15	0.075	0.254
0.003	12	600	60	9	0.15	0.075	0.254
0.003	12	650	60	9	0.15	0.075	0.254

0.003	12	700	60	9	0.15	0.075	0.254
0.003	12	750	60	9	0.15	0.075	0.254
0.003	12	800	60	9	0.15	0.075	0.254
0.003	18	0	60	3	0.05	0.013	0.125
0.003	18	50	60	3	0.05	0.013	0.125
0.003	18	100	60	8	0.1333	0.063	0.234
0.003	18	150	60	11	0.1833	0.1	0.293
0.003	18	200	60	11	0.1833	0.1	0.293
0.003	18	250	60	11	0.1833	0.1	0.293
0.003	18	300	60	11	0.1833	0.1	0.293
0.003	18	350	60	11	0.1833	0.1	0.293
0.003	18	400	60	11	0.1833	0.1	0.293

0.003	18	450	60	11	0.1833	0.1	0.293
0.003	18	500	60	11	0.1833	0.1	0.293
0.003	18	550	60	11	0.1833	0.1	0.293
0.003	18	600	60	11	0.1833	0.1	0.293
0.003	18	650	60	11	0.1833	0.1	0.293
0.003	18	700	60	11	0.1833	0.1	0.293
0.003	18	750	60	11	0.1833	0.1	0.293
0.003	18	800	60	11	0.1833	0.1	0.293
0.003	24	0	60	3	0.05	0.013	0.125
0.003	24	50	60	3	0.05	0.013	0.125
0.003	24	100	60	9	0.15	0.075	0.254
0.003	24	150	60	13	0.2167	0.126	0.331

0.003	24	200	60	13	0.2167	0.126	0.331
0.003	24	250	60	13	0.2167	0.126	0.331
0.003	24	300	60	13	0.2167	0.126	0.331
0.003	24	350	60	13	0.2167	0.126	0.331
0.003	24	400	60	14	0.2333	0.139	0.35
0.003	24	450	60	14	0.2333	0.139	0.35
0.003	24	500	60	14	0.2333	0.139	0.35
0.003	24	550	60	14	0.2333	0.139	0.35
0.003	24	600	60	14	0.2333	0.139	0.35
0.003	24	650	60	14	0.2333	0.139	0.35
0.003	24	700	60	14	0.2333	0.139	0.35
0.003	24	750	60	14	0.2333	0.139	0.35
0.003	24	800	60	14	0.2333	0.139	0.35
0.003	30	0	60	4	0.0667	0.021	0.148
0.003	30	50	60	6	0.1	0.041	0.192
0.003	30	100	60	12	0.2	0.113	0.313
0.003	30	150	60	16	0.2667	0.166	0.387

0.003	30	200	60	16	0.2667	0.166	0.387
0.003	30	250	60	16	0.2667	0.166	0.387
0.003	30	300	60	16	0.2667	0.166	0.387
0.003	30	350	60	16	0.2667	0.166	0.387
0.003	30	400	60	17	0.2833	0.18	0.405
0.003	30	450	60	17	0.2833	0.18	0.405
0.003	30	500	60	17	0.2833	0.18	0.405
0.003	30	550	60	17	0.2833	0.18	0.405
0.003	30	600	60	17	0.2833	0.18	0.405
0.003	30	650	60	17	0.2833	0.18	0.405
0.003	30	700	60	17	0.2833	0.18	0.405
0.003	30	750	60	17	0.2833	0.18	0.405

0.003	30	800	60	17	0.2833	0.18	0.40 5
0.003	36	0	60	4	0.0667	0.021	0.14 8
0.003	36	50	60	6	0.1	0.041	0.19 2
0.003	36	100	60	12	0.2	0.113	0.31 3
0.003	36	150	60	16	0.2667	0.166	0.38 7
0.003	36	200	60	16	0.2667	0.166	0.38 7
0.003	36	250	60	16	0.2667	0.166	0.38 7
0.003	36	300	60	16	0.2667	0.166	0.38 7
0.003	36	350	60	16	0.2667	0.166	0.38 7
0.003	36	400	60	17	0.2833	0.18	0.40 5
0.003	36	450	60	17	0.2833	0.18	0.40 5
0.003	36	500	60	17	0.2833	0.18	0.40 5

0.003	36	550	60	17	0.2833	0.18	0.405
0.003	36	600	60	17	0.2833	0.18	0.405
0.003	36	650	60	17	0.2833	0.18	0.405
0.003	36	700	60	17	0.2833	0.18	0.405
0.003	36	750	60	17	0.2833	0.18	0.405
0.003	36	800	60	17	0.2833	0.18	0.405
0.003	42	0	60	4	0.0667	0.021	0.148
0.003	42	50	60	6	0.1	0.041	0.192
0.003	42	100	60	13	0.2167	0.126	0.331
0.003	42	150	60	17	0.2833	0.18	0.405
0.003	42	200	60	17	0.2833	0.18	0.405
0.003	42	250	60	17	0.2833	0.18	0.405

0.003	42	300	60	17	0.2833	0.18	0.405
0.003	42	350	60	17	0.2833	0.18	0.405
0.003	42	400	60	18	0.3	0.194	0.423
0.003	42	450	60	18	0.3	0.194	0.423
0.003	42	500	60	18	0.3	0.194	0.423
0.003	42	550	60	18	0.3	0.194	0.423
0.003	42	600	60	18	0.3	0.194	0.423
0.003	42	650	60	18	0.3	0.194	0.423
0.003	42	700	60	18	0.3	0.194	0.423
0.003	42	750	60	18	0.3	0.194	0.423
0.003	42	800	60	18	0.3	0.194	0.423
0.003	48	0	60	5	0.0833	0.031	0.171

0.003	48	50	60	7	0.1167	0.052	0.213
0.003	48	100	60	15	0.25	0.152	0.369
0.003	48	150	60	18	0.3	0.194	0.423
0.003	48	200	60	18	0.3	0.194	0.423
0.003	48	250	60	18	0.3	0.194	0.423
0.003	48	300	60	18	0.3	0.194	0.423
0.003	48	350	60	18	0.3	0.194	0.423
0.003	48	400	60	19	0.3167	0.208	0.44
0.003	48	450	60	19	0.3167	0.208	0.44
0.003	48	500	60	19	0.3167	0.208	0.44
0.003	48	550	60	19	0.3167	0.208	0.44
0.003	48	600	60	19	0.3167	0.208	0.44
0.003	48	650	60	19	0.3167	0.208	0.44
0.003	48	700	60	19	0.3167	0.208	0.44
0.003	48	750	60	19	0.3167	0.208	0.44
0.003	48	800	60	19	0.3167	0.208	0.44
0.003	54	0	60	5	0.0833	0.031	0.171

0.003	54	50	60	7	0.1167	0.052	0.213
0.003	54	100	60	15	0.25	0.152	0.369
0.003	54	150	60	18	0.3	0.194	0.423
0.003	54	200	60	18	0.3	0.194	0.423
0.003	54	250	60	18	0.3	0.194	0.423
0.003	54	300	60	18	0.3	0.194	0.423
0.003	54	350	60	18	0.3	0.194	0.423
0.003	54	400	60	19	0.3167	0.208	0.44
0.003	54	450	60	19	0.3167	0.208	0.44
0.003	54	500	60	19	0.3167	0.208	0.44
0.003	54	550	60	19	0.3167	0.208	0.44
0.003	54	600	60	19	0.3167	0.208	0.44
0.003	54	650	60	19	0.3167	0.208	0.44
0.003	54	700	60	19	0.3167	0.208	0.44
0.003	54	750	60	19	0.3167	0.208	0.44
0.003	54	800	60	19	0.3167	0.208	0.44
0.003	60	0	60	5	0.0833	0.031	0.171

0.003	60	50	60	7	0.1167	0.052	0.213
0.003	60	100	60	16	0.2667	0.166	0.387
0.003	60	150	60	19	0.3167	0.208	0.44
0.003	60	200	60	19	0.3167	0.208	0.44
0.003	60	250	60	19	0.3167	0.208	0.44
0.003	60	300	60	19	0.3167	0.208	0.44
0.003	60	350	60	19	0.3167	0.208	0.44
0.003	60	400	60	20	0.3333	0.223	0.458
0.003	60	450	60	20	0.3333	0.223	0.458
0.003	60	500	60	20	0.3333	0.223	0.458
0.003	60	550	60	20	0.3333	0.223	0.458
0.003	60	600	60	20	0.3333	0.223	0.458
0.003	60	650	60	20	0.3333	0.223	0.458
0.003	60	700	60	20	0.3333	0.223	0.458
0.003	60	750	60	20	0.3333	0.223	0.458

0.003	60	800	60	20	0.3333	0.223	0.458
0.004	0	0	60	0	0	0	0.032
0.004	0	50	60	0	0	0	0.032
0.004	0	100	60	0	0	0	0.032
0.004	0	150	60	0	0	0	0.032
0.004	0	200	60	0	0	0	0.032
0.004	0	250	60	0	0	0	0.032
0.004	0	300	60	0	0	0	0.032
0.004	0	350	60	0	0	0	0.032
0.004	0	400	60	0	0	0	0.032
0.004	0	450	60	0	0	0	0.032
0.004	0	500	60	0	0	0	0.032

0.004	0	550	60	0	0	0	0.032
0.004	0	600	60	0	0	0	0.032
0.004	0	650	60	0	0	0	0.032
0.004	0	700	60	0	0	0	0.032
0.004	0	750	60	0	0	0	0.032
0.004	0	800	60	0	0	0	0.032
0.004	6	0	60	0	0	0	0.032
0.004	6	50	60	0	0	0	0.032
0.004	6	100	60	4	0.0667	0.021	0.148
0.004	6	150	60	7	0.1167	0.052	0.213
0.004	6	200	60	7	0.1167	0.052	0.213
0.004	6	250	60	8	0.1333	0.063	0.234

0.004	6	300	60	8	0.1333	0.063	0.234
0.004	6	350	60	8	0.1333	0.063	0.234
0.004	6	400	60	8	0.1333	0.063	0.234
0.004	6	450	60	8	0.1333	0.063	0.234
0.004	6	500	60	8	0.1333	0.063	0.234
0.004	6	550	60	8	0.1333	0.063	0.234
0.004	6	600	60	8	0.1333	0.063	0.234
0.004	6	650	60	8	0.1333	0.063	0.234
0.004	6	700	60	8	0.1333	0.063	0.234
0.004	6	750	60	8	0.1333	0.063	0.234
0.004	6	800	60	8	0.1333	0.063	0.234
0.004	12	0	60	2	0.0333	0.006	0.099

0.004	12	50	60	2	0.0333	0.006	0.099
0.004	12	100	60	7	0.1167	0.052	0.213
0.004	12	150	60	11	0.1833	0.1	0.293
0.004	12	200	60	11	0.1833	0.1	0.293
0.004	12	250	60	11	0.1833	0.1	0.293
0.004	12	300	60	11	0.1833	0.1	0.293
0.004	12	350	60	11	0.1833	0.1	0.293
0.004	12	400	60	11	0.1833	0.1	0.293
0.004	12	450	60	11	0.1833	0.1	0.293
0.004	12	500	60	11	0.1833	0.1	0.293
0.004	12	550	60	11	0.1833	0.1	0.293
0.004	12	600	60	11	0.1833	0.1	0.293

