Evidence for Louse-Transmitted Diseases in Soldiers of Napoleon's Grand Army in Vilnius

Didier Raoult,¹ Olivier Dutour,² Linda Houhamdi,¹ Rimantas Jankauskas,³ Pierre-Edouard Fournier,¹ Yann Ardagna,² Michel Drancourt,¹ Michel Signoli,² Vu Dang La,¹ Yves Macia,² and Gérard Aboudharam¹

¹Unité des Rickettsies, Centre National de la Recherche Scientifique (CNRS) Unité Mixte de Recherche (UMR) 6020 and ²Unité d'Anthropologie, CNRS UMR 6578, Université de la Méditerranée, Faculté de Médecine, Marseille, France; ³Department of Anthropology, Faculty of Medicine, Vilnius University, Vilnius, Lithuania

Background. Many soldiers in Napoleon's Grand Army died of infectious diseases during its retreat from Russia. Because soldiers were commonly infested with body lice, it has been speculated that louse-borne infectious diseases, such as epidemic typhus (caused by *Rickettsia prowazekii*), were common.

Methods. We investigated this possibility during recent excavations of a mass grave of Napoleon's soldiers in Vilnius, Lithuania. Segments of 5 body lice, identified morphologically and by polymerase chain reaction (PCR) amplification and sequencing, were found in earth from the grave that also contained fragments of soldiers' uniforms.

Results. DNA of *Bartonella quintana* (the agent of trench fever) was identified by PCR and sequencing in 3 of the lice. Similarly, PCR and sequencing of dental pulp from the remains of 35 soldiers revealed DNA of *B. quintana* in 7 soldiers and DNA of *R. prowazekii* in 3 other soldiers.

Conclusions. Our results show that louse-borne infectious diseases affected nearly one-third of Napoleon's soldiers buried in Vilnius and indicate that these diseases might have been a major factor in the French retreat from Russia.

Human body lice transmit *Borrelia recurrentis*, *Bartonella quintana*, and *Rickettsia prowazekii*, the agents of louseborne relapsing fever, trench fever, and epidemic typhus, respectively [1]. Although these bacterial pathogens have been known for a long time—since 1867, 1919, and 1911, respectively—historical descriptions of the diseases they cause are confusing. Although "famine fevers" and other fevers were associated with conditions that promoted the multiplication of body lice, such as wars, these parasites were only definitively linked with typhus in 1909 by Nicolle [2]. Subsequently, it has been said that they have caused more deaths than weapons during wartime [3]. Historical accounts show that, during the Russian campaign, Napoleon's soldiers were plagued with body lice and that many died with fever [4].

During construction work in late autumn 2001, mass

The Journal of Infectious Diseases 2006; 193:112-20

graves were discovered on the site of a former Soviet Army barracks in the northern suburbs of Vilnius (Verkiu Street, Siaures Miestelis Territory). Records in local archives indicated that the graves contained French troops, which were garrisoned in Vilnius from December 1812, during the retreat of Napoleon's Grand Army from Moscow [5].

The remains of 717 individuals were found in the first area studied, at a density of 7 corpses/m². Similar densities of corpses were found at other sites along the excavation trench, and this suggested that the site contained a total of 2000-3000 corpses (figure 1). The skeletons were in close proximity to one another (0.2-0.5 m), indicating that they had been buried at the same time. They were not in a position associated with rigor mortis, suggesting that the soldiers had been buried soon after death and that the intense cold had frozen them in the position in which they had been placed. Analysis of fragments of uniforms and buttons revealed that soldiers and officers from 40 different regiments were buried in the trench [5] (figure 2). To identify louse-borne diseases in these remains, we looked for ancient lice and amplified the DNA of the agents of louse-borne diseases in the dental pulp. We performed this search in accordance with the 6 recently published

Received 18 May 2005; accepted 29 July 2005; electronically published 18 November 2005.

Potential conflicts of interest: none reported.

Reprints or correspondence: Dr. Didier Raoult, Unité des Rickettsies, CNRS UMR 6020, Université de la Méditerranée, Faculté de Médecine, 27, blvd. Jean Moulin, 13005 Marseille, France (Didier.Raoult@medecine.univ-mrs.fr).

^{© 2005} by the Infectious Diseases Society of America. All rights reserved. 0022-1899/2006/19301-0017\$15.00

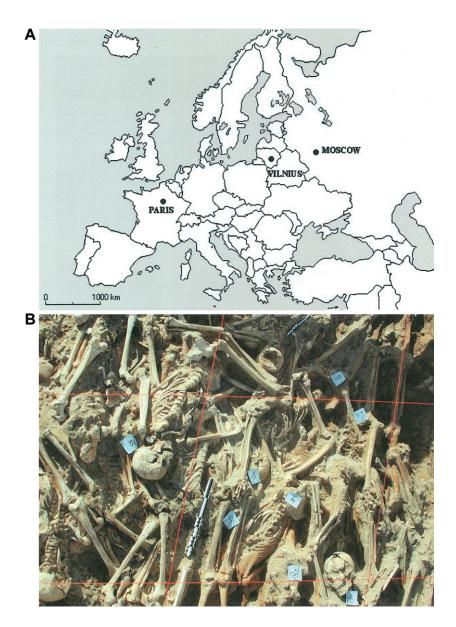


Figure 1. *A*, Map showing the location of Vilnius. The "Grande Armée" retreated form Moscow to Paris. *B*, General view of the grave in Vilnius (photo by P. Adalian, Centre National de la Recherche Scientifique, Unité Mixte de Recherche 6578).

criteria for authentication of molecular data in paleomicrobiology [6]: (1) there should be no positive control; (2) negative controls should test negative (several should be tested that are as similar as possible to the ancient specimens, and the methods used to test the specimens and the negative controls should be as similar as possible); (3) a new primer sequence should be used, one not previously amplified in the laboratory (we named this "suicide polymerase chain reaction [PCR]" [7]); (4) the amplified and sequenced; (5) a second target should be amplified and sequence that differs from modern homologues should be used, to exclude contamination.

MATERIALS AND METHODS

Extraction and identification of lice. We evaluated 5 techniques for identifying lice in earth samples before we tested our sample from Vilnius. In our preliminary study, we used earth from Marseilles that had a texture similar to that from Vilnius and 25 dead lice (strain Orlando; 15 days to 2 months of age) from our rabbit-fed *Pediculus humanus humanus* colony. The lice were dried at 37°C for 10 days before being mixed with 500 g of earth [8].

In the first assay, we slowly mixed the earth into 5 L of distilled water in a polyethylene 900-cm² square dish. After 1



Figure 2. Imperial-type button found in the grave in Vilnius (photo by P. Adalian, Centre National de la Recherche Scientifique, Unité Mixte de Recherche 6578).

h, we carefully searched the debris on the water surface for 0.5–2-mm insect fragments with a binocular magnifying glass. In the other 3 assays, we used paraffin, olive oil, or groundnut oil instead of water. The fifth assay was derived from extraction techniques developed for fossilized insects [9]. Sand was slowly mixed into 2 L of kerosene in a steel 900-cm² square dish. Two liters of cold distilled water was then mixed with the kerosene and left to settle before the water-kerosene interface was examined for insects. DNA was extracted from the insect fragments after they were washed in sterile, distilled water for 2 days with gentle rocking at room temperature.

Amplification of louse DNA. DNA was extracted using the QIAamp Tissue Kit (QIAGEN), in accordance with the manufacturer's instructions. Insect specimens were confirmed to be *P. h. humanus* by use of a nested PCR with primer pairs phND4F1/phND4R1 and phND4F2/phND4R2 (table 1), purchased from Eurogentec. A negative control (water) was tested with the 5 lice.

PCRs were performed in a PTC-200 automated thermal cycler (MJ Research), using Blue Taq DNA Polymerase (Gentaur). Measures were taken to prevent PCR carryover contamination, and each PCR step was performed in a different room. For amplification, the 25- μ L reaction mixture consisted of 1.25 μ L of each primer (1 pmol), 0.8 μ L of MgCl₂ (final concentration, 1.6 mmol/L), 2.5 μ L of dNTP (dATP, dCTP, dGTP, and dTTP; 2 mmol/L each), 2.5 μ L of Blue Taq buffer, 2.5 μ L of bovine serum albumin, 0.2 μ L of DNA polymerase enzyme, 9 μ L of

sterile water, and 5 μ L of the DNA sample. For reamplification, 2.5 µL of each primer (1 pmol), 1.6 µL of MgCl₂ (final concentration, 1.6 mmol/L), 5.0 µL of dNTP, 5.0 µL of Blue Taq buffer, and 0.4 μ L of DNA polymerase enzyme were added to the product from the first amplification. PCR amplification was performed under the following conditions: an initial 3 min of denaturation at 95°C was followed by 44 cycles of denaturation for 30 s at 95°C, annealing for 30 s at 58°C for the first amplification and 44 cycles at 48°C for the reamplification, and extension for 90 s at 72°C. To enable complete extension of the PCR products, amplification was completed by holding the reaction mixture at 72°C for 7 min. PCR products were separated by electrophoresis on 3% agarose gels and were visualized by staining with ethidium bromide. The products were purified using the QIAquick PCR purification Kit (QIAGEN), in accordance with the manufacturer's instructions, and were sequenced in both directions by use of the dRhodamine Terminator Cycle Sequencing Ready Reaction kit (Perkin Elmer), in accordance with the manufacturer's instructions, and an ABI 3100 automated sequencer (Perkin Elmer). The sequences obtained were compared with those available in GenBank, using BLAST [10].

