



Supplementary Information for

**Nipah virus dynamics in bats and implications for spillover to humans**

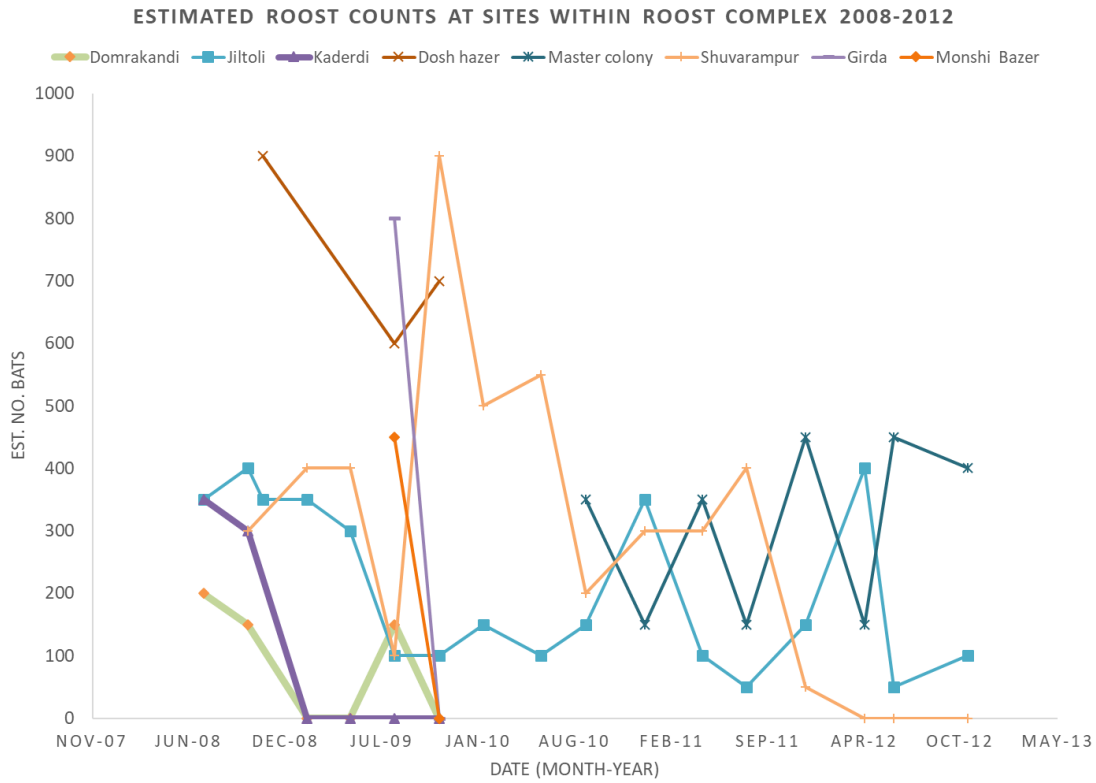
Jonathan H. Epstein, Simon J. Anthony, Ariful Islam, A. Marm Kilpatrick, Shahneaz Ali Khan, Maria Sanchez, Noam Ross, Ina Smith, Carlos Zambrana-Torrel, Yun Tao, Ausraf Islam, Phenix Lan Quan, Kevin J. Olival, Md. Salah Uddin Khan, Emily Gurley, M. Jahangir Hossein, Hume. E. Field, Mark D. Fielder, Thomas Briese, Mahmud Rahman, Christopher C. Broder, Gary Crameri, Lin-Fa Wang, Stephen P. Luby, W. Ian Lipkin, and Peter Daszak