0.004	12	650	60	11	0.1833	0.1	0.293
0.004	12	700	60	11	0.1833	0.1	0.293
0.004	12	750	60	11	0.1833	0.1	0.293
0.004	12	800	60	11	0.1833	0.1	0.293
0.004	18	0	60	3	0.05	0.013	0.125
0.004	18	50	60	4	0.0667	0.021	0.148
0.004	18	100	60	9	0.15	0.075	0.254
0.004	18	150	60	13	0.2167	0.126	0.331
0.004	18	200	60	13	0.2167	0.126	0.331
0.004	18	250	60	13	0.2167	0.126	0.331
0.004	18	300	60	13	0.2167	0.126	0.331
0.004	18	350	60	13	0.2167	0.126	0.331

0.004	18	400	60	13	0.2167	0.126	0.331
0.004	18	450	60	13	0.2167	0.126	0.331
0.004	18	500	60	14	0.2333	0.139	0.35
0.004	18	550	60	14	0.2333	0.139	0.35
0.004	18	600	60	14	0.2333	0.139	0.35
0.004	18	650	60	14	0.2333	0.139	0.35
0.004	18	700	60	14	0.2333	0.139	0.35
0.004	18	750	60	14	0.2333	0.139	0.35
0.004	18	800	60	14	0.2333	0.139	0.35
0.004	24	0	60	3	0.05	0.013	0.125
0.004	24	50	60	4	0.0667	0.021	0.148
0.004	24	100	60	10	0.1667	0.087	0.274
0.004	24	150	60	15	0.25	0.152	0.369
0.004	24	200	60	15	0.25	0.152	0.369
0.004	24	250	60	15	0.25	0.152	0.369
0.004	24	300	60	15	0.25	0.152	0.369

0.004	24	350	60	15	0.25	0.152	0.369
0.004	24	400	60	16	0.2667	0.166	0.387
0.004	24	450	60	16	0.2667	0.166	0.387
0.004	24	500	60	16	0.2667	0.166	0.387
0.004	24	550	60	16	0.2667	0.166	0.387
0.004	24	600	60	16	0.2667	0.166	0.387
0.004	24	650	60	16	0.2667	0.166	0.387
0.004	24	700	60	16	0.2667	0.166	0.387
0.004	24	750	60	16	0.2667	0.166	0.387
0.004	24	800	60	16	0.2667	0.166	0.387
0.004	30	0	60	4	0.0667	0.021	0.148
0.004	30	50	60	7	0.1167	0.052	0.213

0.004	30	100	60	13	0.2167	0.126	0.331
0.004	30	150	60	18	0.3	0.194	0.423
0.004	30	200	60	19	0.3167	0.208	0.44
0.004	30	250	60	19	0.3167	0.208	0.44
0.004	30	300	60	19	0.3167	0.208	0.44
0.004	30	350	60	19	0.3167	0.208	0.44
0.004	30	400	60	20	0.3333	0.223	0.458
0.004	30	450	60	20	0.3333	0.223	0.458
0.004	30	500	60	20	0.3333	0.223	0.458
0.004	30	550	60	20	0.3333	0.223	0.458
0.004	30	600	60	20	0.3333	0.223	0.458
0.004	30	650	60	20	0.3333	0.223	0.458
0.004	30	700	60	20	0.3333	0.223	0.458
0.004	30	750	60	20	0.3333	0.223	0.458

0.004	30	800	60	20	0.3333	0.223	0.458
0.004	36	0	60	4	0.0667	0.021	0.148
0.004	36	50	60	7	0.1167	0.052	0.213
0.004	36	100	60	13	0.2167	0.126	0.331
0.004	36	150	60	18	0.3	0.194	0.423
0.004	36	200	60	19	0.3167	0.208	0.44
0.004	36	250	60	19	0.3167	0.208	0.44
0.004	36	300	60	19	0.3167	0.208	0.44
0.004	36	350	60	19	0.3167	0.208	0.44
0.004	36	400	60	20	0.3333	0.223	0.458
0.004	36	450	60	20	0.3333	0.223	0.458
0.004	36	500	60	20	0.3333	0.223	0.458
0.004	36	550	60	20	0.3333	0.223	0.458
0.004	36	600	60	20	0.3333	0.223	0.458

0.004	36	650	60	20	0.3333	0.223	0.458
0.004	36	700	60	20	0.3333	0.223	0.458
0.004	36	750	60	20	0.3333	0.223	0.458
0.004	36	800	60	20	0.3333	0.223	0.458
0.004	42	0	60	4	0.0667	0.021	0.148
0.004	42	50	60	7	0.1167	0.052	0.213
0.004	42	100	60	14	0.2333	0.139	0.35
0.004	42	150	60	19	0.3167	0.208	0.44
0.004	42	200	60	20	0.3333	0.223	0.458
0.004	42	250	60	20	0.3333	0.223	0.458
0.004	42	300	60	20	0.3333	0.223	0.458
0.004	42	350	60	20	0.3333	0.223	0.458
0.004	42	400	60	21	0.35	0.237	0.475

0.004	42	450	60	21	0.35	0.237	0.475
0.004	42	500	60	21	0.35	0.237	0.475
0.004	42	550	60	21	0.35	0.237	0.475
0.004	42	600	60	21	0.35	0.237	0.475
0.004	42	650	60	21	0.35	0.237	0.475
0.004	42	700	60	21	0.35	0.237	0.475
0.004	42	750	60	21	0.35	0.237	0.475
0.004	42	800	60	21	0.35	0.237	0.475
0.004	48	0	60	5	0.0833	0.031	0.171
0.004	48	50	60	8	0.1333	0.063	0.234
0.004	48	100	60	16	0.2667	0.166	0.387
0.004	48	150	60	20	0.3333	0.223	0.458

0.004	48	200	60	21	0.35	0.237	0.475
0.004	48	250	60	21	0.35	0.237	0.475
0.004	48	300	60	21	0.35	0.237	0.475
0.004	48	350	60	21	0.35	0.237	0.475
0.004	48	400	60	22	0.3667	0.252	0.492
0.004	48	450	60	22	0.3667	0.252	0.492
0.004	48	500	60	22	0.3667	0.252	0.492
0.004	48	550	60	22	0.3667	0.252	0.492
0.004	48	600	60	22	0.3667	0.252	0.492
0.004	48	650	60	22	0.3667	0.252	0.492
0.004	48	700	60	22	0.3667	0.252	0.492
0.004	48	750	60	22	0.3667	0.252	0.492

0.004	48	800	60	22	0.3667	0.252	0.492
0.004	54	0	60	5	0.0833	0.031	0.171
0.004	54	50	60	8	0.1333	0.063	0.234
0.004	54	100	60	16	0.2667	0.166	0.387
0.004	54	150	60	20	0.3333	0.223	0.458
0.004	54	200	60	21	0.35	0.237	0.475
0.004	54	250	60	21	0.35	0.237	0.475
0.004	54	300	60	21	0.35	0.237	0.475
0.004	54	350	60	21	0.35	0.237	0.475
0.004	54	400	60	22	0.3667	0.252	0.492
0.004	54	450	60	22	0.3667	0.252	0.492
0.004	54	500	60	22	0.3667	0.252	0.492

0.004	54	550	60	22	0.3667	0.252	0.492
0.004	54	600	60	22	0.3667	0.252	0.492
0.004	54	650	60	22	0.3667	0.252	0.492
0.004	54	700	60	22	0.3667	0.252	0.492
0.004	54	750	60	22	0.3667	0.252	0.492
0.004	54	800	60	22	0.3667	0.252	0.492
0.004	60	0	60	5	0.0833	0.031	0.171
0.004	60	50	60	8	0.1333	0.063	0.234
0.004	60	100	60	17	0.2833	0.18	0.405
0.004	60	150	60	21	0.35	0.237	0.475
0.004	60	200	60	22	0.3667	0.252	0.492
0.004	60	250	60	22	0.3667	0.252	0.492

0.004	60	300	60	22	0.3667	0.252	0.492
0.004	60	350	60	22	0.3667	0.252	0.492
0.004	60	400	60	23	0.3833	0.267	0.509
0.004	60	450	60	23	0.3833	0.267	0.509
0.004	60	500	60	23	0.3833	0.267	0.509
0.004	60	550	60	23	0.3833	0.267	0.509
0.004	60	600	60	23	0.3833	0.267	0.509
0.004	60	650	60	23	0.3833	0.267	0.509
0.004	60	700	60	23	0.3833	0.267	0.509
0.004	60	750	60	23	0.3833	0.267	0.509
0.004	60	800	60	23	0.3833	0.267	0.509
0.005	0	0	60	0	0	0	0.032

0.005	0	50	60	0	0	0	0.032
0.005	0	100	60	0	0	0	0.032
0.005	0	150	60	0	0	0	0.032
0.005	0	200	60	0	0	0	0.032
0.005	0	250	60	0	0	0	0.032
0.005	0	300	60	0	0	0	0.032
0.005	0	350	60	0	0	0	0.032
0.005	0	400	60	0	0	0	0.032
0.005	0	450	60	0	0	0	0.032
0.005	0	500	60	0	0	0	0.032
0.005	0	550	60	0	0	0	0.032
0.005	0	600	60	0	0	0	0.032

0.005	0	650	60	0	0	0	0.032
0.005	0	700	60	0	0	0	0.032
0.005	0	750	60	0	0	0	0.032
0.005	0	800	60	0	0	0	0.032
0.005	6	0	60	1	0.0167	1E-03	0.071
0.005	6	50	60	1	0.0167	1E-03	0.071
0.005	6	100	60	6	0.1	0.041	0.192
0.005	6	150	60	9	0.15	0.075	0.254
0.005	6	200	60	9	0.15	0.075	0.254
0.005	6	250	60	10	0.1667	0.087	0.274
0.005	6	300	60	10	0.1667	0.087	0.274
0.005	6	350	60	10	0.1667	0.087	0.274

0.005	6	400	60	10	0.1667	0.087	0.274
0.005	6	450	60	10	0.1667	0.087	0.274
0.005	6	500	60	11	0.1833	0.1	0.293
0.005	6	550	60	11	0.1833	0.1	0.293
0.005	6	600	60	11	0.1833	0.1	0.293
0.005	6	650	60	11	0.1833	0.1	0.293
0.005	6	700	60	11	0.1833	0.1	0.293
0.005	6	750	60	11	0.1833	0.1	0.293
0.005	6	800	60	11	0.1833	0.1	0.293
0.005	12	0	60	3	0.05	0.013	0.125
0.005	12	50	60	4	0.0667	0.021	0.148
0.005	12	100	60	9	0.15	0.075	0.254

0.005	12	150	60	13	0.2167	0.126	0.331
0.005	12	200	60	14	0.2333	0.139	0.35
0.005	12	250	60	15	0.25	0.152	0.369
0.005	12	300	60	15	0.25	0.152	0.369
0.005	12	350	60	15	0.25	0.152	0.369
0.005	12	400	60	15	0.25	0.152	0.369
0.005	12	450	60	15	0.25	0.152	0.369
0.005	12	500	60	16	0.2667	0.166	0.387
0.005	12	550	60	16	0.2667	0.166	0.387
0.005	12	600	60	16	0.2667	0.166	0.387
0.005	12	650	60	16	0.2667	0.166	0.387
0.005	12	700	60	16	0.2667	0.166	0.387
0.005	12	750	60	16	0.2667	0.166	0.387