Tooth samples and DNA extraction. Radiographs of the mandible were used to select unerupted teeth to be studied (data not shown). Five negative control teeth were extracted from 5 skeletons excavated from an 18th century grave in Briançon, France. Each skeleton was in an individual coffin in a single grave, and there was no anthropological evidence of an outbreak. One negative control DNA sample was used for every 7 samples. Testing was performed in a blinded manner.

Seventy-two unerupted teeth, identified by radiography, were extracted from 35 skeletons in Vilnius. After thorough washing in PBS, the teeth were fractured longitudinally, and the remnants of the dental pulp were removed aseptically into sterile tubes. DNA was extracted from the samples as described elsewhere [11] and was stored at 4°C for 4 days until use as templates in PCR assays. To avoid contamination, DNA was extracted in 1 building (Marseilles Dental School), and PCR assays were performed in a second building (Timone Hospital microbiology laboratory, where bartonellae and rickettsiae have not been cultured or amplified by PCR previously [12]). To test for other pathogens, including the agents of plague (Yersinia pestis), anthrax (Bacillus anthracis), and typhoid (Salmonella typhi), we attempted to amplify DNA of these organisms by use of previously reported primers [13, 14] in dental pulp remnants, obtained as described above, from 9 teeth from another soldier.

Detection of DNA in teeth. Louse-borne pathogens were detected by suicide PCR, so named because the primers for the target genes selected are used only once. Such primers must never have been used previously in the laboratory and must also nev-

Organism, primer name	Target gene (GenBank accession no.)	Primer position relative to target sequence, nt	Primer sequence (5'→3')	Fragment size, bp	Hybridization temperature, °C
P. h. humanus					
phND4F1	ND4 (AY316847)	2–23	TTGTTGTGCTTTTGACTTCTTG	168	58
phND4R1	ND4 (AY316847)	217-191	CCCTGATTTGAAGTATTAAAGAAACTC		
phND4F2 ^a	ND4 (AY316847)	57–77	GAATTTCCTTATTTGTTTAGC	64	48
phND4R2 ^a	ND4 (AY316847)	158–142	CCGAAATAAGAGCCCGT		
R. prowazekii					
Rp601F1	dnaA (AJ235272)	162115-162139	TGGATAAAATCCAAATATGCTATGG	279	58
Rp601R1	dnaA (AJ235272)	162438-162418	TCCACCTCCGCCATATAGAAA		
Rp601F2 ^a	dnaA (AJ235272)	162209-162229	CTGGAACAACACAAGCAGTGA	141	56
Rp601R2 ^a	dnaA (AJ238272)	162390-162371	TGATGATTCTGCCACAGCTC		
Rp778F1	<i>dna</i> E (AJ238756)	5996-6017	TTTTGTGCTATGCGTAATCACA	246	55
Rp778R1	<i>dna</i> E (AJ238756)	5750-5732	CAAGGCAGGTTGTTTTGATTG		
Rp778F2 ^a	<i>dna</i> E (AJ238756)	5927-5946	ATACAACGGCTTAACCGCAG	77	53
Rp778R2 ^a	<i>dna</i> E (AJ238756)	5844-5825	AACGAAAAGCAAGAGGAGCA		
B. quintana					
hbpEF1	hbpE (AY126675)	231–251	GAGAGTGCTTCACCTAAATAG	429	55
hbpER1	hbpE (AY126675)	700–681	CCACCAATCTGTCCTCCAAA		
hbpEF2 ^a	hbpE (AY126675)	297–316	GAGACGAGTATTAAAGTTTC	282	48
hbpER2 ^a	hbpE (AY126675)	617-599	CTGAGGAACTATTACATCT		
htrAF1	htrA (AY548753)	1–20	AAAGCTGGTATCAAGGCAGG	192	56
htrAR1	htrA (AY548753)	233–213	TCATTTGAATCATTGCGCCCA		
htrAF2 ^a	htrA (AY548753)	52-70	ATTAATGATGTCCGTGATC	113	48
htrAR2 ^a	htrA (AY548753)	203–184	TTTGAGTCTTCTTTCATAAC		
B. recurrentis					
Br-glpQF1	<i>glp</i> Q (AF247155)	21-42	GTTTGCAATAAGTACTGTTCTT	229	53
Br-glpQR1	<i>glp</i> Q (AF247155)	290-271	TCTCTAGCTCTTCCTGGAAA		
Br-glpQF2 ^a	<i>glp</i> Q (AF247155)	86-105	CAGCATTAATTATAGCTCAC	136	49
Br-glpQR2 ^a	<i>glp</i> Q (AF247155)	261–241	AACATTTGTTGTTGTATCTAG		

Table 1. Primers used in this study.

NOTE. Primer positions were numbered relative to the ND4 gene of Pediculus humanus humanus (GenBank accession no. AY316847); to the dnaA (AJ235272) and dnaE (AJ238756) genes of Rickettsia prowazekii; to the hbpE (AY126675) and htrA (AY548753) genes of Bartonella quintana; and to the glpQ gene of B. recurrentis (AF247155).

^a Primer used for sequencing.

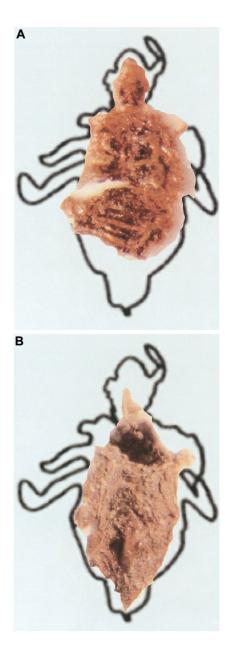


Figure 3. Morphological identification of body lice, using binocular magnification. The outline of a modern dry body louse is included to illustrate the size and positions of the fragments.

er be used subsequently [7, 15]. Specimens were tested for the presence of *R. prowazekii* by use of the double pair of primers Rp601F1/Rp601R1 and Rp601F2/Rp601R2 for the nested amplification. A second suicide PCR was performed for *R. prowazekii*, using the primers Rp778F1/Rp778R1 and Rp778F2/Rp778R2 for the nested amplification. To detect *B. quintana*, we used the primers hbpEF1/hbpER1 and hbpEF2/hbpER2 for the nested amplification. Primer pairs Br-GlpQF1/Br-GlpQR1 and Br-GlpQF2/Br-GlpQR2 were used for detection of *B. recurrentis*.

All PCRs were performed in a PTC-200 automated thermal

cycler (MJ Research), as described above, using hybridization temperatures for each primer pair as detailed in table 1. PCR products were sequenced as described above, and the sequences obtained were compared with those available in GenBank.

RESULTS

Identification of lice in the grave. Two kilograms of earth containing bone fragments and remnants of clothing were obtained from Vilnius and examined for lice. In preliminary studies, the water-kerosene interface method enabled us to recover all of the lice placed in a soil sample; using the technique on the sample from Vilnius, we recovered parts (0.4–1.2 mm in cross section) of the abdomen [3] or the dorsum [2] of 5 lice. These were identified as *P. h. humanus* on the basis of gross morphology and appearance (figure 3) and by means of scanning electron microscopy (data not shown). The 5 remnants are the size of lice, and all match perfectly in form and size with drawn outlines of modern lice. This identification was further confirmed by PCR amplification and sequencing.

PCRs targeting the NADH dehydrogenase 4–encoding gene (ND4) (table 1) were positive for DNA extracted from all 5 louse parts (figure 4), and the sequences of the amplicons were very similar to those of *P. h. humanus* that are available in GenBank: 100% similarity (64/64) with accession number AY860502, 98.5% (63/64) with AY860506, 100% (60/60) with AY860503, 100% (61/61) with AY860504, and 98.3% (58/59) with AY860505. Although 2 of the 5 lice had a single nucleotide mutation at a nondiscriminant position (figure 4), all 5 were clearly identified as *P. h. humanus* on the basis of the sequence data. Also, they differed from *P. h. capitis* at nt 133, a feature that enables discrimination between the European *P. h. humanus* and *P. h. capitis* louse sequences available in GenBank [16]. Negative controls all tested negative.

Detection of pathogens in lice and teeth. Recently, we detected *Y. pestis* and *B. quintana* in DNA extracted from teeth from human remains [7, 11, 12, 17]. Here, we used suicide PCR to detect louse-borne pathogens in Napoleon's soldiers. Of the 72 teeth tested from 35 skeletons, 4 teeth from 3 soldiers were found to be positive by suicide PCR using primers for the *dna*A gene of *R. prowazekii* (table 2 and figure 5). No positive results were obtained with DNA from the louse parts. All 4 amplicons were identified as *R. prowazekii* on the basis of nucleotide similarity rates of 99.3% (140/141) (GenBank accession number AY860510), 100% (135/135) (AY860507), 100% (141/141) (AY860508), and 100% (138/138) (AY860509) with a reference strain of *R. prowazekii* (AJ235272). The presence of *R. prowazekii* in the specimens was confirmed by a second nested PCR using the Rp778 primers.