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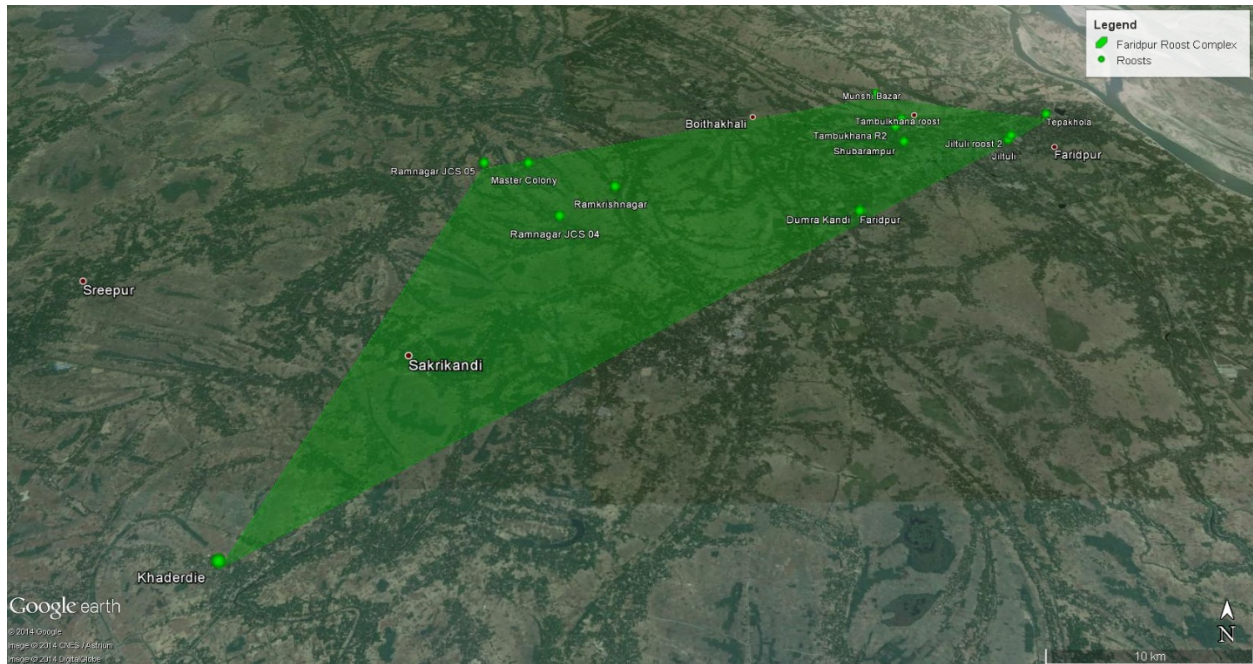
**This PDF file includes:**