0.005	12	800	60	16	0.2667	0.166	0.387
0.005	18	0	60	4	0.0667	0.021	0.148
0.005	18	50	60	6	0.1	0.041	0.192
0.005	18	100	60	11	0.1833	0.1	0.293
0.005	18	150	60	15	0.25	0.152	0.369
0.005	18	200	60	16	0.2667	0.166	0.387
0.005	18	250	60	17	0.2833	0.18	0.405
0.005	18	300	60	17	0.2833	0.18	0.405
0.005	18	350	60	17	0.2833	0.18	0.405
0.005	18	400	60	17	0.2833	0.18	0.405
0.005	18	450	60	17	0.2833	0.18	0.405
0.005	18	500	60	18	0.3	0.194	0.423

0.005	18	550	60	18	0.3	0.194	0.423
0.005	18	600	60	18	0.3	0.194	0.423
0.005	18	650	60	18	0.3	0.194	0.423
0.005	18	700	60	18	0.3	0.194	0.423
0.005	18	750	60	18	0.3	0.194	0.423
0.005	18	800	60	18	0.3	0.194	0.423
0.005	24	0	60	4	0.0667	0.021	0.148
0.005	24	50	60	6	0.1	0.041	0.192
0.005	24	100	60	12	0.2	0.113	0.313
0.005	24	150	60	18	0.3	0.194	0.423
0.005	24	200	60	19	0.3167	0.208	0.44
0.005	24	250	60	20	0.3333	0.223	0.458
0.005	24	300	60	20	0.3333	0.223	0.458

0.005	24	350	60	20	0.3333	0.223	0.458
0.005	24	400	60	21	0.35	0.237	0.475
0.005	24	450	60	21	0.35	0.237	0.475
0.005	24	500	60	21	0.35	0.237	0.475
0.005	24	550	60	21	0.35	0.237	0.475
0.005	24	600	60	21	0.35	0.237	0.475
0.005	24	650	60	21	0.35	0.237	0.475
0.005	24	700	60	21	0.35	0.237	0.475
0.005	24	750	60	21	0.35	0.237	0.475
0.005	24	800	60	21	0.35	0.237	0.475
0.005	30	0	60	6	0.1	0.041	0.192
0.005	30	50	60	10	0.1667	0.087	0.274

0.005	30	100	60	17	0.2833	0.18	0.405
0.005	30	150	60	23	0.3833	0.267	0.509
0.005	30	200	60	25	0.4167	0.297	0.543
0.005	30	250	60	26	0.4333	0.313	0.56
0.005	30	300	60	26	0.4333	0.313	0.56
0.005	30	350	60	26	0.4333	0.313	0.56
0.005	30	400	60	27	0.45	0.328	0.576
0.005	30	450	60	27	0.45	0.328	0.576
0.005	30	500	60	27	0.45	0.328	0.576
0.005	30	550	60	27	0.45	0.328	0.576
0.005	30	600	60	27	0.45	0.328	0.576
0.005	30	650	60	27	0.45	0.328	0.576
0.005	30	700	60	27	0.45	0.328	0.576
0.005	30	750	60	27	0.45	0.328	0.576

0.005	30	800	60	27	0.45	0.328	0.576
0.005	36	0	60	6	0.1	0.041	0.192
0.005	36	50	60	11	0.1833	0.1	0.293
0.005	36	100	60	18	0.3	0.194	0.423
0.005	36	150	60	24	0.4	0.282	0.526
0.005	36	200	60	26	0.4333	0.313	0.56
0.005	36	250	60	27	0.45	0.328	0.576
0.005	36	300	60	27	0.45	0.328	0.576
0.005	36	350	60	27	0.45	0.328	0.576
0.005	36	400	60	28	0.4667	0.344	0.592
0.005	36	450	60	28	0.4667	0.344	0.592
0.005	36	500	60	28	0.4667	0.344	0.592
0.005	36	550	60	28	0.4667	0.344	0.592

0.005	36	600	60	28	0.4667	0.344	0.592
0.005	36	650	60	28	0.4667	0.344	0.592
0.005	36	700	60	28	0.4667	0.344	0.592
0.005	36	750	60	28	0.4667	0.344	0.592
0.005	36	800	60	28	0.4667	0.344	0.592
0.005	42	0	60	6	0.1	0.041	0.192
0.005	42	50	60	11	0.1833	0.1	0.293
0.005	42	100	60	20	0.3333	0.223	0.458
0.005	42	150	60	25	0.4167	0.297	0.543
0.005	42	200	60	27	0.45	0.328	0.576
0.005	42	250	60	28	0.4667	0.344	0.592
0.005	42	300	60	28	0.4667	0.344	0.592

0.005	42	350	60	28	0.4667	0.344	0.592
0.005	42	400	60	29	0.4833	0.36	0.608
0.005	42	450	60	29	0.4833	0.36	0.608
0.005	42	500	60	29	0.4833	0.36	0.608
0.005	42	550	60	29	0.4833	0.36	0.608
0.005	42	600	60	29	0.4833	0.36	0.608
0.005	42	650	60	29	0.4833	0.36	0.608
0.005	42	700	60	29	0.4833	0.36	0.608
0.005	42	750	60	29	0.4833	0.36	0.608
0.005	42	800	60	29	0.4833	0.36	0.608
0.005	48	0	60	7	0.1167	0.052	0.213
0.005	48	50	60	12	0.2	0.113	0.313

0.005	48	100	60	23	0.3833	0.267	0.509
0.005	48	150	60	27	0.45	0.328	0.576
0.005	48	200	60	28	0.4667	0.344	0.592
0.005	48	250	60	29	0.4833	0.36	0.608
0.005	48	300	60	29	0.4833	0.36	0.608
0.005	48	350	60	29	0.4833	0.36	0.608
0.005	48	400	60	30	0.5	0.375	0.625
0.005	48	450	60	30	0.5	0.375	0.625
0.005	48	500	60	30	0.5	0.375	0.625
0.005	48	550	60	30	0.5	0.375	0.625
0.005	48	600	60	30	0.5	0.375	0.625
0.005	48	650	60	30	0.5	0.375	0.625

0.005	48	700	60	30	0.5	0.375	0.625
0.005	48	750	60	30	0.5	0.375	0.625
0.005	48	800	60	30	0.5	0.375	0.625
0.005	54	0	60	7	0.1167	0.052	0.213
0.005	54	50	60	12	0.2	0.113	0.313
0.005	54	100	60	23	0.3833	0.267	0.509
0.005	54	150	60	27	0.45	0.328	0.576
0.005	54	200	60	28	0.4667	0.344	0.592
0.005	54	250	60	29	0.4833	0.36	0.608
0.005	54	300	60	29	0.4833	0.36	0.608
0.005	54	350	60	29	0.4833	0.36	0.608
0.005	54	400	60	30	0.5	0.375	0.625

0.005	54	450	60	30	0.5	0.375	0.625
0.005	54	500	60	30	0.5	0.375	0.625
0.005	54	550	60	30	0.5	0.375	0.625
0.005	54	600	60	30	0.5	0.375	0.625
0.005	54	650	60	30	0.5	0.375	0.625
0.005	54	700	60	30	0.5	0.375	0.625
0.005	54	750	60	30	0.5	0.375	0.625
0.005	54	800	60	30	0.5	0.375	0.625
0.005	60	0	60	7	0.1167	0.052	0.213
0.005	60	50	60	12	0.2	0.113	0.313
0.005	60	100	60	24	0.4	0.282	0.526
0.005	60	150	60	28	0.4667	0.344	0.592

0.005	60	200	60	29	0.4833	0.36	0.608
0.005	60	250	60	30	0.5	0.375	0.625
0.005	60	300	60	30	0.5	0.375	0.625
0.005	60	350	60	30	0.5	0.375	0.625
0.005	60	400	60	31	0.5167	0.392	0.64
0.005	60	450	60	31	0.5167	0.392	0.64
0.005	60	500	60	31	0.5167	0.392	0.64
0.005	60	550	60	31	0.5167	0.392	0.64
0.005	60	600	60	31	0.5167	0.392	0.64
0.005	60	650	60	31	0.5167	0.392	0.64
0.005	60	700	60	31	0.5167	0.392	0.64
0.005	60	750	60	31	0.5167	0.392	0.64
0.005	60	800	60	31	0.5167	0.392	0.64
0.006	0	0	60	0	0	0	0.032
0.006	0	50	60	0	0	0	0.032
0.006	0	100	60	0	0	0	0.032
0.006	0	150	60	0	0	0	0.032

0.006	0	200	60	0	0	0	0.032
0.006	0	250	60	0	0	0	0.032
0.006	0	300	60	1	0.0167	1E-03	0.071
0.006	0	350	60	1	0.0167	1E-03	0.071
0.006	0	400	60	1	0.0167	1E-03	0.071
0.006	0	450	60	1	0.0167	1E-03	0.071
0.006	0	500	60	1	0.0167	1E-03	0.071
0.006	0	550	60	1	0.0167	1E-03	0.071
0.006	0	600	60	1	0.0167	1E-03	0.071
0.006	0	650	60	1	0.0167	1E-03	0.071
0.006	0	700	60	1	0.0167	1E-03	0.071
0.006	0	750	60	1	0.0167	1E-03	0.071

0.006	0	800	60	1	0.0167	1E-03	0.071
0.006	6	0	60	1	0.0167	1E-03	0.071
0.006	6	50	60	1	0.0167	1E-03	0.071
0.006	6	100	60	7	0.1167	0.052	0.213
0.006	6	150	60	10	0.1667	0.087	0.274
0.006	6	200	60	10	0.1667	0.087	0.274
0.006	6	250	60	13	0.2167	0.126	0.331
0.006	6	300	60	13	0.2167	0.126	0.331
0.006	6	350	60	13	0.2167	0.126	0.331
0.006	6	400	60	13	0.2167	0.126	0.331
0.006	6	450	60	13	0.2167	0.126	0.331
0.006	6	500	60	14	0.2333	0.139	0.35
0.006	6	550	60	14	0.2333	0.139	0.35
0.006	6	600	60	14	0.2333	0.139	0.35

0.006	6	650	60	14	0.2333	0.139	0.35
0.006	6	700	60	14	0.2333	0.139	0.35
0.006	6	750	60	14	0.2333	0.139	0.35
0.006	6	800	60	14	0.2333	0.139	0.35
0.006	12	0	60	3	0.05	0.013	0.125
0.006	12	50	60	4	0.0667	0.021	0.148
0.006	12	100	60	11	0.1833	0.1	0.293
0.006	12	150	60	15	0.25	0.152	0.369
0.006	12	200	60	16	0.2667	0.166	0.387
0.006	12	250	60	17	0.2833	0.18	0.405
0.006	12	300	60	17	0.2833	0.18	0.405
0.006	12	350	60	17	0.2833	0.18	0.405
0.006	12	400	60	17	0.2833	0.18	0.405
0.006	12	450	60	17	0.2833	0.18	0.405