Amplification of the *hbp*E gene of *B. quintana* was possible with DNA from 10 teeth from 7 skeletons and from 3 lice. Tooth amplicon sequences from 1 tooth from each skeleton

lousel	TTTTTCTCCTTCTATCTTTCTTTTAGCTCTTCATTCGTCTCCT
louse2	TTTTTCTCCTTCTATCCTTCTTTTAGCTCTTCATTCGTCTCCT
louse3	TTTCTCCTTCTATCTTTTAGCTCTTCATTCGTCTCCT
louse4	TTTCTCCTTCTATCTTTTTAGCTCTTCATTCGTCTCCT
louse5	CTCCTTCTTTTAGCTCTTCGTCTCCT
P. h. humanus	GAATTTCCTTATTTGTTTAGCTTTTTCTCCCTTCTATCTTTTTTAGCTCTTCATTCGTCTCCT
P. h. humanus	GAATTTCCTTATTTGTTTAGCTTTTTCTCCTTCTATCTTTCTT
P. h. capitis	<u>GAATTTCCTTATTTGTTTAGC</u> TTTTTCTCCTTCTATCTTTCTTTTAGCTCTTCATTCGTCTCCT
	phND4F2 * *
	-
louse1	TTTGGCGGGTGACTTGGATGT
louse2	TTTGGCGGGTGACTTGGATGT
louse3	TTTGGCGGGTGACTTGGAT
louse4	TTTGGCGGGTGACTTGGATG-
louse5	TTTGGCGGGTGACTTGGATG-
P. h. humanus	TTTGGCGGGTGACTTGGATGTACGGGCTCTTATTTCGG
P. h. humanus	TTTGGCGGGTGACTTGGATGTACGGGCTCTTATTTCGG
P. h. capitis	TTTGGCGGGTGACCTGGATGTACGGGCTCTTATTTCGG
P. h. capitis	TTTGGCGGGTGACCCTGGATGTACGGGGCTCTTATTTCGG
P. h. capitis P. h. capitis	
-	TTTGGCGGGTGACCTGGATGTACGGGCTCTTATTTCGG
P. h. capitis	TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG
P. h. capitis P. h. capitis	TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG
P. h. capitis P. h. capitis P. h. capitis	TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG
P. h. capitis P. h. capitis P. h. capitis P. h. capitis P. h. capitis	TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG TTTGGCGGGTGAC <mark>C</mark> TGGATGTACGGGCTCTTATTTCGG

Figure 4. Alignment of *ND4* nucleotide sequences from the 5 tested lice with those from *Pediculus humanus humanus* and *P. h. capitis*. Boxed nucleotides denote primer positions. Asterisks indicate divergent nucleotides. Green nucleotides are divergent among tested louse strains. The discriminant nucleotide allowing differentiation between *P. h. humanus* and *P. h. capitis* is shown in blue (*P. h. humanus*; GenBank accession nos. AY316847 and AY316839) or red (*P. h. capitis*; GenBank accession nos. AY316867, AY316866, AY316866, AY316852, AY316855, AY316856, and AY316857). The GenBank accession nos. of the 5 louse sequences are AY860502, AY860503, AY860504, AY860505, and AY860506.

were obtained. They were identified as *B. quintana* on the basis of nucleotide sequence similarity rates of 99.6% (279/280) (GenBank accession number AY860520), 99.6% (278/279) (AY860511), 100% (252/252) (AY860512), 99.6% (276/277) (AY860513), 99.6% (277/278) (AY860514), 99.3% (274/276) (AY860515), and 98.2% (273/278) (AY860516) with a reference strain of *B. quintana* (AY126675). Louse amplicon sequences were also identified as *B. quintana* on the basis of nucleotide sequence similarity rates of 99.4% (172/173) (GenBank accession number AY860517), 99.1% (222/224) (AY860518), and 99.3% (274/276) (AY860519) with GenBank accession number AY126675 (figure 6). The presence of *B. quintana* was confirmed using the *htr*A-based nested PCR on DNA from 7 skeletons.

All negative controls tested negative. No amplification products were obtained from the teeth or lice with primers for *B. recurrentis*. Similarly, we could not identify *Y. pestis*, *B. anthracis*, or *S. typhi* DNA in the 9 teeth we tested from 1 soldier.

DISCUSSION

The majority of the 500,000 soldiers who started the Russian campaign died of dysentery, pneumonia, or fever. It is estimated [3] that, of the 25,000 soldiers who reached Vilnius, only 3000

survived. On the basis of the results of our study, we believe that many were infected with louse-transmitted diseases. Similar large outbreaks of disease have occurred after many wars in the past. Their etiologies are mostly controversial, however,

Table 2. Positive specimens in soldiers' dental pulp.

			PCR result			
	Tooth		Bartonella quintana		Rickettsia prowazekii	
Soldier	no.	hbpE	htrA	Rp601	Rp778	
PL3K19	33	+	+	_	_	
PL3K26	35	+	+	_	_	
PL3K80	37	+	+	_	_	
PL3K84	11	+	+	_	_	
PL3K128	28	+	+	-	_	
PL2K225	23	+	+	-	_	
PL3K2	35	+	+	-	_	
PL3K170	45	_	_	+	+	
PL3K38	22	_	_	+	+	
PL3K158	17	_	_	+	+	
PL3K158	43	_	-	+	+	

NOTE. PCR, polymerase chain reaction.

AY860507 AY860510 AY860509 AY860508 AJ235272 NC_006142 NC_003103	AATCACCTACTAAGACTTTTGCCGATATCGGCAACAGTGCA CAGAATCACCTACTAAGACTTTTGCCGATATCGGCAACAGTGCA GAATCACCTACTAAGACTTTTGCCGATATCGGCAACAGTGCA TAGAATCACCTACTAAGACTTTTGCCGATATCGGCAACAGTGCA (CTGGAACAACACAAGCAGTGA)TAGAATCACCTACTAAGACTTTTGCCGATATCGGCAACAGTGCA CAGAATTACCTACTAAAACTTTTTCCCAATATTAGCAACAGTGCA CAGAATTACCTACTAACAACTTTTTGCCGATATCGGCAACAGTGCA RD601F2 * * * * * * * * * * * *
	Rp001F2
AY860507 AY860510 AY860509 AY860508 AJ235272 NC_006142 NC_003103	CTAAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTAAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTAAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTAAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTAAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTTAATTCAGAAAATATCGTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTTAATTCAGAAAATATCCTTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTTAATTCAGAAAATACCATTTCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTTAATTCAGAAAATACCATTTCCAACACTTGATGTACGTTTTACTTTCGATAATTTTGTG CTTAATTCAGAAAATACCATTTCCACCCTTGATGTACGTTTTACTTTCGATAATTTTGTG * * * * * * * * *
AY860507	GTTGGAGTACCAAATGAACTAGCTTATGCAGCAG
AY860510	GTTGGAGTACCAAATGAACTAGCTTATGCAGCAGCAA
AY860509	GTTGGAGTACCAAATGAACTAGCTTATGCAGCAGCA-
AY860508	GTTGGAGTACCAAATGAACTAGCTTATGCAGCAGCAA
AJ235272	GTTGGAGTACCAAATGAACTAGCTTATGCAGCAGCAAGAGCTGTGGCAGAATCATCA
NC_006142	GTTGGAG <mark>C</mark> ACCGAATGA <mark>G</mark> CTAGCTTATGCAGC <mark>G</mark> GCAA
NC_003103	GTTGGAG <mark>C</mark> CCCAAATGA <mark>G</mark> CTAGCCTATGCAGC <mark>C</mark> GCAA
	* * * * *
	Rp601R2

Figure 5. Alignment of *dna*A nucleotide sequences from the 4 polymerase chain reaction (PCR)–positive teeth with those of *Rickettsia prowazekii* (GenBank accession no. AJ235272), *R. typhi* (NC_006142), and *R. conorii* (NC_003103). Boxed nucleotides denote primer positions. Asterisks indicate divergent nucleotides. Green nucleotides are divergent among PCR-positive soldiers' teeth. The discriminant nucleotides allowing differentiation between *R. prowazekii* and other *Rickettsia* species are shown in blue (*R. prowazekii*) or red (*R. typhi* and *R. conorii*). The GenBank accession nos. of the sequences from the 4 PCR-positive teeth are AY860507, AY860510, AY860509, and AY860508.

because diagnoses made at the time were largely based on unreliable clinical and epidemiological data. For example, in Napoleon's time, lice were not recognized as vectors of disease [18], and typhus was first recognized as a distinct disease only in the 19th century [18]. We consider our results to be valid, because they fulfil the current recommendations for paleomicrobiology. The negativity of our negative controls supports the validity of our positive tests, as does the obtaining of original sequences in lice and in *B. quintana*. Positive tests were confirmed by a second target gene amplification and sequencing.

We identified parts of 5 body lice in the earth from the mass grave in Vilnius. Previously, lice from the 1st century have been identified morphologically in Israel [19], and ancient head lice have been collected in Europe from Herculanum [20] and from pre-Columbian South American mummies [21]. We have recently shown that body and head lice of European origin can be differentiated by sequencing [16], and we identified the DNA signature of the body louse in that study.

B. quintana was reported to occur in lice at the end of World War I [22] and is now recognized to be the most commonly found louse-borne pathogen [23]. We have now identified the organism in body lice from a century earlier and from the dental pulp of 7 of Napoleon's soldiers. We believe that these findings provide firm evidence that the soldiers had trench fever. Previously, we reported the presence of *B. quintana* genes

in 4000-year-old teeth [17] and the presence of *Bartonella hen*selae genes in naturally infected cats [24] from the present day and from the Middle Ages [25].

Although we could not identify DNA of *R. prowazekii* in the lice we studied, we could detect the DNA of the organism in the dental pulp of 3 soldiers, indicating that Napoleon's soldiers also had epidemic typhus. Although finding bacterial DNA in teeth does not necessarily mean that the organism was the cause of death, when the DNA of a deadly agent such as *R. prowazekii* is present, it is very likely that the organism was the cause of death. Previously, we were unable to detect the DNA of *R. prowazekii* in teeth from people who died during the Black Death [7] but could detect DNA of *Y. pestis* in teeth from the suspected plague victims [11, 12]. In the present study, we were unable to find DNA of *Y. pestis* in 9 teeth from 1 of Napoleon's soldiers [7, 17].