- Figures S1 to S6
- Tables S1 to S4
- SI References

## Supporting Information

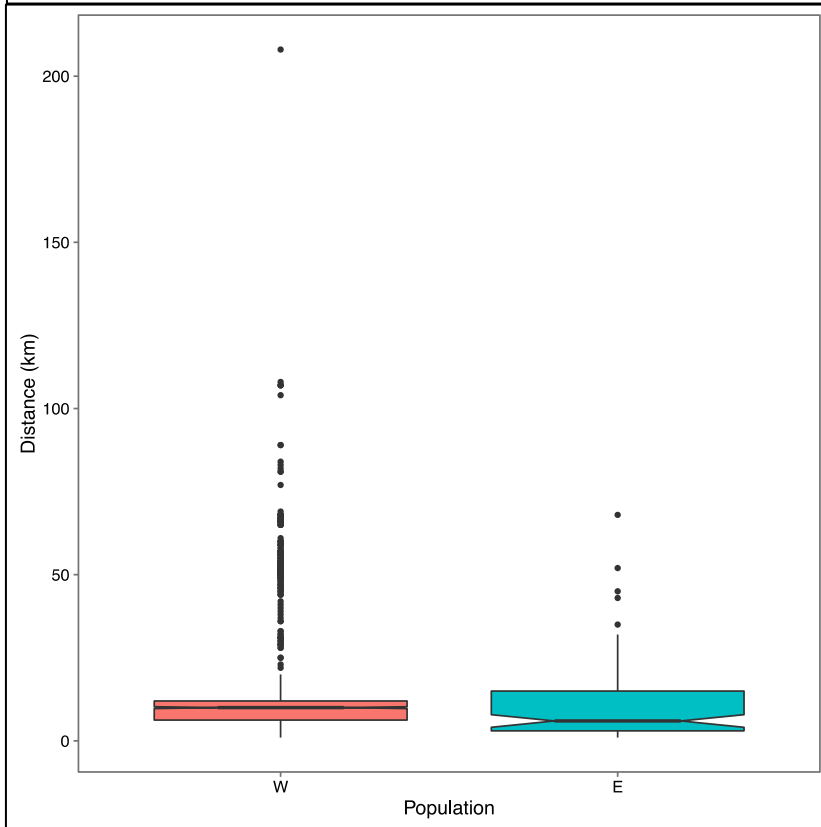


**Figure S1.** *Pteropus medius* counts from selected roosting sites within the Faridpur Roost Complex: 2008-2012. Sites were included if repeated counts were conducted. Domrakandi and Kaderdi were the two primary roost sites sampled for the longitudinal study and counts were used for the model parameter.



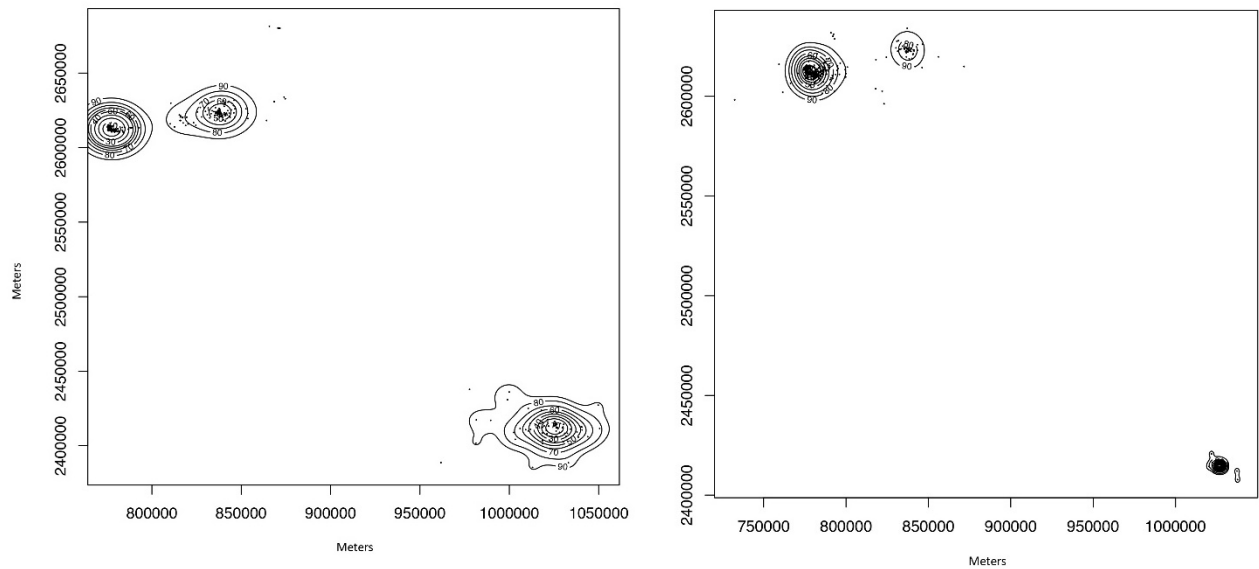
**Figure S2.** Faridpur Roost Complex. 51 Individual bats were recaptured during the longitudinal study at various locations. 33 bats were recaptured at a different site from where they were originally sampled. 15 unique roosts within an 80km<sup>2</sup> area were identified.