0.006	12	500	60	18	0.3	0.194	0.423
0.006	12	550	60	18	0.3	0.194	0.423
0.006	12	600	60	18	0.3	0.194	0.423
0.006	12	650	60	18	0.3	0.194	0.423
0.006	12	700	60	18	0.3	0.194	0.423
0.006	12	750	60	18	0.3	0.194	0.423
0.006	12	800	60	18	0.3	0.194	0.423
0.006	18	0	60	4	0.0667	0.021	0.148
0.006	18	50	60	8	0.1333	0.063	0.234
0.006	18	100	60	15	0.25	0.152	0.369
0.006	18	150	60	19	0.3167	0.208	0.44
0.006	18	200	60	20	0.3333	0.223	0.458
0.006	18	250	60	21	0.35	0.237	0.475

0.006	18	300	60	21	0.35	0.237	0.475
0.006	18	350	60	21	0.35	0.237	0.475
0.006	18	400	60	21	0.35	0.237	0.475
0.006	18	450	60	22	0.3667	0.252	0.492
0.006	18	500	60	23	0.3833	0.267	0.509
0.006	18	550	60	23	0.3833	0.267	0.509
0.006	18	600	60	23	0.3833	0.267	0.509
0.006	18	650	60	23	0.3833	0.267	0.509
0.006	18	700	60	23	0.3833	0.267	0.509
0.006	18	750	60	23	0.3833	0.267	0.509
0.006	18	800	60	23	0.3833	0.267	0.509
0.006	24	0	60	5	0.0833	0.031	0.171

0.006	24	50	60	9	0.15	0.075	0.254
0.006	24	100	60	17	0.2833	0.18	0.405
0.006	24	150	60	23	0.3833	0.267	0.509
0.006	24	200	60	23	0.3833	0.267	0.509
0.006	24	250	60	24	0.4	0.282	0.526
0.006	24	300	60	24	0.4	0.282	0.526
0.006	24	350	60	24	0.4	0.282	0.526
0.006	24	400	60	25	0.4167	0.297	0.543
0.006	24	450	60	26	0.4333	0.313	0.56
0.006	24	500	60	26	0.4333	0.313	0.56
0.006	24	550	60	27	0.45	0.328	0.576
0.006	24	600	60	27	0.45	0.328	0.576
0.006	24	650	60	27	0.45	0.328	0.576

0.006	24	700	60	27	0.45	0.328	0.576
0.006	24	750	60	27	0.45	0.328	0.576
0.006	24	800	60	27	0.45	0.328	0.576
0.006	30	0	60	7	0.1167	0.052	0.213
0.006	30	50	60	13	0.2167	0.126	0.331
0.006	30	100	60	22	0.3667	0.252	0.492
0.006	30	150	60	27	0.45	0.328	0.576
0.006	30	200	60	28	0.4667	0.344	0.592
0.006	30	250	60	29	0.4833	0.36	0.608
0.006	30	300	60	29	0.4833	0.36	0.608
0.006	30	350	60	29	0.4833	0.36	0.608
0.006	30	400	60	30	0.5	0.375	0.625
0.006	30	450	60	31	0.5167	0.392	0.64

0.006	30	500	60	31	0.5167	0.392	0.64
0.006	30	550	60	32	0.5333	0.408	0.656
0.006	30	600	60	32	0.5333	0.408	0.656
0.006	30	650	60	32	0.5333	0.408	0.656
0.006	30	700	60	32	0.5333	0.408	0.656
0.006	30	750	60	32	0.5333	0.408	0.656
0.006	30	800	60	32	0.5333	0.408	0.656
0.006	36	0	60	7	0.1167	0.052	0.213
0.006	36	50	60	14	0.2333	0.139	0.35
0.006	36	100	60	23	0.3833	0.267	0.509
0.006	36	150	60	29	0.4833	0.36	0.608
0.006	36	200	60	29	0.4833	0.36	0.608
0.006	36	250	60	30	0.5	0.375	0.625

0.006	36	300	60	30	0.5	0.375	0.625
0.006	36	350	60	30	0.5	0.375	0.625
0.006	36	400	60	31	0.5167	0.392	0.64
0.006	36	450	60	33	0.55	0.424	0.672
0.006	36	500	60	33	0.55	0.424	0.672
0.006	36	550	60	34	0.5667	0.44	0.687
0.006	36	600	60	34	0.5667	0.44	0.687
0.006	36	650	60	34	0.5667	0.44	0.687
0.006	36	700	60	34	0.5667	0.44	0.687
0.006	36	750	60	34	0.5667	0.44	0.687
0.006	36	800	60	34	0.5667	0.44	0.687
0.006	42	0	60	7	0.1167	0.052	0.213
0.006	42	50	60	14	0.2333	0.139	0.35

0.006	42	100	60	25	0.4167	0.297	0.543
0.006	42	150	60	30	0.5	0.375	0.625
0.006	42	200	60	30	0.5	0.375	0.625
0.006	42	250	60	31	0.5167	0.392	0.64
0.006	42	300	60	31	0.5167	0.392	0.64
0.006	42	350	60	32	0.5333	0.408	0.656
0.006	42	400	60	33	0.55	0.424	0.672
0.006	42	450	60	34	0.5667	0.44	0.687
0.006	42	500	60	34	0.5667	0.44	0.687
0.006	42	550	60	34	0.5667	0.44	0.687
0.006	42	600	60	34	0.5667	0.44	0.687
0.006	42	650	60	34	0.5667	0.44	0.687
0.006	42	700	60	34	0.5667	0.44	0.687

0.006	42	750	60	34	0.5667	0.44	0.687
0.006	42	800	60	34	0.5667	0.44	0.687
0.006	48	0	60	8	0.1333	0.063	0.234
0.006	48	50	60	14	0.2333	0.139	0.35
0.006	48	100	60	28	0.4667	0.344	0.592
0.006	48	150	60	31	0.5167	0.392	0.64
0.006	48	200	60	31	0.5167	0.392	0.64
0.006	48	250	60	32	0.5333	0.408	0.656
0.006	48	300	60	33	0.55	0.424	0.672
0.006	48	350	60	34	0.5667	0.44	0.687
0.006	48	400	60	35	0.5833	0.457	0.703
0.006	48	450	60	36	0.6	0.474	0.718
0.006	48	500	60	36	0.6	0.474	0.718
0.006	48	550	60	36	0.6	0.474	0.718

0.006	48	600	60	36	0.6	0.474	0.718
0.006	48	650	60	36	0.6	0.474	0.718
0.006	48	700	60	36	0.6	0.474	0.718
0.006	48	750	60	36	0.6	0.474	0.718
0.006	48	800	60	36	0.6	0.474	0.718
0.006	54	0	60	8	0.1333	0.063	0.234
0.006	54	50	60	14	0.2333	0.139	0.35
0.006	54	100	60	28	0.4667	0.344	0.592
0.006	54	150	60	31	0.5167	0.392	0.64
0.006	54	200	60	31	0.5167	0.392	0.64
0.006	54	250	60	32	0.5333	0.408	0.656
0.006	54	300	60	33	0.55	0.424	0.672
0.006	54	350	60	34	0.5667	0.44	0.687
0.006	54	400	60	35	0.5833	0.457	0.703

0.006	54	450	60	36	0.6	0.474	0.718
0.006	54	500	60	36	0.6	0.474	0.718
0.006	54	550	60	36	0.6	0.474	0.718
0.006	54	600	60	36	0.6	0.474	0.718
0.006	54	650	60	36	0.6	0.474	0.718
0.006	54	700	60	36	0.6	0.474	0.718
0.006	54	750	60	36	0.6	0.474	0.718
0.006	54	800	60	36	0.6	0.474	0.718
0.006	60	0	60	8	0.1333	0.063	0.234
0.006	60	50	60	14	0.2333	0.139	0.35
0.006	60	100	60	29	0.4833	0.36	0.608
0.006	60	150	60	33	0.55	0.424	0.672
0.006	60	200	60	33	0.55	0.424	0.672

0.006	60	250	60	34	0.5667	0.44	0.687
0.006	60	300	60	35	0.5833	0.457	0.703
0.006	60	350	60	36	0.6	0.474	0.718
0.006	60	400	60	37	0.6167	0.491	0.733
0.006	60	450	60	37	0.6167	0.491	0.733
0.006	60	500	60	37	0.6167	0.491	0.733
0.006	60	550	60	37	0.6167	0.491	0.733
0.006	60	600	60	37	0.6167	0.491	0.733
0.006	60	650	60	37	0.6167	0.491	0.733
0.006	60	700	60	37	0.6167	0.491	0.733
0.006	60	750	60	37	0.6167	0.491	0.733
0.006	60	800	60	37	0.6167	0.491	0.733

0.007	0	0	60	0	0	0	0.032
0.007	0	50	60	0	0	0	0.032
0.007	0	100	60	0	0	0	0.032
0.007	0	150	60	0	0	0	0.032
0.007	0	200	60	0	0	0	0.032
0.007	0	250	60	0	0	0	0.032
0.007	0	300	60	1	0.0167	1E-03	0.071
0.007	0	350	60	1	0.0167	1E-03	0.071
0.007	0	400	60	1	0.0167	1E-03	0.071
0.007	0	450	60	1	0.0167	1E-03	0.071
0.007	0	500	60	1	0.0167	1E-03	0.071
0.007	0	550	60	1	0.0167	1E-03	0.071

0.007	0	600	60	1	0.0167	1E-03	0.071
0.007	0	650	60	1	0.0167	1E-03	0.071
0.007	0	700	60	1	0.0167	1E-03	0.071
0.007	0	750	60	1	0.0167	1E-03	0.071
0.007	0	800	60	1	0.0167	1E-03	0.071
0.007	6	0	60	1	0.0167	1E-03	0.071
0.007	6	50	60	1	0.0167	1E-03	0.071
0.007	6	100	60	7	0.1167	0.052	0.213
0.007	6	150	60	10	0.1667	0.087	0.274
0.007	6	200	60	10	0.1667	0.087	0.274
0.007	6	250	60	13	0.2167	0.126	0.331
0.007	6	300	60	13	0.2167	0.126	0.331

0.007	6	350	60	13		0.2167	0.126	0.331
0.007	6	400	60	13		0.2167	0.126	0.331
0.007	6	450	60	13		0.2167	0.126	0.331
0.007	6	500	60	14		0.2333	0.139	0.35
0.007	6	550	60	14		0.2333	0.139	0.35
0.007	6	600	60	14		0.2333	0.139	0.35
0.007	6	650	60	14		0.2333	0.139	0.35
0.007	6	700	60	14		0.2333	0.139	0.35
0.007	6	750	60	14		0.2333	0.139	0.35
0.007	6	800	60	14		0.2333	0.139	0.35
0.007	12	0	60	3		0.05	0.013	0.125
0.007	12	50	60	4		0.0667	0.021	0.148
0.007	12	100	60	12		0.2	0.113	0.313
0.007	12	150	60	16		0.2667	0.166	0.387
0.007	12	200	60	17		0.2833	0.18	0.405
0.007	12	250	60	18		0.3	0.194	0.423