The critical issue in the use of PCR is the prevention of DNA contamination [17]. In our study, we followed recent recommendations to ensure that our results were not influenced by contamination. We did not use positive controls, which can be a considerable source of contamination, and we ensured that our negative controls [7, 26] produced no amplicons. We used separate rooms for sample preparation and for PCR amplification, and we used primers for sequences that had not previously been studied in the laboratory in which the

NY860311 ITITICALITATICALTORIAMAGCITOTITATIGTITA NY860313 ITITICALITATICATIORIAMAGCITOTITATIGTITA NY860313 ITITICALITATICATICATICATICATIONIAMAGCITOTITATIGTITA NY860313 NY00ANGANAA ITITICALITATICATICATICATICANATICALITATIGTITA NY860311 NY00ANGANAA -TATITAAATITATICATICATICANATICANATICATICATICANATICANATICATICATICANATICANATICATICANATIC		
AY960513 TITICALITATITATGNIGATAAAASCITUTITATGTII AY960514 AITITCALITATTATGNIGATAAAASCITUTITATGTII AY960516 ITITCALITATTATGNIGATAAAASCITUTITATGTII AY960516 ITITCALITATTATGNIGATAAAASCITUTITATGTIIT AY960516 ITITCALITATTITGATGATAAAASCITUTITATGTIIT AY960517 ITITCALITATTITGATGATGATAAASCITUTITATGTITT AY960518 ITITCALITATTITGATGATGATAAASCITUTITATGTITT AY960519 ITITCALITATTITGATGATGATAAAASCITUTITATGTITT AY960511 EAGACGAGUATTAAAGTITCALAATTATATGATGATAAAASCITUTITATGATGATAAAACCITUTITATGTATATATATTATGATAAAAACCITUTITATGTAATATATATTATTATGATAAAAACCITUTITATATGATAAAAACCITUTITATATGATAAAAACCITUTITATATGATAAAAACCITUTITATATGATAAAAACCITUTITATATGATAAAAAACCITUTITATATGATAAAAAAAAAAAAAAAAAAAAAAAAAAA	AY860511	
N9860514 ATTITCANTTATTATGNIGATAAAASCTTUTTANIGTIT N9860515 TITCANTTATTATGNIGATAAASCTTUTTANIGTIT N9860516 ATTITCANTTATTITGANGTAGAAAASCTTUTTANIGTIT N9860518 ATTITCANTTATTITGANGTAAAASCTTUTTANIGTIT N9860519 ATTITCANTTATTITGANGTAAAASCTTUTTANIGTIT N9860519 ATTITCANTTATTITGANGTAAAASCTUTTTANIGTIT N126675 GAACGAGTATAAAGTTUGATAAATTITATGATGATAAAASCTUTTANIGTIT N216675 GAACGAGTATAAAGTTUGATAAATTITAGATGAGAAAAACCTUTTANIGTIT N216675 GAACGAGTATAAAGTTUGATAAATTITAGTATGATAAAACCTUTTANIGTIT N2166511 ATGGAAGAAAAA ATTITAATTAAATTITATGTAAAAACCTUTTATATTATTTUTATATTATTATTATTATTATTATTAT	AY860512	TTGATAAAAGCTTGTTTATGTTTT
NY860510 TRATTICAL TLATTATAGNIGALAAAGCTUTTIAINGTITI NY860516 ATTICAL TLATTITIGANG TAAAAGCTUTTIAINGTITI NY860518 ATTICAL TLATTITIGANG TAAAAGCTUTTIAINGTITI NY860518 ATTICAL TLATTITIGANG TAAAAGCTUTTIAINGTITI NY860518 ATTICAL TLATTITIGANG TAAAAGCTUTTIAINGTUTI NY860517 ATTICAL TLATTITAGANG TAAAAGCTUTTIAINGTUTI NY860512 CCACAAACAATTITATAGNIGALAAAGCTUTTIAINGTUTI NY860512 ATOGAACAAAA TAATTIAAATTITATTIGCTAAAATTAAATTITATTIGTAAATA NY860512 ATOGAACAAAA TAATTIAAATTITATTIGCTAAAATTAAATTITATTIGTAAATA NY860512 ATOGAACAAAA TAATTIAAATTITATTIGCTAAAATTAAATTITATTIGTAAATA NY860513 ATOGAACAAAA TAATTIAAATTITATTIGCTAAAATTAAATTITATTIGTAAATA NY860514 ATOGAACAAAA TAATTIAAATTITATTITATTITATTITATITATTITATITATTITA	AY860513	TTTTCATTTATTATGATTGATAAAAGCTTGTTTATGTTTT
NY860515 TICAITTAITTITGATGATAAAAGCTUTTIAIGTIT NY860516 ATTITOAITTAITTITGATGATAAAAGCTUTTIAIGTIT NY860518 ATTITOAITTAITTITGATGATAAAAGCTUTTIAIGTIT NY860518 ATTITOAITTAITTITGATGATGATAAAAGCTUTTIAIGTIT NY860518 ATTITOAITTAITTIGATGATGATAAAGCTUTTIAIGTITI NY860511 ATTITOAITTAITTITGATGATGATAAAGCTUTTIAIGTITI NY860512 ATTAGATAAAGTTUTAGATTATAAGTTUTTAGATGATAAAAGCTUTTIAIGTITI NY860513 ATGGAGAGAAAA ATGGAGAGAAAAA TATTAAATTITATTTGTAAAATTAAATTTATTGTAAATA NY860513 ATGGAGAGAAAA ATGGAGAGAAAAA TATTAAATTATATTTGTAAAATTAAATTTATTGTAAATA NY860513 ATGGAGAGAAAA ATGGAGAGAAAAA TATTAAATTTATTGTAAAATTAAATTTATTGTAAATTAAATTTATTGTAAATA NY860516 ATGGAGAGAAAA NY860517 ATGGAGAGAAAA NY860518 ATGGAGAGAAAA NY860519 ATGGAGAGAAAA NY860511 ATGGAGAGAAAA NY860512 ATGGAGAGAAAA NY860513 ATGGAGAGAAAA NY860514 ATGGAGAGAAAA NY860511 CGAAATAAGTTATTAGGATAAATTTATTTGTAGATATAATTATT	AY860514	ATTTTCATTTATTATGATTGATAAAAGCTTGTTTATGTTTT
AVS60516ATTITOATTATTITGATGAAAAACTTUTTIATAGTITA AVS60518ATTITOATTATTITGATGATAAAACGTUTTIATAGTIT AVS60518ATTITOATTATTITGATGATAAAACGTUTTIATAGTIT AVS60517ATTITOAATTATTATGATGATAAAACGTUTTIATAGTIT AVS60517ATTITAAATTATTATGATGATAAAACGTUTTIATAGTITA AVS60512 ATOGAAGAAAATAATTAAAATTATTATGCTAAAATTAAATT	AY860520	-TATTTTCATTTATTATGATTGATAAAAGCTTGTTTATGTTTT
AVS60516ATTITOATTATTITGATGAAAAACTTUTTIATAGTITA AVS60518ATTITOATTATTITGATGATAAAACGTUTTIATAGTIT AVS60518ATTITOATTATTITGATGATAAAACGTUTTIATAGTIT AVS60517ATTITOAATTATTATGATGATAAAACGTUTTIATAGTIT AVS60517ATTITAAATTATTATGATGATAAAACGTUTTIATAGTITA AVS60512 ATOGAAGAAAATAATTAAAATTATTATGCTAAAATTAAATT	AY860515	TTCATTTATTTTGATTGATAAAAGCTTGTTTATGTTTT
AVS60519ATTITOATTATTITGATGATAAAAGCTUTUTAINGTIT AVS60518ATTITOATTATAAGCTGATAAAAGCTUTUTAINGTIT AVS60519ATTATOATTATAAGGTGATAAAAGCTUTUTAINGTIT NC_003103 DEPT AVS60511 ATGGAGGAGAAAATAATTAAAATTATATTATGGATAAAAAGCTUTUTAINGTIT NC_005103 ATGGAGGAAAAATAATTAAAATTATTTGGAAAATTAAATTATATTGGAAAA AYS60511 ATGGAGGAAAAATAATTAAAATTATTTGGAAAATTAAATTATATTGGAAAA AYS60513 ATGGAGAAAAA	AY860516	ATTTTCATTTATTTTGATTGATAAAAGCTTGTTTATGTTTT
NY860518 ATTICALITATITYAATTEATATAAAGCTIOTITATOTIT NY860517 ATTICALITATATITYAATTAAAAGCTIOTITATOTITATITYA NY860517 CACADAACAGTATITAAAGCTICGATATITACATTATITYACATTAATAAAAGCTIOTITATAGTITA NY860511 ATGGAAGAAAA		
AV960517 ATTITCA-TRATTICATIONATICATIONAL CONTENTION CONTENTICON CONTENTION CONTENTION CONTENTION CONTENTION CONTENTION CONT		
N1126675 EMGACCAGTATTAAAGTTTCGATTATTTACATTACTTACTATATATA		
NC_003103 CCACCAMACAGERATGTACCTACGERATAGAAAARTABAAGTCCT NY60511 ATGGAGGAAAATAATTAAAATTTATTGCTAAAATTAAATT		
bpp2 ••••••••••••••••••••••••••••••••••••		
NYBOS11 ATOCAL NYBOS12 ATOCALGANAA TAATTANANTTYATTGCTANANTTYATTGCTANANTTYATTGTANATA NYBOS12 ATOCALGANAA TAATTANANTTYATTGCTANANTTAATTTATTGTANATA NYBOS12 ATOCALGANAA TAATTANANTTYATTGCTANANTTAATTTATTGTANATA NYBOS12 ATOCALGANAA TAATTANANTTYATTGCTANANTAATTTATTGTANATTAATTTATTGTANATAATTAAT	NC_003103	
AY860512 ATGGARGANAA TANTTAAAATTTATTUGTAAAATTTATTUGTAAATTTATTUGTAAATTTATTUGTAAATT AY860513 ATGGARGANAATANTTAAAATTTATTUGTAAAATTAAATTTTATTUGTAAAATTAAATTTATTUGTAAAATAAAT		mpra
AY860513 ATGGAAGAAAA TAATTAAAATTTATTGCTAAAATTAAATTTATATGTAAAAT AY860514 ATGGAAGAAAA TAATTAAAATTTATTGCTAAAATTAAATTTATTGTAAAATA AY860515 ATGGAAGAAAA TAATTAAAATTTATTTGCTAAAATTAAATTTATTGTAAATA AY860516 ATGGAAGAAAA		
AY860514 ATGGAAGAAAATAATTAAAATTTATTGCTAAAATTAAATT		
AY860520 ATGGAAGAAAA TAATTAAAATTTATTGCTAAAATTAAATTTATATGTAAATTA AY860515 ATGGAAGAAAA TAATTAAAATTTATTGCTAAAATTAAATTTATTGTAAAATA AY860516 ATGGAAGAAAA TAATTAAAATTTATTTGCTAAAATTAAATTTATTGTAAATA AY860518 ATGGAAGAAAA TAATTAAAATTTATTTGCTAAAATTAAATTTATTGTAAATA AY860517 ATGGAAGAAAA		
AY860515 ATGGAAGAAAATAATTAAATTTATTGCTAAAATTAAATT	AY860514	
AY960516 ATGGAAGAAAATAATTAAATTTTATTGCTAAATTAAAT	AY860520	
AY860519 ATGGAGAAAAATAATTAAAATTTATTGCTAAAATTAAATT	AY860515	
AY860518 ATGGAGAAAAATAATTAAAATTTATTGCTAAAATTAAATT	AY860516	ATGGAAGAAAAA TAATTAAATTTTATTTGCTAAAATTAAATTTATTGTAAAATA
AY860517 ATGGAAGAAAATAATTAAAATTATTATTGGTAAAATAATTTATTGGAAATA AY126675 ATGGAAGAAAATAATTAAAATTATTTTTAAAAATTATATGTAAATTATTGTGAAATA NC_003103 ATCAAAGATAGAACCTCTTAAGCAAATTAATTTATAGAATTAGTAATTTATTGTGAAATA NC_003103 ATCAAAGATAGAACCTCTTAAGCAAATTTAACGAATTAGAAATTATATGTGTATTT AY860511 GAAATTATGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAAGTGAATT AY860513 GAAATTATGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAAGTGAATT AY860514 GAAATTATGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAAGTGAATT AY860515 GAAATTAGTAGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATTT AY860516 GAAATTATGTAGTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGTGAATT AY860517 GAAATTAGTAGTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGTGAATT AY860518 GAAATTATGTAGTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGTGATTT AY860517 GAAATTAGTAGTAGTTTTTAAGCATAAATTACAGTACTCTGTTTTTAAATGTGAATT AY860517 GAAATTAGTAGTACATTTTTTAAGCATAAATTACAGTACTCTGTTTTTAAATGTAATTTTAY AY860511 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATAGAGGTACTAGTTTTTAAATGTAAGGGGT-ATAATTT AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATACAGGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGGAGGGT-ATAATTT AY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAGGGGT-ATAATTT AY860515	AY860519	ATGGAAGAAAAATAATTAAAATTTATTTGCTAAAATTAAATT
ATGGAAGAAAAATAATTAAAATTAATTAGTAGAATTAGAATTAGAATTAGTAG	AY860518	ATGGAAGAAAAATAATTAAAATTTATTTGCTAAAATTAAATT