Mean foraging distance from roost in western and eastern colonies, based on satellite telemetry



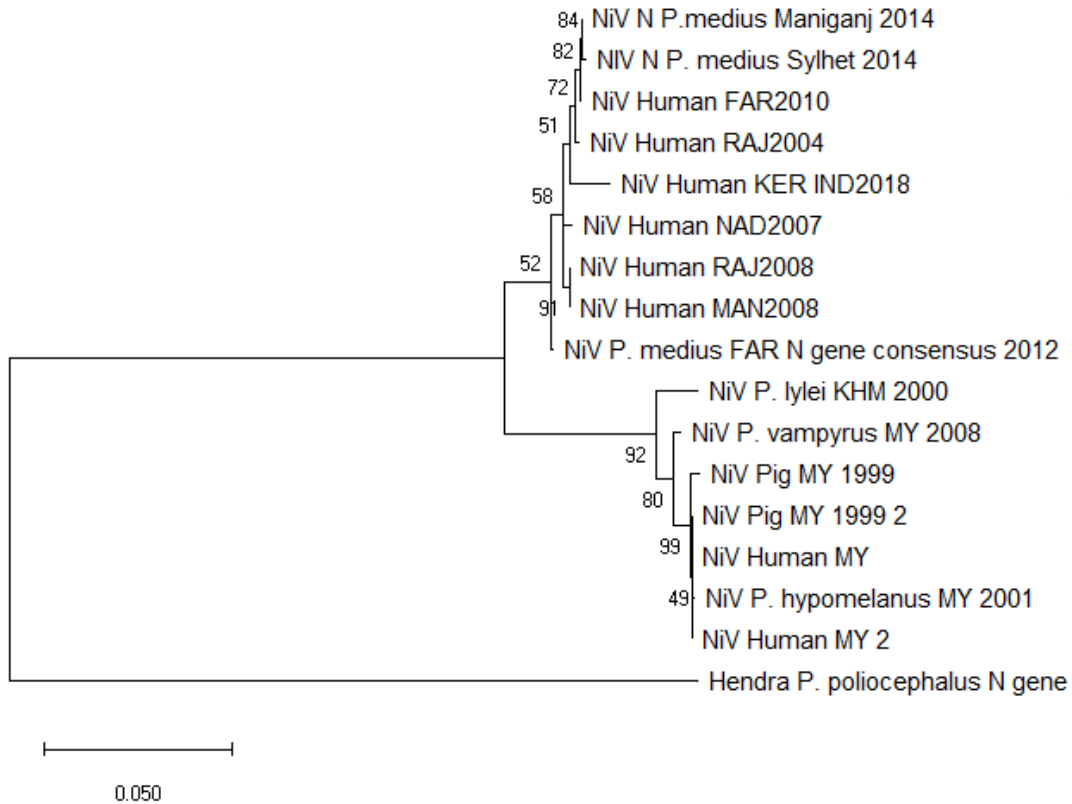
**Figure S3.** Mean foraging distance of western (W) and eastern (E) bat populations, based on satellite telemetry locations obtained between 1800h and 0600h, when *P. medius* typically forages.

Home range of *Pteropus medius* in wet and dry seasons.



**Figure S4.** a) Home range of *Pteropus medius* during the wet season (left) and dry season (right). Maps are projected in UTM (Universal Transverse Mercator) Zone 45 where units are represented in meters. The mean wet season home range size was 2,746 km<sup>2</sup>. Home range size in the dry season is contracted and represents less than a quarter (618 km<sup>2</sup>) of the home range in the wet season.

Nipah virus phylogenetic tree, based on near complete N gene sequences



**Figure S5. Nipah Virus phylogenetic tree, N gene:** Clustal W alignment using nearly whole N gene consensus sequence from *P. medius* (1,592 nt) using Geneious Prime 2019 (1). The evolutionary history was inferred by using the Maximum Likelihood method and Hasegawa-Kishino-Yano model (2). The percentage of trees in which the associated taxa clustered together is shown next to the branches. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. Evolutionary analyses were conducted in MEGA X (3). Genbank accession numbers for sequences (from top to bottom): *P. medius* Maniganj & Sylhet pending (63); JN808864, AY988601, MH396625, FJ513078, JN808863, JN808857, AY858110, FN869553, AJ627196, AJ564623, AY029767, AF376747, AY029768, JN255803.