0.007	12	300	60	18	0.3	0.194	0.423
0.007	12	350	60	18	0.3	0.194	0.423
0.007	12	400	60	18	0.3	0.194	0.423
0.007	12	450	60	18	0.3	0.194	0.423
0.007	12	500	60	20	0.3333	0.223	0.458
0.007	12	550	60	20	0.3333	0.223	0.458
0.007	12	600	60	20	0.3333	0.223	0.458
0.007	12	650	60	20	0.3333	0.223	0.458
0.007	12	700	60	20	0.3333	0.223	0.458
0.007	12	750	60	20	0.3333	0.223	0.458
0.007	12	800	60	20	0.3333	0.223	0.458
0.007	18	0	60	5	0.0833	0.031	0.171

0.007	18	50	60	9	0.15	0.075	0.254
0.007	18	100	60	17	0.2833	0.18	0.405
0.007	18	150	60	21	0.35	0.237	0.475
0.007	18	200	60	22	0.3667	0.252	0.492
0.007	18	250	60	24	0.4	0.282	0.526
0.007	18	300	60	24	0.4	0.282	0.526
0.007	18	350	60	24	0.4	0.282	0.526
0.007	18	400	60	24	0.4	0.282	0.526
0.007	18	450	60	25	0.4167	0.297	0.543
0.007	18	500	60	26	0.4333	0.313	0.56
0.007	18	550	60	26	0.4333	0.313	0.56
0.007	18	600	60	26	0.4333	0.313	0.56
0.007	18	650	60	26	0.4333	0.313	0.56
0.007	18	700	60	26	0.4333	0.313	0.56
0.007	18	750	60	26	0.4333	0.313	0.56
0.007	18	800	60	26	0.4333	0.313	0.56

0.007	24	0	60	6	0.1	0.041	0.192
0.007	24	50	60	10	0.1667	0.087	0.274
0.007	24	100	60	19	0.3167	0.208	0.44
0.007	24	150	60	25	0.4167	0.297	0.543
0.007	24	200	60	25	0.4167	0.297	0.543
0.007	24	250	60	27	0.45	0.328	0.576
0.007	24	300	60	27	0.45	0.328	0.576
0.007	24	350	60	27	0.45	0.328	0.576
0.007	24	400	60	29	0.4833	0.36	0.608
0.007	24	450	60	30	0.5	0.375	0.625
0.007	24	500	60	30	0.5	0.375	0.625
0.007	24	550	60	30	0.5	0.375	0.625
0.007	24	600	60	30	0.5	0.375	0.625

0.007	24	650	60	30	0.5	0.375	0.625
0.007	24	700	60	30	0.5	0.375	0.625
0.007	24	750	60	30	0.5	0.375	0.625
0.007	24	800	60	30	0.5	0.375	0.625
0.007	30	0	60	8	0.1333	0.063	0.234
0.007	30	50	60	14	0.2333	0.139	0.35
0.007	30	100	60	24	0.4	0.282	0.526
0.007	30	150	60	29	0.4833	0.36	0.608
0.007	30	200	60	30	0.5	0.375	0.625
0.007	30	250	60	32	0.5333	0.408	0.656
0.007	30	300	60	32	0.5333	0.408	0.656
0.007	30	350	60	32	0.5333	0.408	0.656
0.007	30	400	60	34	0.5667	0.44	0.687

0.007	30	450	60	34	0.5667	0.44	0.687
0.007	30	500	60	34	0.5667	0.44	0.687
0.007	30	550	60	34	0.5667	0.44	0.687
0.007	30	600	60	34	0.5667	0.44	0.687
0.007	30	650	60	34	0.5667	0.44	0.687
0.007	30	700	60	34	0.5667	0.44	0.687
0.007	30	750	60	34	0.5667	0.44	0.687
0.007	30	800	60	34	0.5667	0.44	0.687
0.007	36	0	60	9	0.15	0.075	0.254
0.007	36	50	60	16	0.2667	0.166	0.387
0.007	36	100	60	26	0.4333	0.313	0.56
0.007	36	150	60	32	0.5333	0.408	0.656
0.007	36	200	60	32	0.5333	0.408	0.656

0.007	36	250	60	34	0.5667	0.44	0.687
0.007	36	300	60	34	0.5667	0.44	0.687
0.007	36	350	60	34	0.5667	0.44	0.687
0.007	36	400	60	36	0.6	0.474	0.718
0.007	36	450	60	36	0.6	0.474	0.718
0.007	36	500	60	36	0.6	0.474	0.718
0.007	36	550	60	36	0.6	0.474	0.718
0.007	36	600	60	36	0.6	0.474	0.718
0.007	36	650	60	36	0.6	0.474	0.718
0.007	36	700	60	36	0.6	0.474	0.718
0.007	36	750	60	36	0.6	0.474	0.718
0.007	36	800	60	36	0.6	0.474	0.718

0.007	42	0	60	9	0.15	0.075	0.254
0.007	42	50	60	16	0.2667	0.166	0.387
0.007	42	100	60	27	0.45	0.328	0.576
0.007	42	150	60	32	0.5333	0.408	0.656
0.007	42	200	60	32	0.5333	0.408	0.656
0.007	42	250	60	34	0.5667	0.44	0.687
0.007	42	300	60	34	0.5667	0.44	0.687
0.007	42	350	60	34	0.5667	0.44	0.687
0.007	42	400	60	36	0.6	0.474	0.718
0.007	42	450	60	36	0.6	0.474	0.718
0.007	42	500	60	36	0.6	0.474	0.718
0.007	42	550	60	36	0.6	0.474	0.718

0.007	42	600	60	36	0.6	0.474	0.718
0.007	42	650	60	36	0.6	0.474	0.718
0.007	42	700	60	36	0.6	0.474	0.718
0.007	42	750	60	36	0.6	0.474	0.718
0.007	42	800	60	36	0.6	0.474	0.718
0.007	48	0	60	10	0.1667	0.087	0.274
0.007	48	50	60	16	0.2667	0.166	0.387
0.007	48	100	60	30	0.5	0.375	0.625
0.007	48	150	60	33	0.55	0.424	0.672
0.007	48	200	60	33	0.55	0.424	0.672
0.007	48	250	60	35	0.5833	0.457	0.703
0.007	48	300	60	36	0.6	0.474	0.718

0.007	48	350	60	36	0.6	0.474	0.718
0.007	48	400	60	38	0.6333	0.508	0.748
0.007	48	450	60	38	0.6333	0.508	0.748
0.007	48	500	60	38	0.6333	0.508	0.748
0.007	48	550	60	38	0.6333	0.508	0.748
0.007	48	600	60	38	0.6333	0.508	0.748
0.007	48	650	60	38	0.6333	0.508	0.748
0.007	48	700	60	38	0.6333	0.508	0.748
0.007	48	750	60	38	0.6333	0.508	0.748
0.007	48	800	60	38	0.6333	0.508	0.748
0.007	54	0	60	10	0.1667	0.087	0.274
0.007	54	50	60	16	0.2667	0.166	0.387

0.007	54	100	60	30	0.5	0.375	0.625
0.007	54	150	60	33	0.55	0.424	0.672
0.007	54	200	60	33	0.55	0.424	0.672
0.007	54	250	60	35	0.5833	0.457	0.703
0.007	54	300	60	36	0.6	0.474	0.718
0.007	54	350	60	36	0.6	0.474	0.718
0.007	54	400	60	38	0.6333	0.508	0.748
0.007	54	450	60	38	0.6333	0.508	0.748
0.007	54	500	60	38	0.6333	0.508	0.748
0.007	54	550	60	38	0.6333	0.508	0.748
0.007	54	600	60	38	0.6333	0.508	0.748
0.007	54	650	60	38	0.6333	0.508	0.748

0.007	54	700	60	38	0.6333	0.508	0.748
0.007	54	750	60	38	0.6333	0.508	0.748
0.007	54	800	60	38	0.6333	0.508	0.748
0.007	60	0	60	10	0.1667	0.087	0.274
0.007	60	50	60	16	0.2667	0.166	0.387
0.007	60	100	60	31	0.5167	0.392	0.64
0.007	60	150	60	36	0.6	0.474	0.718
0.007	60	200	60	36	0.6	0.474	0.718
0.007	60	250	60	38	0.6333	0.508	0.748
0.007	60	300	60	39	0.65	0.525	0.763
0.007	60	350	60	39	0.65	0.525	0.763
0.007	60	400	60	40	0.6667	0.542	0.777
0.007	60	450	60	40	0.6667	0.542	0.777

0.007	60	500	60	40	0.6667	0.542	0.777
0.007	60	550	60	40	0.6667	0.542	0.777
0.007	60	600	60	40	0.6667	0.542	0.777
0.007	60	650	60	40	0.6667	0.542	0.777
0.007	60	700	60	40	0.6667	0.542	0.777
0.007	60	750	60	40	0.6667	0.542	0.777
0.007	60	800	60	40	0.6667	0.542	0.777
0.008	0	0	60	0	0	0	0.032
0.008	0	50	60	1	0.0167	1E-03	0.071
0.008	0	100	60	1	0.0167	1E-03	0.071
0.008	0	150	60	1	0.0167	1E-03	0.071
0.008	0	200	60	1	0.0167	1E-03	0.071

0.008	0	250	60	1	0.0167	1E-03	0.071
0.008	0	300	60	2	0.0333	0.006	0.099
0.008	0	350	60	2	0.0333	0.006	0.099
0.008	0	400	60	2	0.0333	0.006	0.099
0.008	0	450	60	2	0.0333	0.006	0.099
0.008	0	500	60	2	0.0333	0.006	0.099
0.008	0	550	60	2	0.0333	0.006	0.099
0.008	0	600	60	2	0.0333	0.006	0.099
0.008	0	650	60	2	0.0333	0.006	0.099
0.008	0	700	60	2	0.0333	0.006	0.099
0.008	0	750	60	2	0.0333	0.006	0.099
0.008	0	800	60	2	0.0333	0.006	0.099

0.008	6	0	60	1	0.0167	1E-03	0.071
0.008	6	50	60	3	0.05	0.013	0.125
0.008	6	100	60	10	0.1667	0.087	0.274
0.008	6	150	60	14	0.2333	0.139	0.35
0.008	6	200	60	14	0.2333	0.139	0.35
0.008	6	250	60	17	0.2833	0.18	0.405
0.008	6	300	60	17	0.2833	0.18	0.405
0.008	6	350	60	17	0.2833	0.18	0.405
0.008	6	400	60	18	0.3	0.194	0.423
0.008	6	450	60	18	0.3	0.194	0.423
0.008	6	500	60	19	0.3167	0.208	0.44
0.008	6	550	60	19	0.3167	0.208	0.44
0.008	6	600	60	19	0.3167	0.208	0.44
0.008	6	650	60	19	0.3167	0.208	0.44
0.008	6	700	60	19	0.3167	0.208	0.44
0.008	6	750	60	19	0.3167	0.208	0.44
0.008	6	800	60	19	0.3167	0.208	0.44

0.008	12	0	60	4	0.0667	0.021	0.148
0.008	12	50	60	7	0.1167	0.052	0.213
0.008	12	100	60	17	0.2833	0.18	0.405
0.008	12	150	60	21	0.35	0.237	0.475
0.008	12	200	60	22	0.3667	0.252	0.492
0.008	12	250	60	23	0.3833	0.267	0.509
0.008	12	300	60	23	0.3833	0.267	0.509
0.008	12	350	60	23	0.3833	0.267	0.509
0.008	12	400	60	24	0.4	0.282	0.526
0.008	12	450	60	24	0.4	0.282	0.526
0.008	12	500	60	26	0.4333	0.313	0.56
0.008	12	550	60	26	0.4333	0.313	0.56
0.008	12	600	60	26	0.4333	0.313	0.56
0.008	12	650	60	26	0.4333	0.313	0.56
0.008	12	700	60	26	0.4333	0.313	0.56