NC_003103 ATCAAGATAGAACCTCTTAGGCAAATTTAATTTATAATATTGAGATTGGAATTT AY860511 GAAATTAGTAGTTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTAAATGTGATTT AY860512 GAAATATAGTAGTTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATT AY860513 GAAATATAGTAGTTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATT AY860514 GAAATATAGTAGTTAGTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATT AY860516 GAAATATAGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATT AY860519 GAAATATAGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTAAATGTGATT AY860519 GAAATATAGTAGTTAGTTTTTAAGCATAAATTTACAGTACTCTGTTTTTAAATGTGATT AY860519 GAAATATAGTAGTTAGTTTTTAAGCATAAATTTACAGTACTCTGTTTTTAAATGTGATTT AY860519 GAAATATAGTAGTTAGTTTTTAAGCATAAATTTACAGTACTCTGTTTTTAAATGTGATTT AY860519 GAAATATAGTAGTTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATTT AY860510 GAAATATAGTAGTAGTTTTTAAGCATAAAATTACAGTACTCTGTTTTTTAAATGTGATTT AY860510 CCAA-CCGGA-AATACTCTGTCTTTTTAAGCATAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860511 T -TTATTATTAAACAATAGCATAGGGTATAATTTATGAGTGGT-ATAATTT AY860512 T -TTATTATTTAAACAATAGCAATGGGTATAATTTATGAGTGGT-ATAATTT AY860512 T -TTATTATTTAAACAATAGCAATGGGTATAATTTATGAGTGGT-ATAATTT AY860513 T -TTATTATTAAACAATAGCAATGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860514 T -TTATTATTAAACAATAGCAATGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860515 T -TTATTATTAAACAATAGCAATGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860516 T -TTATTATTAAACAATAGCAATGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860517 T -TTATTATTAAACAATAGCAATGGGATATAATTTTATGAATATGAGGGGT-ATAATTT AY860518 T -TTATTATTAAACAATAGCAATGGGATATAATTTTATGAATATGAGGGGT-ATAATTT AY860519 T -TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860519 T -TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860519 T -TTATTATTATAACAATAGCAATCGGGTATAATTTTATGAAGGGT-ATAATTT AY860519 T -TTATTATTATAACAATAGCAATCGGGTATAAATTTTATGAGGGGT-ATAATTT AY860519 T -TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAAGGGGT-ATAATTT AY860510 T ATGAATATGGAATTTATAATAGGATCCGGTTTTTGCCTCCATCCGGCCTCTGGGGCA- AY860511 TATGAATATGGAATTTATAATAGGATCCGGTTTTTGCCTCATCCGGCCTCTGGGGCAA AY860512 TATGAATATGGAATTTATAATAGGATCCGTTTTTGCCTCATCCGGCCTGTGGGAC	AY860517	ATGGAAGAAAAATAATTAAAATTTATTTGCTAAAATTAAATT
- ************************************	AY126675	ATGGAAGAAAAATAATTAAAATTTATTTGCTAAAATTAAATT
	NC_003103	ATCAAAGATAGAACCTCTTAAGCAAATTTAATTTTATAAAATTAGAATTTGTAAGCTATT
NY860512 GAAAATATAGTTAGTTATTTAAGCATAAAATTTACAGTACTCGGTTTTTAAAGTGATTT NY860513 GAAAATATAGTTAGTTATTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT NY860514 GAAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTTAAATGTGATTT NY860515 GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTTAAATGTGATT NY860516 GAAAATATAGTTAGTTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATT NY860519 GAAAATATAGTAGTTTTTAAGCATAAAATTACAGTACTCGGTTTTTAAATGTGATTT NY860519 GAAAATATAGTTAGTTTTTAAGCATAAAATTACAGTACTCGGTTTTTAAATGTGATTT NY860517 GAAAATATAGTAGTTTTTAAGCATAAAATTACAGTACTCGTTTTTTAAATGTGATTT NY860518 GAAATATATGTTAGTTTTTAAGCATAAAGTTACCGGTTATATTTATAGTATATGGGGGT-ATAATTT NY860511 T-TTATTATTTAAACAATAGCATACGGGTATAATTTATGAATATGAGGGGT-ATAATTT NY860512 T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTAGAATATGAGGGGT-ATAATTT NY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTAGAATATGAGGGGT-ATAATTT NY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTT NY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTT NY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTT NY860518 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTAGAATATGAGGGT-ATAATTT NY860519 TATTATTATAACAATAGCAATCGGGTATAATTTATGAATATGAGGGGT-ATAATTT NY860510 <td>_</td> <td></td>	_	
AY860513 GAAATATAGTTAGTTATTTAAGCATAAAATTTACAGTACTCGGTTTTTAAAGTGATTT AY860514 GAAATATAGTAGTTATTAAGCATAAAATTTACAGTACTCGGTTTTTAAAGTGATTT AY860520 GAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860515 GAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860516 GAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860517 GAAATATAGTAGTTATTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860518 GAAATATAGTAGTTATTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860517 GAAATATAGTAGTTATTTAAGCATAAAATTTACAGTACTCGGTTTTTAAATGTGATTT AY860518 T-TATTAGTAGTTAGTTTTTAAGCATAGACATACAGTACTCGGTTATTATTAAAGTAATTTAAATTTAAATTTAAATTTAAATTT AY860511 T-TTATTATTAAACAATAGCAATCGGGTATAATTTACCGTATCTTGTATTTTAAATTTA AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860515 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGAGGGT-ATAATTT AY860518 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAATATGAGGGT-ATAATTT	AY860511	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
AY860514 GAAAATATAGTIGGTITTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860515 GAAAATATAGTIAGTITTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860515 GAAAATATAGTIAGTITTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860519 GAAAATATAGTIAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860519 GAAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860510 GAAAATATAGTAGTTTTTAAGCATAAAATTTACAGTACTGTTTTTTAAATGTGATTT AY860511 GAAAATAAGTAGTTAGTTTTTAAGCATAAAATTTACAGTACTGTGTTTTTAAATGTGATTT AY860512 CCAA-CACGGA-AATCAGTCGTCTTATAACAGTACCTGTTTTTTAAATGTGATTT AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT AY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT AY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT AY860515 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAGATAGGAGGGT-ATAATTT AY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGATAGGAGGGT-ATAATTT AY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGATAGGAGGGT-ATAATTT AY860518 TATAGATATGAAATTAACAATAGGAATCGGGTTAAATTTATGAGAATGAGGGGT-ATAATTT AY860517	AY860512	
AY860520 GAAAATARAGTUGTITTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860515 GAAAATARAGTUGTITTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860516 GAAAATATAGTUGTITTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAAATGTGATTT AY860517 GAAAATATAGTUGTITTTAAGCATAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860517 GAAAATATAGTUGTITTTAAGCATAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860517 GAAAATATAGTUGTITTTAAGCATAAATTTACAGTACTGTGTTTTTTAAATGTGATT AY860510 T-TTATTATAGTAGTTTTAAGCATAAATTTACAGGTACTGTGTTTTTTAAATGTGATT YY860511 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTACGATATGAGGGGT-ATAATTT YY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGGAGGGT-ATAATTT YY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860515 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860517 TTATTATTATAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860518 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860511 TATGATATGAAATTAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860518 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT YY860519 TATGATATAGAAATTAACAATAGCAATCGGGTATAATTTTATGAATAGGAGGGGT-ATAATTT YY860511	AY860513	
AY860515 GAAAATARAGTIAGTITTTTAAGCATAAAATTITACAGTACTCTGTTTTTAAAATGTGATTT AY860516 GAAAATATAGTIAGTITTTTAAGCATAAAATTITACAGTACTCTGTTTTTAAAATGTGATTT AY860519 GAAAATATAGTIAGTITTTAAGCATAAAATTITACAGTACTCTGTTTTTTAAAATGTGATTT AY860510 GAAAATATAGTIAGTITTTAAGCATAAAATTITACAGTACTCTGTTTTTTAAAATGTGATTT AY860517 GAAAATATAGTAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAAATGTGATTT AY860518 GAAAATATAGTAGTTAGTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAAATGTGATTT AY860510 T-TTATTATTAAACAATAGCATACGGGTATAATTTACGAGTACTGGGGT-ATAATTT AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGGAGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAGATGAGGGT-ATAATTT AY860516 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAGATAGGGGT-ATAATTT AY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAGATAGGGGT-ATAATTT AY860518 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAATAGAGGGGT-ATAATTT AY860519 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATAGAGGGGT-ATAATTT AY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAGATAGAGGGGT-ATAATTT AY860517 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAATAGAGGGGT-ATAATTT AY860517 T-TTATTATTAACAATAGCAATCGGGTATAATTTATGAATAGAGGGGT-ATAATTT AY860517 T-TTATTATTAACAATTAGCAATCGGGTATAATTTATGAGATAGGGGGT-ATAATTT AY860517	AY860514	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
AY860516 GAAAATARAGTIGGTITTTAAGCATAAAITTTACAGTACTCTGTITTTAAAATGTGATTT AY860519 GAAAATARAGTIGGTITTTAAGCATAAAATTTACAGTACTCTGTTITTTAAAATGTGATTT AY860518 GAAAATATAGTIGGTITTTAAGCATAAAATTTACAGTACTCTGTTITTTAAATGTGATTT AY860519 GAAAATATAGTIGGTITTTAAGCATAAAATTTACAGTACTCTGTTITTTAAATGTGATTT AY126675 GAAAATATAGTIAGTITTTAAGCATAAAATTTACAGTACTCTGTTITTTAAATGTGATTT NC_003103 CCAA-CACGGA-AATCATTCGTCTTATAATCAAGCCATACGTACTCTTGTTTTTTAAAATGTGATTT AY860511 T-TTATTATAGCAATAGCAATCGGGTATAATTTTACGAATAGGGGGT-ATAATTT AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGGATATGAGGGGT-ATAATTT AY860513 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGGATATGAGGGGT-ATAATTT AY860514 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGGATATGAGGGGT-ATAATTT AY860515 T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGGATATGAGGGGT-ATAATTT AY860519 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGGATATGAGGGGT-ATAATTT AY860519 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGGATATGAGGGGT-ATAATTT AY860510 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGGATATGAGGGGT-ATAATTT AY860511 TATGATATGAAATTAGAAATGGAATCGGGTATAATTTATGGAATAGGAGGGT-ATAATTT AY860512 TATGTATATGAAATTAGCAATCGGGTATAATTTATGGATATGGAGGGT-ATAATTT AY860513 TATGTATATGAAATTAGCAATCGGGTATAATTTATAGAATAGGAGGGT-ATAATTT Y	AY860520	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