**Figure S6.** Platform terminal transmitter (PTT) and collar attachment on an anesthetized adult *Pteropus medius*, Bangladesh.

**Table S1.**

PCR positive bats and their sero-status.

Bat sample ID	Date	Loc	sex	Age	Serology Test result		
					ELISA	Luminex (MFI)	
29	Jan-06	Ramnagar	M	J	Neg	-	
59	Jan-06	Ramnagar	PF	A	Neg		
76	Jan-06	Ramnagar	PF	A	Neg		
21	Feb-09	Faridpur	PF	A	-	25817	Pos
58	May-09	Faridpur	F	A		159	Neg
87	May-09	Faridpur	M	A	-	113	Neg
55	Nov-09	Faridpur	M	A		25955	Pos
26	Jun-10	Faridpur	M	A		30	Neg
32	Jun-10	Faridpur	M	J		758	Pos
28	Jun-10	Faridpur	M	J		377	Neg



**Table S2.** Maximum likelihood estimates of fitted parameter values and (95% CI). All rates are on a weekly time-step unless otherwise indicated.

Parameter	Name	Maximum likelihood estimate	Lower 95% CI	Upper 95% CI
$B_{jj}$	Transmission rate, juveniles→juveniles	0.013	0.0096	0.013
$B_{ja}$	Transmission rate, juveniles→adults	0.030	0.024	0.034
$B_{aj}$	Transmission rate, adults→juveniles	0.0024	0.00195	0.0029
$B_{aa}$	Transmission rate, adults→adults	0.00047	0	0.0041
$R_A/N_A (t=0)$	Initial adult seroprevalence	0.019	0	0.068
$\Delta$	Recrudescence	$2.30 \times 10^{-7}$	$1.41 \times 10^{-8}$	$7.10 \times 10^{-7}$
$(1-\mu)^{52}$	Adult annual survival	0.755	0.719	0.798
$\lambda$	Rate of maternal antibody loss	0.057	0.040	0.073
$\tau$	Rate of adult antibody loss	0.0034	0.0021	0.0041

**Table S3.** Recaptured bats and NiV IgG sero-status from the Faridpur population

Bat Chip ID	Age1	Sex	Capture Date	Location 1	Serostatus1	Age2	Capture Date 2	Serostatus2	Location 2	Status Change	Age3	Capture Date 3	Location 3	Serostatus 3	Status Change 2
17044540	A	M	24/07/08	JH	0	A	19/09/10	1	SH	C					
26774096	A	M	05/10/09	JH	1	A	13/11/09	1	SH	N					
26783883	J	F	15/05/09	SH	1	A	14/02/10	0	SH	R					
26789012	A	M	15/05/09	SH	0	A	02/10/10	1	SH	C					
26791784	A	F	14/05/09	SH	1	A	30/04/12	0	JH	R					
26816627	A	F	11/05/09	SH	0	A	26/08/09	0	DM	N					
26824582	J	M	09/05/09	JH	0	A	20/09/10	0	TP	N	A	05/05/11	TP	0	N
27099360	A	M	24/09/10	RM_MC	0	A	18/08/11	1	TB	C	A	18/11/12	JH	0	R
27102063	A	M	16/11/09	SH	1	A	16/02/10	1	SH	N	A	19/12/11	TP	1	N
27103623	J	M	21/09/10	TP	1	A	17/12/11	0	TP	R					
27105342	J	M	21/09/10	TP	0	A	19/12/11	1	TP	C					
27105562	P	M	24/04/10	RM_JCS	0	J	20/10/10	0	RM_JCS 05	N					
27110270	A	M	24/07/10	RM_JCS	0	A	04/04/11	0	RM_JCS	N					
27111334	A	M	23/07/10	RM_JCS	0	A	19/10/10	0	RM_JCS	N					
27123779	J	F	21/06/10	RM_JCS2	0	J	28/02/11	0	RK	N					
27123803	J	F	21/08/10	RM_JCS1	0	J	28/02/11	0	RK	N					
27123868	J	M	18/02/10	SH	0	A	26/04/12	1	JH	C					
27126256	A	F	10/02/10	SH	0	A	18/12/11	0	TP	N					
27259351	A	M	20/09/10	TP	0	A	30/04/12	0	JH	N					
27259370	A	M	22/07/10	RM_JCS1	0	A	04/04/11	0	RM_JCS1	N					
27261073	J	F	22/06/10	RM_JCS2	1	J	22/07/10	1	RM_JCS1	N					
27261577	A	M	21/09/10	TP	0	A	17/12/11	1	TP	C					
27266775	A	M	21/08/10	RM_JCS1	1	A	18/11/12	0	JH	R					
27291793	A	M	24/09/10	RM_JCS1	0	A	22/01/11	1	RM_JCS1	C					
27296568	A	M	12/11/09	SH	1	A	07/05/11	1	SH	N					
27296851	A	M	22/04/10	RM_JCS1	0	A	25/05/10	0	RM_JCS2	N					
27301580	A	M	17/06/10	SH	1	A	05/05/11	1	TP	N					
27301857	A	M	11/02/10	SH	0	A	22/04/10	1	RM_JCS1	C	A	03/05/11	SH	0	R