0.008	12	750	60	26	0.4333	0.313	0.56
0.008	12	800	60	26	0.4333	0.313	0.56
0.008	18	0	60	6	0.1	0.041	0.192
0.008	18	50	60	12	0.2	0.113	0.313
0.008	18	100	60	21	0.35	0.237	0.475
0.008	18	150	60	24	0.4	0.282	0.526
0.008	18	200	60	25	0.4167	0.297	0.543
0.008	18	250	60	27	0.45	0.328	0.576
0.008	18	300	60	27	0.45	0.328	0.576
0.008	18	350	60	27	0.45	0.328	0.576
0.008	18	400	60	27	0.45	0.328	0.576
0.008	18	450	60	28	0.4667	0.344	0.592
0.008	18	500	60	29	0.4833	0.36	0.608

0.008	18	550	60	29	0.4833	0.36	0.608
0.008	18	600	60	29	0.4833	0.36	0.608
0.008	18	650	60	29	0.4833	0.36	0.608
0.008	18	700	60	29	0.4833	0.36	0.608
0.008	18	750	60	29	0.4833	0.36	0.608
0.008	18	800	60	29	0.4833	0.36	0.608
0.008	24	0	60	7	0.1167	0.052	0.213
0.008	24	50	60	13	0.2167	0.126	0.331
0.008	24	100	60	23	0.3833	0.267	0.509
0.008	24	150	60	28	0.4667	0.344	0.592
0.008	24	200	60	28	0.4667	0.344	0.592
0.008	24	250	60	30	0.5	0.375	0.625

0.008	24	300	60	30	0.5	0.375	0.625
0.008	24	350	60	30	0.5	0.375	0.625
0.008	24	400	60	32	0.5333	0.408	0.656
0.008	24	450	60	33	0.55	0.424	0.672
0.008	24	500	60	34	0.5667	0.44	0.687
0.008	24	550	60	34	0.5667	0.44	0.687
0.008	24	600	60	34	0.5667	0.44	0.687
0.008	24	650	60	34	0.5667	0.44	0.687
0.008	24	700	60	34	0.5667	0.44	0.687
0.008	24	750	60	34	0.5667	0.44	0.687
0.008	24	800	60	34	0.5667	0.44	0.687
0.008	30	0	60	9	0.15	0.075	0.254

0.008	30	50	60	17	0.2833	0.18	0.405
0.008	30	100	60	29	0.4833	0.36	0.608
0.008	30	150	60	34	0.5667	0.44	0.687
0.008	30	200	60	35	0.5833	0.457	0.703
0.008	30	250	60	37	0.6167	0.491	0.733
0.008	30	300	60	37	0.6167	0.491	0.733
0.008	30	350	60	37	0.6167	0.491	0.733
0.008	30	400	60	39	0.65	0.525	0.763
0.008	30	450	60	39	0.65	0.525	0.763
0.008	30	500	60	40	0.6667	0.542	0.777
0.008	30	550	60	40	0.6667	0.542	0.777
0.008	30	600	60	40	0.6667	0.542	0.777

0.008	30	650	60	40	0.6667	0.542	0.777
0.008	30	700	60	40	0.6667	0.542	0.777
0.008	30	750	60	40	0.6667	0.542	0.777
0.008	30	800	60	40	0.6667	0.542	0.777
0.008	36	0	60	10	0.1667	0.087	0.274
0.008	36	50	60	19	0.3167	0.208	0.44
0.008	36	100	60	31	0.5167	0.392	0.64
0.008	36	150	60	37	0.6167	0.491	0.733
0.008	36	200	60	37	0.6167	0.491	0.733
0.008	36	250	60	39	0.65	0.525	0.763
0.008	36	300	60	39	0.65	0.525	0.763
0.008	36	350	60	39	0.65	0.525	0.763
0.008	36	400	60	41	0.6833	0.56	0.792

0.008	36	450	60	41	0.6833	0.56	0.792
0.008	36	500	60	42	0.7	0.577	0.806
0.008	36	550	60	42	0.7	0.577	0.806
0.008	36	600	60	42	0.7	0.577	0.806
0.008	36	650	60	42	0.7	0.577	0.806
0.008	36	700	60	42	0.7	0.577	0.806
0.008	36	750	60	42	0.7	0.577	0.806
0.008	36	800	60	42	0.7	0.577	0.806
0.008	42	0	60	10	0.1667	0.087	0.274
0.008	42	50	60	19	0.3167	0.208	0.44
0.008	42	100	60	31	0.5167	0.392	0.64
0.008	42	150	60	38	0.6333	0.508	0.748
0.008	42	200	60	38	0.6333	0.508	0.748

0.008	42	250	60	40	0.6667	0.542	0.777
0.008	42	300	60	40	0.6667	0.542	0.777
0.008	42	350	60	40	0.6667	0.542	0.777
0.008	42	400	60	42	0.7	0.577	0.806
0.008	42	450	60	42	0.7	0.577	0.806
0.008	42	500	60	43	0.7167	0.595	0.82
0.008	42	550	60	43	0.7167	0.595	0.82
0.008	42	600	60	43	0.7167	0.595	0.82
0.008	42	650	60	43	0.7167	0.595	0.82
0.008	42	700	60	43	0.7167	0.595	0.82
0.008	42	750	60	43	0.7167	0.595	0.82
0.008	42	800	60	43	0.7167	0.595	0.82
0.008	48	0	60	12	0.2	0.113	0.313
0.008	48	50	60	20	0.3333	0.223	0.458
0.008	48	100	60	34	0.5667	0.44	0.687
0.008	48	150	60	39	0.65	0.525	0.763

0.008	48	200	60	39	0.65	0.525	0.763
0.008	48	250	60	41	0.6833	0.56	0.792
0.008	48	300	60	42	0.7	0.577	0.806
0.008	48	350	60	42	0.7	0.577	0.806
0.008	48	400	60	44	0.7333	0.613	0.834
0.008	48	450	60	44	0.7333	0.613	0.834
0.008	48	500	60	45	0.75	0.631	0.848
0.008	48	550	60	45	0.75	0.631	0.848
0.008	48	600	60	45	0.75	0.631	0.848
0.008	48	650	60	45	0.75	0.631	0.848
0.008	48	700	60	45	0.75	0.631	0.848
0.008	48	750	60	45	0.75	0.631	0.848

0.008	48	800	60	45	0.75	0.631	0.848
0.008	54	0	60	12	0.2	0.113	0.313
0.008	54	50	60	20	0.3333	0.223	0.458
0.008	54	100	60	34	0.5667	0.44	0.687
0.008	54	150	60	39	0.65	0.525	0.763
0.008	54	200	60	39	0.65	0.525	0.763
0.008	54	250	60	41	0.6833	0.56	0.792
0.008	54	300	60	42	0.7	0.577	0.806
0.008	54	350	60	42	0.7	0.577	0.806
0.008	54	400	60	44	0.7333	0.613	0.834
0.008	54	450	60	44	0.7333	0.613	0.834
0.008	54	500	60	45	0.75	0.631	0.848

0.008	54	550	60	45	0.75	0.631	0.848
0.008	54	600	60	45	0.75	0.631	0.848
0.008	54	650	60	45	0.75	0.631	0.848
0.008	54	700	60	45	0.75	0.631	0.848
0.008	54	750	60	45	0.75	0.631	0.848
0.008	54	800	60	45	0.75	0.631	0.848
0.008	60	0	60	12	0.2	0.113	0.313
0.008	60	50	60	20	0.3333	0.223	0.458
0.008	60	100	60	35	0.5833	0.457	0.703
0.008	60	150	60	40	0.6667	0.542	0.777
0.008	60	200	60	40	0.6667	0.542	0.777
0.008	60	250	60	42	0.7	0.577	0.806
0.008	60	300	60	43	0.7167	0.595	0.82

0.008	60	350	60	43	0.7167	0.595	0.82
0.008	60	400	60	44	0.7333	0.613	0.834
0.008	60	450	60	44	0.7333	0.613	0.834
0.008	60	500	60	45	0.75	0.631	0.848
0.008	60	550	60	45	0.75	0.631	0.848
0.008	60	600	60	45	0.75	0.631	0.848
0.008	60	650	60	45	0.75	0.631	0.848
0.008	60	700	60	45	0.75	0.631	0.848
0.008	60	750	60	45	0.75	0.631	0.848
0.008	60	800	60	45	0.75	0.631	0.848
0.009	0	0	60	0	0	0	0.032
0.009	0	50	60	1	0.0167	1E-03	0.071
0.009	0	100	60	1	0.0167	1E-03	0.071

0.009	0	150	60	1	0.0167	1E-03	0.071
0.009	0	200	60	1	0.0167	1E-03	0.071
0.009	0	250	60	1	0.0167	1E-03	0.071
0.009	0	300	60	2	0.0333	0.006	0.099
0.009	0	350	60	2	0.0333	0.006	0.099
0.009	0	400	60	2	0.0333	0.006	0.099
0.009	0	450	60	2	0.0333	0.006	0.099
0.009	0	500	60	2	0.0333	0.006	0.099
0.009	0	550	60	2	0.0333	0.006	0.099
0.009	0	600	60	2	0.0333	0.006	0.099
0.009	0	650	60	2	0.0333	0.006	0.099
0.009	0	700	60	2	0.0333	0.006	0.099

0.009	0	750	60	2	0.0333	0.006	0.099
0.009	0	800	60	2	0.0333	0.006	0.099
0.009	6	0	60	2	0.0333	0.006	0.099
0.009	6	50	60	4	0.0667	0.021	0.148
0.009	6	100	60	11	0.1833	0.1	0.293
0.009	6	150	60	15	0.25	0.152	0.369
0.009	6	200	60	15	0.25	0.152	0.369
0.009	6	250	60	18	0.3	0.194	0.423
0.009	6	300	60	18	0.3	0.194	0.423
0.009	6	350	60	18	0.3	0.194	0.423
0.009	6	400	60	19	0.3167	0.208	0.44
0.009	6	450	60	19	0.3167	0.208	0.44
0.009	6	500	60	20	0.3333	0.223	0.458

0.009	6	550	60	20	0.3333	0.223	0.458
0.009	6	600	60	20	0.3333	0.223	0.458
0.009	6	650	60	20	0.3333	0.223	0.458
0.009	6	700	60	20	0.3333	0.223	0.458
0.009	6	750	60	20	0.3333	0.223	0.458
0.009	6	800	60	20	0.3333	0.223	0.458
0.009	12	0	60	5	0.0833	0.031	0.171
0.009	12	50	60	9	0.15	0.075	0.254
0.009	12	100	60	19	0.3167	0.208	0.44
0.009	12	150	60	23	0.3833	0.267	0.509
0.009	12	200	60	24	0.4	0.282	0.526
0.009	12	250	60	25	0.4167	0.297	0.543
0.009	12	300	60	25	0.4167	0.297	0.543