AY860519 GAAATATATAGTTAGTTATTTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGTGATTT AY860518 GAAATATAGTTAGTTATTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY860517 GAAATATATGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT AY126675 GAAATATATGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT NC_003103 CCAA-CACCGA-AATCATTCGTCTTATATCAATCAGTCTCTATTTTAAATGTGATTTTTT AY860511 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860512 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860513 T-TTATTATTTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860514 T-TTATTATTTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860515 T-TTATTATTTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860516 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860517 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860518 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860511 TATGATATGAAATTTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860512 TATGATATGAAATTTAACAATAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860511 TTATTATTATAACAATAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860511 TATGATATGAAATTAAATAGAATTAGCAATCGGGTATAATTTATGGAATATGAGGGT-ATAATTT <	AY860515	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
AY860518 GAAAATATAGTTAGTTATTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGGATTT AY860517 GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTAAATGGATTT NC_003103 CCAA-CACGGA-AATCATCGTCTTATAATCAAGCTCAATCGTTTTTTAAATGTGATTT NC_003103 CCAA-CACGGA-AATCATCGTCTTATAATCAAGCTCAATCGTTTTTTAAATGTGAATT AY860511 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860512 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860513 T-TTATTATTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860514 T-TTATTATTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860515 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860516 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTATGGAATATGAGGGGT-ATAATTT AY860518 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860518 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860511 TATGAATGGAATTGGAATTAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860512 T-TTATTATTTAACCAATAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860513 TATGAATATGAAATTTAATAGCAATCGGGTATAATTTATGGAATATGGAGGGT-ATAATTT AY860514 TATGAATATGAAATTTAATAGCAATCGGGTATAATTTATATGGAATCGGGT-ATAATTTATATTGGAATATGGAGGGT-ATAATTT AY860511 TATGAATATGAAATTTAATAGCAATCGGGTATAATTTATATATGGAAGCCTCGTGTGGTGCAC	AY860516	GAAAATATAGTTAGTTTTTAAGCATAAATTTTTACAGTACTCTGTTTTTAAAAATGTGATTT
AY860517 GAAATATAGTTAGTTATTTAAGCATAAATTTACAGTACTCTGTTTTTAAATGGATTT AY12675 GAAATATAGTTAGTTTTTAAGCATAAATTTACAGTACTCTGTTTTTAAATGGATTT NC_003103 CCAA-CACQGA-AATCATTCGTCTTATATCAAGTCAATCGGTATTAATTTAAATGGAGGGT-ATAATTT AY860511 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAATATGGAGGGT-ATAATTT AY860512 T-TTATTATTAAACAATAGCAATCGGGTATAATTTATGAATATGGAGGGT-ATAATTT AY860513 T-TTATTATTAACAATAGCAATCGGGTATAATTTATGAATATGGAGGGT-ATAATTT AY860514 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGGAGGGT-ATAATTT AY860515 T-TTATTATTAACAATAGCAATCGGGTATAATTTATGGAATATGAGGGGT-ATAATTT AY860516 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860517 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGGAATATGAGGGGT-ATAATTT AY860518 T-TTATTATTAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860517 T-TTATTATTAACAATAGCAATCGGGTATAATTTATATGAATATGAGGGGT-ATAATTT AY860518 T-TTATTATTAACAATAGCAATCGGATATAATTTATGAATATGAGGGGT-ATAATTT AY860511 TATGATATGAAATTTAACAATAGCAATCGGTATAATTTATGAATATGAGGGGT-ATAATTT AY860511 TATGATATGAAATTAATAGCAATCGGTATAATTTATGAATATGAGGGT-ATAATTT AY860511 TATGATATGAAATTAATAGCAATCGGTATAATTTATGAATATGAGGGGT-ATAATTT AY860512 T-TTATTATTAACAATAGCAATCGGTATAATTTATGAATATGAGGGGT-ATAATTTA AY860513	AY860519	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
AY126675GAAAATATAGTTAGTTAGTTATTATACACATAAAATTTACAGTACTCGTTTTTTAAAATGTGATTT CCAA-CACGGA-AATCAGTCGTCTTATACAAGCTCCAATCCGATCTTTTAAAATGTAGAGGGT-ATAATTT AY860511T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860512AY860513T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860513T-TTATTATTTAAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860514AY860515T-TTATTATTTAAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860515T-TTATTATTTAAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860515AY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860518AY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAAATATGAGGGGT-ATAATTT AY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860518AY126675T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860511TATGAATATGAAATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTT AY860513AY860511TATGAATATGAAATTTATAAACGATCGGTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860514AY860516TATGAATATGAAATTTATAATAGGATCCGTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516TATGAATATGAAATTTATAATAGGATCCGTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516AY860511GGCTG- AY860513GGCTG- AY860514AY860513GGCTG- AY860514AY860514TATGAATATGAAATTTATAATAGGATCCGTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516AY860511GGCTG- AY860516AY860512GGCTG- AY860513AY860513GGCTG- AY860514AY860514 <td>AY860518</td> <td>GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT</td>	AY860518	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
NC_003103 CCAA-CACGGA-AATCATTCGTCTTATAATCAAGCTCAATCGTATCTTTGAATTTCTTT ** ** ** ** ** ** ** ** ** ** ** ** **	AY860517	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
NC_003103 CCAA-CACGGA-AATCATTCGTCTTATAATCAAGCTCAATCGTATCTTTGAATTTCTTT ** ** ** ** ** ** ** ** ** ** ** ** **	AY126675	GAAAATATAGTTAGTTTTTAAGCATAAAATTTACAGTACTCTGTTTTTTAAATGTGATTT
- ** ** ** ** ** ** *** *** *** *** ***		
AY860511T-TTATTATATATAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860512T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860513T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860514T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860515T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTATAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTATAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860511TATGAATATGAAATATTATAATAGGATCCGTTTTTGCCTTCCATTCCAGCCCCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860517TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860511GGCTG- <td></td> <td></td>		
AY860512T-TTATTATATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860513T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860514T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860515T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAACGATATCCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTNC_003103TATGAATATGAAATTTATATATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860517TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860519GGCTG-AY860511GGCTG-AY860512TATGAATATGAAATTTAATATGGATCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860513GGCTG- <td< td=""><td>AY860511</td><td></td></td<>	AY860511	
AY860513T-TTATTATATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860514T-TTATTATTTAAACAATAGCAATCGGGTATAAATTTTATGAATATGAGGGGT-ATAATTTAY860515T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518TATGAATATGAAATTGAAATAGCAATCGGGTATTAATTTTATGCATTGCAAGGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAAAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCCCTGTGGTACAAY860517		
AY860514T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860515T-TTATTTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATAGGAGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTAGAATATGAAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTAGAATATGAAGGGGT-ATAATTTNC_003103TATGAATATGAAATTTATAATAGCAATCGCGCTATGCGGTATAATTTTGCATTCCAGCCCTCGTGGTACAAY860511TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860512TATGAATATGAAATTTATAATATGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860517		
AY860520T-TTATTATTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860515T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAACGATATCCGCGCGGTATAATTTTGTCATTGCATGCA		
AY860515T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860511T-TTATTATTTAAACAATAGCAATCGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY126675T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860511TACCAAAATCTGAGTAACGATATCGCGCACGAACAATAAAATTATTGTCATTGCAAAGT*** *****AY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGGACCAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGGACCAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGGACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517AY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860511GGCTG-AY860512AY860513GGCTG-AY860514GGCTG-AY860515GGCTG-AY860516GGCTG-AY860515GGCTG-AY860516GGCTG-AY860517AY860518ATGAAATTGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCGAGCCTCTGTGGTACAAY860519GGCTG-AY860516GGCTG-AY860517AY860518AY860519GGCTG-AY860519GGCTG-AY860516 <t< td=""><td></td><td></td></t<>		