Location Codes: Location codes: Jhiltuli (JH); Jiltuli Roost 2 (JH2); Shuvarampur (SH); RamnagarMC (RM); Tepakhola (TP); Ramnagar Roost JCS (RM\_JCS); Ramnagar JCS 1 (RM\_JCS1); Ramnagar JCS 02 (RM\_JCS2); Tambukhana R2 (TB2); Domrakhandi (DM); Khaderdi (KD); Ramkrishnagar (RK); Tepakhola Master Colony (TPMC). Status Change: C = seroconversion, N = No Change, R = sero-reversion.

Table S3 (cont...). Recaptured bats and NiV IgG sero-status from the Faridpur population

Bat Chip ID	Age1	Sex	Capture Date	Location 1	Serostatus1	Age2	Capture Date 2	Serostatus2	Location 2	Status Change	Age3	Capture Date 3	Location 3	Serostatus 3	Status Change 2
27305044	J	M	22/06/10	RM_JCS2	1	A	15/11/12	0	JH	R					
27306794	A	M	15/06/10	SH	1	A	11/07/12	1	TPMC	N					
27306824	A	M	23/07/10	RM_JCS1	1	A	24/09/10	1	RM_JCS1	N	A	18/11/12	JH	1	N
54867532	A	M	23/01/11	JH2	1	A	18/11/12	0	JH	R					
54872600	A	M	19/10/10	RM_JCS2	0	A	30/04/11	0	RM_MC	N					
54877598	J	F	18/01/11	SH	0	A	01/05/12	0	JH	N					
65770323	J	M	04/04/11	RM_JCS1	0	J	01/05/11	0	RM_MC	N					
65780555	A	M	05/05/11	TP	1	A	13/11/12	1	JH	N					
68608827	J	M	14/08/11	TB2	1	J	18/12/11	1	TP	N					
68612032	J	M	15/07/12	TPMC	0		18/11/12	0	JH	N					
80825550	A	M	11/12/07	DM	0	A	13/04/08	1	DM	R					
80855347	A	M	06/12/07	DM	1	A	22/07/08	1	KD	N					
80867630	A	M	11/12/07	DM	0	A	14/05/09	0	SH	N					
80876042	A	M	06/12/07	DM	0	A	14/08/11	0	TB2	N					
80877779	A	M	07/12/07	DM	1	A	21/07/08	1	DM	N					
81030044	A	M	06/02/06	RM_JCS1		A	24/07/10	0	RM_JCS1	NA		04/04/11	RM_JCS1	0	N
81055270	A	F	12/12/07	DM	0	A	20/12/11	1	TP	C					
81095300	A	M	09/12/07	DM	1	A	18/07/08	1	DM	N					
99605347	A	M	15/12/07	DM	0	A	07/04/08	0	DM	N					
99618528	A	M	20/07/08	DM	1	A	16/02/10	1	SH	N					
103821120	A	F	12/04/08	DM	0	A	16/05/09	1	SH	C					
104083112	A	M	03/04/08	DM	1	A	20/07/08	1	DM	N					
65777367	P	M	30/04/11	RM_MC	0	J	14/11/12	0	JH	N					