0.009	12	350	60	25	0.4167	0.297	0.543
0.009	12	400	60	27	0.45	0.328	0.576
0.009	12	450	60	27	0.45	0.328	0.576
0.009	12	500	60	28	0.4667	0.344	0.592
0.009	12	550	60	28	0.4667	0.344	0.592
0.009	12	600	60	28	0.4667	0.344	0.592
0.009	12	650	60	28	0.4667	0.344	0.592
0.009	12	700	60	28	0.4667	0.344	0.592
0.009	12	750	60	28	0.4667	0.344	0.592
0.009	12	800	60	28	0.4667	0.344	0.592
0.009	18	0	60	7	0.1167	0.052	0.213
0.009	18	50	60	14	0.2333	0.139	0.35
0.009	18	100	60	22	0.3667	0.252	0.492

0.009	18	150	60	25	0.4167	0.297	0.543
0.009	18	200	60	26	0.4333	0.313	0.56
0.009	18	250	60	28	0.4667	0.344	0.592
0.009	18	300	60	28	0.4667	0.344	0.592
0.009	18	350	60	28	0.4667	0.344	0.592
0.009	18	400	60	29	0.4833	0.36	0.608
0.009	18	450	60	30	0.5	0.375	0.625
0.009	18	500	60	30	0.5	0.375	0.625
0.009	18	550	60	30	0.5	0.375	0.625
0.009	18	600	60	30	0.5	0.375	0.625
0.009	18	650	60	30	0.5	0.375	0.625
0.009	18	700	60	30	0.5	0.375	0.625
0.009	18	750	60	30	0.5	0.375	0.625

0.009	18	800	60	30	0.5	0.375	0.625
0.009	24	0	60	8	0.1333	0.063	0.234
0.009	24	50	60	15	0.25	0.152	0.369
0.009	24	100	60	27	0.45	0.328	0.576
0.009	24	150	60	32	0.5333	0.408	0.656
0.009	24	200	60	32	0.5333	0.408	0.656
0.009	24	250	60	34	0.5667	0.44	0.687
0.009	24	300	60	34	0.5667	0.44	0.687
0.009	24	350	60	34	0.5667	0.44	0.687
0.009	24	400	60	37	0.6167	0.491	0.733
0.009	24	450	60	38	0.6333	0.508	0.748
0.009	24	500	60	39	0.65	0.525	0.763

0.009	24	550	60	39	0.65	0.525	0.763
0.009	24	600	60	39	0.65	0.525	0.763
0.009	24	650	60	39	0.65	0.525	0.763
0.009	24	700	60	39	0.65	0.525	0.763
0.009	24	750	60	39	0.65	0.525	0.763
0.009	24	800	60	39	0.65	0.525	0.763
0.009	30	0	60	10	0.1667	0.087	0.274
0.009	30	50	60	19	0.3167	0.208	0.44
0.009	30	100	60	32	0.5333	0.408	0.656
0.009	30	150	60	37	0.6167	0.491	0.733
0.009	30	200	60	38	0.6333	0.508	0.748
0.009	30	250	60	40	0.6667	0.542	0.777
0.009	30	300	60	40	0.6667	0.542	0.777

0.009	30	350	60	40	0.6667	0.542	0.777
0.009	30	400	60	43	0.7167	0.595	0.82
0.009	30	450	60	43	0.7167	0.595	0.82
0.009	30	500	60	44	0.7333	0.613	0.834
0.009	30	550	60	44	0.7333	0.613	0.834
0.009	30	600	60	44	0.7333	0.613	0.834
0.009	30	650	60	44	0.7333	0.613	0.834
0.009	30	700	60	44	0.7333	0.613	0.834
0.009	30	750	60	44	0.7333	0.613	0.834
0.009	30	800	60	44	0.7333	0.613	0.834
0.009	36	0	60	11	0.1833	0.1	0.293
0.009	36	50	60	21	0.35	0.237	0.475
0.009	36	100	60	34	0.5667	0.44	0.687

0.009	36	150	60	40	0.6667	0.542	0.777
0.009	36	200	60	40	0.6667	0.542	0.777
0.009	36	250	60	42	0.7	0.577	0.806
0.009	36	300	60	42	0.7	0.577	0.806
0.009	36	350	60	42	0.7	0.577	0.806
0.009	36	400	60	45	0.75	0.631	0.848
0.009	36	450	60	45	0.75	0.631	0.848
0.009	36	500	60	46	0.7667	0.65	0.861
0.009	36	550	60	46	0.7667	0.65	0.861
0.009	36	600	60	46	0.7667	0.65	0.861
0.009	36	650	60	46	0.7667	0.65	0.861
0.009	36	700	60	46	0.7667	0.65	0.861

0.009	36	750	60	46	0.7667	0.65	0.861
0.009	36	800	60	46	0.7667	0.65	0.861
0.009	42	0	60	11	0.1833	0.1	0.293
0.009	42	50	60	21	0.35	0.237	0.475
0.009	42	100	60	34	0.5667	0.44	0.687
0.009	42	150	60	41	0.6833	0.56	0.792
0.009	42	200	60	41	0.6833	0.56	0.792
0.009	42	250	60	43	0.7167	0.595	0.82
0.009	42	300	60	43	0.7167	0.595	0.82
0.009	42	350	60	43	0.7167	0.595	0.82
0.009	42	400	60	46	0.7667	0.65	0.861
0.009	42	450	60	46	0.7667	0.65	0.861
0.009	42	500	60	47	0.7833	0.669	0.874
0.009	42	550	60	47	0.7833	0.669	0.874

0.009	42	600	60	47	0.7833	0.669	0.874
0.009	42	650	60	47	0.7833	0.669	0.874
0.009	42	700	60	47	0.7833	0.669	0.874
0.009	42	750	60	47	0.7833	0.669	0.874
0.009	42	800	60	47	0.7833	0.669	0.874
0.009	48	0	60	13	0.2167	0.126	0.331
0.009	48	50	60	22	0.3667	0.252	0.492
0.009	48	100	60	37	0.6167	0.491	0.733
0.009	48	150	60	42	0.7	0.577	0.806
0.009	48	200	60	42	0.7	0.577	0.806
0.009	48	250	60	44	0.7333	0.613	0.834
0.009	48	300	60	45	0.75	0.631	0.848

0.009	48	350	60	45	0.75	0.631	0.848
0.009	48	400	60	48	0.8	0.687	0.887
0.009	48	450	60	48	0.8	0.687	0.887
0.009	48	500	60	49	0.8167	0.707	0.9
0.009	48	550	60	49	0.8167	0.707	0.9
0.009	48	600	60	49	0.8167	0.707	0.9
0.009	48	650	60	49	0.8167	0.707	0.9
0.009	48	700	60	49	0.8167	0.707	0.9
0.009	48	750	60	49	0.8167	0.707	0.9
0.009	48	800	60	49	0.8167	0.707	0.9
0.009	54	0	60	13	0.2167	0.126	0.331
0.009	54	50	60	22	0.3667	0.252	0.492
0.009	54	100	60	37	0.6167	0.491	0.733
0.009	54	150	60	42	0.7	0.577	0.806
0.009	54	200	60	42	0.7	0.577	0.806
0.009	54	250	60	44	0.7333	0.613	0.834

0.009	54	300	60	45	0.75	0.631	0.848
0.009	54	350	60	45	0.75	0.631	0.848
0.009	54	400	60	48	0.8	0.687	0.887
0.009	54	450	60	48	0.8	0.687	0.887
0.009	54	500	60	49	0.8167	0.707	0.9
0.009	54	550	60	49	0.8167	0.707	0.9
0.009	54	600	60	49	0.8167	0.707	0.9
0.009	54	650	60	49	0.8167	0.707	0.9
0.009	54	700	60	49	0.8167	0.707	0.9
0.009	54	750	60	49	0.8167	0.707	0.9
0.009	54	800	60	49	0.8167	0.707	0.9
0.009	60	0	60	14	0.2333	0.139	0.35
0.009	60	50	60	24	0.4	0.282	0.526
0.009	60	100	60	38	0.6333	0.508	0.748
0.009	60	150	60	43	0.7167	0.595	0.82
0.009	60	200	60	43	0.7167	0.595	0.82
0.009	60	250	60	45	0.75	0.631	0.848

0.009	60	300	60	46	0.7667	0.65	0.861
0.009	60	350	60	46	0.7667	0.65	0.861
0.009	60	400	60	48	0.8	0.687	0.887
0.009	60	450	60	48	0.8	0.687	0.887
0.009	60	500	60	49	0.8167	0.707	0.9
0.009	60	550	60	49	0.8167	0.707	0.9
0.009	60	600	60	49	0.8167	0.707	0.9
0.009	60	650	60	49	0.8167	0.707	0.9
0.009	60	700	60	49	0.8167	0.707	0.9
0.009	60	750	60	49	0.8167	0.707	0.9
0.009	60	800	60	49	0.8167	0.707	0.9
0.01	0	0	60	0	0	0	0.032
0.01	0	50	60	1	0.0167	1E-03	0.071
0.01	0	100	60	1	0.0167	1E-03	0.071
0.01	0	150	60	1	0.0167	1E-03	0.071
0.01	0	200	60	1	0.0167	1E-03	0.071

0.01	0	250	60	1		0.0167	1E-03	0.071
0.01	0	300	60	2		0.0333	0.006	0.099
0.01	0	350	60	2		0.0333	0.006	0.099
0.01	0	400	60	2		0.0333	0.006	0.099
0.01	0	450	60	2		0.0333	0.006	0.099
0.01	0	500	60	2		0.0333	0.006	0.099
0.01	0	550	60	2		0.0333	0.006	0.099
0.01	0	600	60	2		0.0333	0.006	0.099
0.01	0	650	60	2		0.0333	0.006	0.099
0.01	0	700	60	2		0.0333	0.006	0.099
0.01	0	750	60	2		0.0333	0.006	0.099
0.01	0	800	60	2		0.0333	0.006	0.099

0.01	6	0	60	3	0.05	0.013	0.125
0.01	6	50	60	5	0.0833	0.031	0.171
0.01	6	100	60	12	0.2	0.113	0.313
0.01	6	150	60	16	0.2667	0.166	0.387
0.01	6	200	60	16	0.2667	0.166	0.387
0.01	6	250	60	19	0.3167	0.208	0.44
0.01	6	300	60	20	0.3333	0.223	0.458
0.01	6	350	60	20	0.3333	0.223	0.458
0.01	6	400	60	21	0.35	0.237	0.475
0.01	6	450	60	21	0.35	0.237	0.475
0.01	6	500	60	22	0.3667	0.252	0.492
0.01	6	550	60	22	0.3667	0.252	0.492
0.01	6	600	60	22	0.3667	0.252	0.492

0.01	6	650	60	22	0.3667	0.252	0.492
0.01	6	700	60	22	0.3667	0.252	0.492
0.01	6	750	60	22	0.3667	0.252	0.492
0.01	6	800	60	22	0.3667	0.252	0.492
0.01	12	0	60	6	0.1	0.041	0.192
0.01	12	50	60	10	0.1667	0.087	0.274
0.01	12	100	60	19	0.3167	0.208	0.44
0.01	12	150	60	23	0.3833	0.267	0.509
0.01	12	200	60	24	0.4	0.282	0.526
0.01	12	250	60	25	0.4167	0.297	0.543
0.01	12	300	60	26	0.4333	0.313	0.56
0.01	12	350	60	26	0.4333	0.313	0.56
0.01	12	400	60	28	0.4667	0.344	0.592
0.01	12	450	60	28	0.4667	0.344	0.592