AY860516T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860519T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY80518T-TTATTATTTAAACAATAAY126675T-TTATTATTTAAACAATAAY860517T-TTATTATTTAAACAATAAY860511TATGAATATGAGAATTTTATAAACAATAAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAACGATATTCCGGCACGAACAATAAAATTATTGGCATCAACAAAY860511TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517		
AY860519T-TTATTATTTAAACAATAGCAATAGCGATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860518T-TTATTATTTAAACAATAGCAATAGCGATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAAY860517T-TTATTATTTAAACAATANC_003103TACCAAAATCTGAGTAACGATATCGGGTATAATTTTATGAATATGAGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAACGATATCCGCACGAACAATAAAATTATTGTCATTGCATAGCAAAGT******AY860511TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860511GGCTG-AY860512AY860513GGCTG-AY860514GGCTAY860515GGCTG-AY860516GGCTAY860517AY860518CGCTG-AY860519GGAY860518AY860519GGAY860517AY860518CGCTG-AY860517		
AY860518T-TTATTATTTAAACAATAGCAATAGCGATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY860517T-TTATTATTTAAACAATAGCAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTAY126675T-TTATTATTTAAACAATAGCAATCGGGTATAATTTTATGAATATGAGGGGT-ATAATTTNC_003103TACCAAAATCTGAGTAACGATATCCGCACGAACAATAAAAATTATTGTCATGCAAGGTAY860511TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGGACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGGACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860511GGCTG-AY860512AY860513GGCTG-AY860514GGCTG-AY860515GGCTG-AY860516GGCTG-AY860516GGCTG-AY860517AY860518AY860519GGAY860516GGCTG-AY860517AY860518AY860519GGAY860519GGAY860518AY860519GGAY860517AY860518AY860519 <td></td> <td></td>		
AY860517T-TTATTATTTAAACAATA		
AY126675T-TTATTATTTAAACAATAGCAATAGCGATATATTTTATGAATATGAGGGGT-ATAATTT TACCAAAATCTGAGTAACGATATTCCGCACGAACAATAAAATTATTTGTCATTGCATAGAAAGT *** ** ** **AY860511TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860512AY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860513AY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860515AY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516AY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517AY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517AY860511GGCTG- AY860512AY860512 ACACACCACCACCAACAGTGTAACCAATCATTGTCTTGTTCATCTGATGTAGCACA AY860513AY860511GGCTG- AY860513AY860513GGCT AY860514AY860514GGCTG- AY860515AY860515GGCTG- AY860516AY860516GGCTG- AY860517AY860517 AY860518AY860518TATGAATTGAAATTTATAATAGGATCCGTTTTGTCTTGTTCATCTGATGTAGCAGAAY860514GGCTG- ACCACCACCACCAACAGTGTAACCAATCATTGTCTTGTTCATCTGATGTAGCAGAAY860515GGCTG- AY860516AY860516GGCTG- AY860517AY860517 AY860518AY860518 AY860519AY860517 AY860517AY860518 AY860517AY860519GG AY860517AY860517 AY860518AY860518 AY860517AY860517 AY86		
NC_003103 TACCAAAATCTGAGTAACGATATTCCGCACGAACAATAAAATTATTTGTCATTGCAAAGT **** *** AY860511 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860512 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860513 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860514 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860515 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGGTACA AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGGTACA AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860518 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860518 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517 AY860511 GGCTG- AY860512 AY860513 GGCTG- AY860514 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860517 GGCTG- AY860518 AY860519 GG		
*** ** ***AY860511TATGAATATGAAATTTATATATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517		
AY860511TATGAATATGAAATTTATAAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517	NC_003103	
AY860512TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGAY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860510TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517	AV860511	
AY860513TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860510TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517		
AY860514TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860520TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517AY860517AY860511GGCTG-AY860512AY860513GGCT -AY860514GGCT -AY860515GGCTG-AY860516GGCTG -AY860517AY860518GCT -AY860514GGCT -AY860517AY860518GGCT -AY860516GGCTG -AY860517GGCTG -AY860518AY860519GGAY860517AY860518AY860517AY860518		
AY860520TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860515TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860516TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860519TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860518TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACAAY860517		
AY860515 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860518 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860518 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517 AY860511 GGCTG- AY860512 AY860513 GGCTG- AY860514 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860517 AY860513 GGCTG- AY860514 GGCTG- AY860515 GGCTG- AY860516 GGCT AY860517 AY860518 AY860519 GG AY860517 AY860518 AY800517		
AY860516 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860519 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860519 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517		
AY860519 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860518 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA AY860517 AY126675 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA NC_003103 CAACACCACCACCAACAGTGTAACCAATCATTGTCTTGTTTCATCTGATGTAGCAGA AY860511 GGCTG- AY860512 AY860513 GGCT AY860514 GGCT AY860515 GGCTG- AY860516 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860517 GGCTG- AY860518 GGCTG- AY860519 GG AY860517 AY860518 AY860517 AY860517 GGCTGGAGATGTAATAGTTCCTCAG NC_003103 AAAGG		
AY860518 TATGAATATG AY860517 AY126675 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA NC_003103 CAACACCACCACCAACAGTGTAACCAATCATTGTCTTTGTTTCATCTGAGTGTAGCAGA AY860511 GGCTG- AY860512 AY860513 GGCT AY860514 GGCT AY860515 GGCTG- AY860516 GGCT AY860516 GGCT AY860517 GGCTG- AY860518 GGCT AY860515 GGCTG- AY860516 GGCT AY860517 AY860518 AY860517 AY860518 AY860517 AY860518		
AY860517 AY126675 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA NC_003103 CAACACCACCACCAACAGTGTAACCAATCATTGTCTTTGTTTCATCTGATGTAGCAGA AY860511 GGCTG- AY860512 AY860513 GGCT - AY860514 GGCT - AY860515 GGCTG- AY860516 GGCT - AY860517 GGCTG - AY860518 GGCT - AY860519 GG AY860518 AY860517 AY860518		
AY126675 TATGAATATGAAATTTATAATAGGATCCGTTTTTGCCTTCATTCCAGCCTCTGTGGTACA NC_003103 CAACACCACCACCAACAGTGTAACCAATCATTGTCTTTGTTTCATCTGATGTAGCAGA AY860511 GGCTG- AY860512 AY860513 GGCTG- AY860514 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860518 GGCT AY860518 AY860517 AY860518 AY860517 GGCTGCAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
NC_003103 CAACACCACCACCAACAGTGTAACCAATCATTGTCTTTGTTTCATCTGATGTAGCAGA AY860511 GGCTG- AY860512 AY860513 GGCT AY860514 GGCT AY860515 GGCTG- AY860516 GGCTG- AY860515 GGCTG- AY860516 GGCTG- AY860517 GGCTG- AY860518 GGCTG- AY860519 GG AY860517 AY860518 AY860517 AY860518 AY860517 GGCTGGAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
- AY860511 GGCTG- AY860512 AY860513 GGCT AY860514 GGCTG- AY860515 GGCTG- AY860516 GGCT AY860518 AY860519 GG AY860517 AY860517 AY126675 GGCTGCAAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860512 AY860513 GGCT AY860514 GGCT AY860515 GGCTG- AY860516 GGCT AY860519 GG AY860517 AY860517 AY126675 GGCTGCAGAGATGTAATAGTTCCTCAG NC_003103 AAGGG	NC_003103	CAACACCACCACCAACAGTGTAACCAATCATTGTCTTTGTTTCATCTGATGTAGCAGA
AY860512 AY860513 GGCT AY860514 GGCT AY860515 GGCTG- AY860516 GGCT AY860519 GG AY860517 AY860517 AY126675 GGCTGCAGAGATGTAATAGTTCCTCAG NC_003103 AAGGG	AY860511	GGCTG-
AY860513 GGCT AY860514 GGCT AY860520 GGCTG- AY860515 GGCTG- AY860516 GGCT AY860519 GG AY860517 AY860517 GGCTGCAATGTTCCTCAG NC_003103 AAAGGG		
AY860514 GGCT AY860520 GGCTG- AY860515 GGCTG AY860516 GGCT AY860519 GG AY860518 AY860517 AY126675 GGCTGCAATATAGTTCCTCAG NC_003103 AAAGGG		
AY860520 GGCTG- AY860515 GGCTG- AY860516 GGCT AY860519 GG AY860518 AY860517 AY126675 GGCTGGAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860515 GGCTG- AY860516 GGCT AY860519 GG AY860518 AY860517 AY126675 GGCTGCAGAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860516 GGCT AY860519 GG AY860518 AY860517 AY126675 GGCTGCAGAGTGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860519 GG AY860518 AY860517 AY126675 GGCTGCAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860518 AY860517 AY126675 GGCTGCAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY860517 AY126675 GGCTGCAGAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
AY126675 GGCTGCAGATGTAATAGTTCCTCAG NC_003103 AAAGGG		
NC_003103 AAAGGG		
ndpk2	MC_003103	
		unbus