Location Codes: Location codes: Jhiltuli (JH); Jiltuli Roost 2 (JH2); Shuvarampur (SH); RamnagarMC (RM); Tepakhola (TP); Ramnagar Roost JCS (RM\_JCS); Ramnagar JCS 1 (RM\_JCS1); Ramnagar JCS 02 (RM\_JCS2); Tambukhana R2 (TB2); Domrakhandi (DM); Khaderdi (KD); Ramkrishnagar (RK); Tepakhola Master Colony (TPMC). Status Change: C = seroconversion, N = No Change, R = sero-reversion.

Table S4. Satellite telemetry study: bat characteristics and duration of transmission.

PTT #	Microship ID	Colony location	Date collared	Final location date	Approx.Duration (mo)	Sex	Age	Mass (g)	BCS	Forearm (mm)	Head (mm)	Body (mm)	pregnant	lactating
90831	17035561	F	2/13/2009	5/12/2009	3	F	A	673	G	169.7	74.7	197.5	Y	N
90832	17034004	F	2/13/2009	6/17/2009	4	F	A	663	G	171.4	71.1	195.7	N	N
90833	17019016	F	2/14/2009	4/12/2009	2	M	A	688	G	182.5	78.4	217.6	-	-
90834	080867630*	F	2/14/2009	5/11/2009	3	M	A	665	G	186.4	76.1	201.6	-	-
90835	17027862	F	2/16/2009	7/1/2009	5	M	A	684	G	166.6	68.7	221.6	-	-
90836	17071891	F	2/16/2009	6/3/2009	4	F	A	652	F	181.6	71.8	206.3	Y	Y
101469	54876270	F	1/17/2011	8/13/2011	7	M	A	626	G	175	75	210	-	-
101467	54870019	F	1/17/2011	1/29/2012	12	F	A	603	F	165	70	195	Y	N
101466	54867013	F	2/28/2011	6/8/2011	3	F	A	684	G	164	70	190	Y	N
101468	54883815	F	2/28/2011	4/4/2012	13	M	A	772	G	172.3	71.84	195	-	-
90839	54867601	F	3/1/2011	4/28/2013	25	M	A	771	G	175.53	74	211.14	-	-
101470	65623841	F	3/1/2011	12/8/2011	9	F	A	731	G	172.68	71.6	205.68	Y	N
101471	65628805	C	3/29/2011	5/9/2011	1	M	A	717	G	176	78	220	-	-
90840	65635619	C	3/29/2011	8/8/2011	4	M	A	698	G	169	81	202	-	-
90838	65628094	C	3/30/2011	6/26/2011	3	F	J	446	F	161	73	190	N	N
90837	65775297	C	3/30/2011	6/17/2011	2	M	A	620	F	178	71	190	-	-

PTT = Platform Terminal Transmitter; Colony Location: F=Faridpur, C-Chittagong; BCS = Body Condition Score: G=Good, F=Fair, P=Poor;

### SI References

1. Anonymous (2019) Geneious Prime 2019.
2. M. Hasegawa, H. Kishino, T.-a. J. J. o. m. e. Yano, Dating of the human-ape splitting by a molecular clock of mitochondrial DNA. **22**, 160-174 (1985).
3. S. Kumar *et al.*, MEGA X: Molecular Evolutionary Genetics Analysis across Computing Platforms. **35**, 1547-1549 (2018).