0.01	12	500	60	29	0.4833	0.36	0.608
0.01	12	550	60	29	0.4833	0.36	0.608
0.01	12	600	60	29	0.4833	0.36	0.608
0.01	12	650	60	29	0.4833	0.36	0.608
0.01	12	700	60	29	0.4833	0.36	0.608
0.01	12	750	60	29	0.4833	0.36	0.608
0.01	12	800	60	29	0.4833	0.36	0.608
0.01	18	0	60	9	0.15	0.075	0.254
0.01	18	50	60	15	0.25	0.152	0.369
0.01	18	100	60	23	0.3833	0.267	0.509
0.01	18	150	60	26	0.4333	0.313	0.56
0.01	18	200	60	27	0.45	0.328	0.576
0.01	18	250	60	29	0.4833	0.36	0.608

0.01	18	300	60	30	0.5	0.375	0.625
0.01	18	350	60	30	0.5	0.375	0.625
0.01	18	400	60	32	0.5333	0.408	0.656
0.01	18	450	60	33	0.55	0.424	0.672
0.01	18	500	60	33	0.55	0.424	0.672
0.01	18	550	60	33	0.55	0.424	0.672
0.01	18	600	60	33	0.55	0.424	0.672
0.01	18	650	60	33	0.55	0.424	0.672
0.01	18	700	60	33	0.55	0.424	0.672
0.01	18	750	60	33	0.55	0.424	0.672
0.01	18	800	60	33	0.55	0.424	0.672
0.01	24	0	60	10	0.1667	0.087	0.274

0.01	24	50	60	16	0.2667	0.166	0.387
0.01	24	100	60	28	0.4667	0.344	0.592
0.01	24	150	60	34	0.5667	0.44	0.687
0.01	24	200	60	34	0.5667	0.44	0.687
0.01	24	250	60	36	0.6	0.474	0.718
0.01	24	300	60	37	0.6167	0.491	0.733
0.01	24	350	60	37	0.6167	0.491	0.733
0.01	24	400	60	40	0.6667	0.542	0.777
0.01	24	450	60	40	0.6667	0.542	0.777
0.01	24	500	60	41	0.6833	0.56	0.792
0.01	24	550	60	41	0.6833	0.56	0.792
0.01	24	600	60	41	0.6833	0.56	0.792

0.01	24	650	60	41	0.6833	0.56	0.792
0.01	24	700	60	41	0.6833	0.56	0.792
0.01	24	750	60	41	0.6833	0.56	0.792
0.01	24	800	60	41	0.6833	0.56	0.792
0.01	30	0	60	12	0.2	0.113	0.313
0.01	30	50	60	20	0.3333	0.223	0.458
0.01	30	100	60	32	0.5333	0.408	0.656
0.01	30	150	60	38	0.6333	0.508	0.748
0.01	30	200	60	39	0.65	0.525	0.763
0.01	30	250	60	41	0.6833	0.56	0.792
0.01	30	300	60	41	0.6833	0.56	0.792
0.01	30	350	60	41	0.6833	0.56	0.792

0.01	30	400	60	44	0.7333	0.613	0.834
0.01	30	450	60	44	0.7333	0.613	0.834
0.01	30	500	60	45	0.75	0.631	0.848
0.01	30	550	60	45	0.75	0.631	0.848
0.01	30	600	60	45	0.75	0.631	0.848
0.01	30	650	60	45	0.75	0.631	0.848
0.01	30	700	60	45	0.75	0.631	0.848
0.01	30	750	60	45	0.75	0.631	0.848
0.01	30	800	60	45	0.75	0.631	0.848
0.01	36	0	60	13	0.2167	0.126	0.331
0.01	36	50	60	22	0.3667	0.252	0.492
0.01	36	100	60	34	0.5667	0.44	0.687

0.01	36	150	60	41	0.6833	0.56	0.792
0.01	36	200	60	41	0.6833	0.56	0.792
0.01	36	250	60	43	0.7167	0.595	0.82
0.01	36	300	60	43	0.7167	0.595	0.82
0.01	36	350	60	43	0.7167	0.595	0.82
0.01	36	400	60	46	0.7667	0.65	0.861
0.01	36	450	60	46	0.7667	0.65	0.861
0.01	36	500	60	47	0.7833	0.669	0.874
0.01	36	550	60	47	0.7833	0.669	0.874
0.01	36	600	60	47	0.7833	0.669	0.874
0.01	36	650	60	47	0.7833	0.669	0.874
0.01	36	700	60	47	0.7833	0.669	0.874
0.01	36	750	60	47	0.7833	0.669	0.874
0.01	36	800	60	47	0.7833	0.669	0.874

0.01	42	0	60	13	0.2167	0.126	0.331
0.01	42	50	60	22	0.3667	0.252	0.492
0.01	42	100	60	34	0.5667	0.44	0.687
0.01	42	150	60	42	0.7	0.577	0.806
0.01	42	200	60	42	0.7	0.577	0.806
0.01	42	250	60	44	0.7333	0.613	0.834
0.01	42	300	60	44	0.7333	0.613	0.834
0.01	42	350	60	44	0.7333	0.613	0.834
0.01	42	400	60	47	0.7833	0.669	0.874
0.01	42	450	60	47	0.7833	0.669	0.874
0.01	42	500	60	48	0.8	0.687	0.887
0.01	42	550	60	48	0.8	0.687	0.887

0.01	42	600	60	48	0.8	0.687	0.887
0.01	42	650	60	48	0.8	0.687	0.887
0.01	42	700	60	48	0.8	0.687	0.887
0.01	42	750	60	48	0.8	0.687	0.887
0.01	42	800	60	48	0.8	0.687	0.887
0.01	48	0	60	15	0.25	0.152	0.369
0.01	48	50	60	23	0.3833	0.267	0.509
0.01	48	100	60	37	0.6167	0.491	0.733
0.01	48	150	60	43	0.7167	0.595	0.82
0.01	48	200	60	43	0.7167	0.595	0.82
0.01	48	250	60	45	0.75	0.631	0.848
0.01	48	300	60	46	0.7667	0.65	0.861
0.01	48	350	60	46	0.7667	0.65	0.861

0.01	48	400	60	48	0.8	0.687	0.887
0.01	48	450	60	48	0.8	0.687	0.887
0.01	48	500	60	49	0.8167	0.707	0.9
0.01	48	550	60	49	0.8167	0.707	0.9
0.01	48	600	60	49	0.8167	0.707	0.9
0.01	48	650	60	49	0.8167	0.707	0.9
0.01	48	700	60	49	0.8167	0.707	0.9
0.01	48	750	60	49	0.8167	0.707	0.9
0.01	48	800	60	49	0.8167	0.707	0.9
0.01	54	0	60	15	0.25	0.152	0.369
0.01	54	50	60	23	0.3833	0.267	0.509
0.01	54	100	60	37	0.6167	0.491	0.733
0.01	54	150	60	43	0.7167	0.595	0.82
0.01	54	200	60	43	0.7167	0.595	0.82
0.01	54	250	60	45	0.75	0.631	0.848
0.01	54	300	60	46	0.7667	0.65	0.861
0.01	54	350	60	46	0.7667	0.65	0.861

0.01	54	400	60	48	0.8	0.687	0.887
0.01	54	450	60	48	0.8	0.687	0.887
0.01	54	500	60	49	0.8167	0.707	0.9
0.01	54	550	60	49	0.8167	0.707	0.9
0.01	54	600	60	49	0.8167	0.707	0.9
0.01	54	650	60	49	0.8167	0.707	0.9
0.01	54	700	60	49	0.8167	0.707	0.9
0.01	54	750	60	49	0.8167	0.707	0.9
0.01	54	800	60	49	0.8167	0.707	0.9
0.01	60	0	60	16	0.2667	0.166	0.387
0.01	60	50	60	25	0.4167	0.297	0.543
0.01	60	100	60	38	0.6333	0.508	0.748
0.01	60	150	60	44	0.7333	0.613	0.834
0.01	60	200	60	44	0.7333	0.613	0.834
0.01	60	250	60	46	0.7667	0.65	0.861
0.01	60	300	60	47	0.7833	0.669	0.874

0.01	60	350	60	47	0.7833	0.669	0.874
0.01	60	400	60	48	0.8	0.687	0.887
0.01	60	450	60	48	0.8	0.687	0.887
0.01	60	500	60	49	0.8167	0.707	0.9
0.01	60	550	60	49	0.8167	0.707	0.9
0.01	60	600	60	49	0.8167	0.707	0.9
0.01	60	650	60	49	0.8167	0.707	0.9
0.01	60	700	60	49	0.8167	0.707	0.9
0.01	60	750	60	49	0.8167	0.707	0.9
0.01	60	800	60	49	0.8167	0.707	0.9

Table S 3. The GenBank accession numbers, strain names, sampling dates, and sampling locations of nucleotide sequences from countries other than Egypt in the Chapter II's study.

Accession number	Host	Strain name	Sampling date	Sampling location
EF532628	Avian	A/chicken/Gaza/450/2006	2006	Gaza
EF532622	Avian	A/duck/Gaza/834/2006	2006	Gaza
EF532630	Avian	A/chicken/Gaza/713/2006	2006	Gaza
EF532631	Avian	A/chicken/Gaza/714/2006	2006	Gaza
KT792916	Avian	A/chicken/Gaza/797/2015	6/10/15	Gaza
KT792914	Avian	A/chicken/Gaza/803/2015	6/1/15	Gaza
KT792912	Avian	A/chicken/Gaza/869/2015	6/27/15	Gaza
KT792913	Avian	A/duck/Gaza/829/2015	6/21/15	Gaza
KT792917	Avian	A/duck/Gaza/872/2015	2015/06/28	Gaza
KT792911	Avian	A/chicken/Gaza/870/2015	6/24/15	Gaza
KT792918	Avian	A/duck/Gaza/552/2015	4/12/15	Gaza
KT792915	Avian	A/chicken/Gaza/799/2015	6/15/15	Gaza
KT792910	Avian	A/chicken/Gaza/876/2015	6/29/15	Gaza
KT792920	Avian	A/chicken/Qatanna/468/2015	3/22/15	Qatana
JN582043	Avian	A/turkey/Jenin/341/2011	3/2/11	Jenin
JN600467	Avian	A/harrier/Israel/531/2011	4/7/11	Israel
HM466695	Avian	A/chicken/Israel/65/2010	1/25/10	Israel
JN582041	Avian	A/turkey/Israel/362/2011	3/6/11	Israel
EF532623	Avian	A/turkey/Israel/345/2006	2006	Israel

EF532626	Avian	A/chicken/Israel/397/2006	2006	Israel
EF532627	Avian	A/turkey/Israel/446/2006	2006	Israel
EU574927	Avian	A/chicken/Israel/1055/2008	2008	Israel
KT792921	Avian	A/turkey/Israel/633/2015	5/11/15	Israel
KT792922	Avian	A/turkey/Israel/14/2015	1/16/15	Israel
KT792919	Avian	A/turkey/Israel/658/2015	5/18/15	Israel
HQ606466	Avian	A/emu/Israel/552/2010	2010/05	Israel