Figure 6. Alignment of *hbp*E nucleotide sequences from the 7 polymerase chain reaction (PCR)–positive teeth and the 3 PCR-positive lice with those of *Bartonella quintana* (GenBank accession no. AY126675) and *B. henselae* (NC_003103). Boxed nucleotides denote primer positions. Asterisks indicate divergent nucleotides. Green nucleotides are divergent among PCR-positive soldiers' teeth and lice. The discriminant nucleotides allowing differentiation between *B. quintana* and *B. henselae* are shown in blue (*B. quintana*) or red (*B. henselae*). The GenBank accession nos. of the sequences from the 7 PCR-positive teeth are AY860511, AY860512, AY860513, AY860514, AY860515, AY860516, AY860520, and those of the sequences from the 3 PCR-positive lice are AY860517, AY860518, and AY860519.

amplifications were performed. Using primers only once in a laboratory, a technique named "suicide PCR" [7, 15], is particularly useful in preventing contamination and is facilitated by the growing number of pathogens for which the complete genome is known. Amplification of a second target and originality of the ancient sequence are also critical [17].

In conclusion, our work shows that Napoleon's soldiers in Vilnius were exposed to body lice containing *B. quintana* and that 10 (29%) of the soldiers had evidence of infection with either *R. prowazekii* or *B. quintana*. Our study also adds to the growing evidence that searching for the DNA of infectious agents in dental pulp is an important tool for investigating the history of infectious diseases [27].

Acknowledgment

We thank Patrick Kelly for helpful discussions.

References

- 1. Raoult D, Roux V. The body louse as a vector of reemerging human diseases. Clin Infect Dis **1999**; 29:888–911.
- Weiss E. History of rickettsiology. In: Walker DH, ed. Biology of rickettsial disease. Boca Raton, Florida: CRC Press, 1988:15–32.
- 3. Zinsser H. Rats, lice, and history. London: Broadway House, 1935.
- Weiss K. The role of rickettsioses in history. In: Walker DH, editor. Biology of rickettsial diseases. Boca Raton, Florida: CRC Press, 1988: 1–14.
- Signoli M, Ardagna Y, Adalian P, et al. Discovery of a mass grave of Napoleonic period in Lithuania (1812, Vilnius). C R Palevol 2004; 3: 219–27.
- Drancourt M, Raoult D. Palaeomicrobiology: current issues and perspectives. Nat Rev Microbiol 2005; 3:23–5.
- Raoult D, Aboudharam G, Crubezy E, Larrouy G, Ludes B, Drancourt M. Molecular identification by "suicide PCR" of *Yersinia pestis* as the agent of Medieval Black Death. Proc Natl Acad Sci USA 2000;97: 12800–3.
- Houhamdi L, Fournier PE, Fang R, Lepidi H, Raoult D. An experimental model of human body louse infection with *Rickettsia prowazekii*. J Infect Dis 2002; 186:1639–46.
- Morgan AV. Late Pleistocene and early Holocene Coleoptera in the lower Great Lakes region. In: Laub RS, Miller NG, Steadman DW, eds. Late Pleistocene and early Holocene paleoecology and archae-

ology of the eastern Great Lakes region. Bull Buffalo Soc Nat Sci 1988; 33:195–206.

- 10. Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. Basic local alignment search tool. J Mol Biol **1990**; 215:403–10.
- Drancourt M, Aboudharam G, Signoli M, Dutour O, Raoult D. Detection of 400-year-old *Yersinia pestis* DNA in human dental pulp: an approach to the diagnosis of ancient septicemia. Proc Natl Acad Sci USA **1998**; 95:12637–40.
- Drancourt M, Roux V, Dang LV, et al. Genotyping, Orientalis-like Yersinia pestis, and plague pandemics. Emerg Infect Dis 2004; 10:1585–92.
- 13. Charrel RN, La Scola B, Raoult D. Multi-pathogens sequence containing plasmids as positive controls for universal detection of potential agents of bioterrorism. BMC Microbiol **2004**; 4:1–11.
- Massi MN, Shirakawa T, Gotoh A, Bishnu A, Hatta M, Kawabata M. Rapid diagnosis of typhoid fever by PCR assay using one pair of primers from flagellin gene of *Salmonella typhi*. J Infect Chemother 2003; 9:233–7.
- 15. Fournier PE, Raoult D. Suicide PCR on skin biopsy specimens for diagnosis of rickettsioses. J Clin Microbiol **2004**; 42:3428–34.
- Yong Z, Fournier PE, Rydkina E, Raoult D. The geographical segregation of human lice preceded that of *Pediculus humanus capitis* and *Pediculus humanus humanus*. C R Biol 2003; 326:565–74.
- Drancourt M, Tran-Hung L, Courtin J, Lumley H, Raoult D. Bartonella quintana in a 4000-year-old human tooth. J Infect Dis 2005; 191:607–11.
- Raoult D, Woodward T, Dumler JS. The history of epidemic typhus. Infect Dis Clin North Am 2004; 18:127–40.
- Mumcuoglu KY, Zias J, Tarshis M, Lavi M, Stiebel GD. Body louse remains found in textiles excavated at Masada, Israel. J Med Entomol 2003; 40:585–7.
- 20. Capasso L, Di Tota G. Lice buried under the ashes of Herculaneum. Lancet **1998**; 351:992.
- 21. Ewing HE. Lice from human mummies. Science 1924; LX:389-90.
- Maurin M, Raoult D. Bartonella (Rochalimaea) quintana infections. Clin Microbiol Rev 1996; 9:273–92.
- Fournier PE, Ndihokubwayo JB, Guidran J, Kelly PJ, Raoult D. Human pathogens in body and head lice. Emerg Infect Dis 2002; 8:1515–8.
- 24. Aboudharam G, La VD, Davoust B, Drancourt M, Raoult D. Molecular detection of *Bartonella* spp. in the dental pulp of stray cats buried for a year. Microb Pathog **2005**; 38:47–51.
- La VD, Clavel B, Lepetz S, Aboudharam G, Raoult D, Drancourt M. Molecular detection of *Bartonella henselae* DNA in the dental pulp of 800-year-old French cats. Clin Infect Dis 2004; 39:1391–4.
- Millar BC, Xu J, Moore JE. Risk assessment models and contamination management: implications for broad-range ribosomal DNA PCR as a diagnostic tool in medical bacteriology. J Clin Microbiol 2002; 40: 1575–80.
- Drancourt M, Raoult D. Molecular detection of *Yersinia pestis* in dental pulp. Microbiology 2004; 150:263–4.