feline strains from Italy and Australia grouped together, as did the P[9] strains from the United States.

Thus, both the VP7 and VP4 genes of G3P[9] strain identified in this study were most closely related to a raccoon dog rotavirus strain (RAC-DG5), suggesting an animal origin of this rotavirus strain. These strains are likely an example of an animal strain causing limited disease in humans, rather than existence of a true strain, which has entered and adapted to the human environment. Recent whole-genome sequencing of 2 G3P[9] strains isolated from children in Italy showed they were composed of genes of human, bovine, and feline origin (2); whether the G3P[9] strains from Malaysia identified in this study are also human/animal reassortant strains requires further study.

Identification of G3P[9] strains in Malaysia continues to highlight the presence of these rare strains in Asian communities. The close similarity of the strains to a G3P[9] strain from a raccoon dog further highlights the transmission of rotavirus strains between animal and human sources. Whether this strain can establish itself in humans and cause disease is unknown, but the identification of rare strains illustrates that movement of rotaviruses between various hosts does occur from time to time.

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References


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Avian Malaria Deaths in Parrots, Europe

To the Editor: Avian malaria is an insect-borne disease induced by a so far unknown number of protozoan blood parasites of the genera Plasmodium and Haemoproteus (hematozoa) (1,2). The unintentional introduction of P. relictum to the Hawaiian Islands, USA, has had fatal effects for the native bird fauna (3). In Europe, asymptomatic blood infections by hematozoa have been regularly observed, with an especially high prevalence in songbirds (4). However, numerous outbreaks of fatal protozoan infections have been reported over the past 40 years, mainly among psittacines of Australia that have been kept in aviaries (5,6). Diagnosis in all these cases was based on histopathologic detection of protozoan cyst-like structures of unexplained origin in the heart and skeletal muscles and, to a lesser extent, in other organs. In most cases, the protozoans were identified as members of the genus Leucocytozoon because of their morphologic features. Recent studies suggest that these cases may, in fact, have been infections of Besnoitia spp. (Sarcocystidae) or other unknown hematozoa (5); however, genetic evidence is lacking.

In August 2010, sudden deaths of parrots were noticed in 2 separate aviaries in northern Germany and Switzerland (online Technical Appendix Table, www.cdc.gov/EID/content/17/5/950-Techapp.pdf). Nine yellow-crowned parakeets (Cyanoramphus auriceps), 3 barred parakeets (Bolborhynchus lineola), and 2 budgerigars (Melopsittacus undulatus) died within 2–5 days after a history of reduced general conditions and reduced activity and food intake before death. In addition, 2 budgerigars and 1 barred parakeet in the aviary in Germany showed
lethargy and reduced food intake for 2 weeks but fully recovered. About half of the birds were juvenile. No new birds had been introduced into the aviaries during the previous 24 months.

Necropsy and histologic examination of 7 animals with fatal disease showed numerous large cyst-like protozoan structures (size up to 800 μm in diameter; online Technical Appendix Figure) in myocardial and skeletal muscles and, to a lesser extent, in the lung and the smooth muscles of the intestinal tract without obvious signs of inflammation. The cyst-like structures had a thick eosinophilic outer wall, were partly compartmented by internal septae, and were filled with many merozoites. Surrounding muscle fibers were degenerated or necrotic and, in some cases, associated with hemorrhage. Blood smears of clinically affected animals screened for ≤ 5 × 10<sup>5</sup> cells each did not show parasites.

To further characterize the parasites, we carried out a nested PCR and subsequent DNA sequencing as described (7). Notably, phylogenetic comparison of 479 bp of the mitochondrial cytochrome b gene derived from protozoan cyst-like structures with known sequences of avian hematozoa found 99%–100% homology of parasites from both outbreaks with the avian malaria parasites (Haemoproteus spp.) of European songbirds (Figure). Identical cytochrome b sequences were detected in a yellow-crowned parakeet from Switzerland (CYAUR1), a budgerigar from Germany (MEUND1), and a Haemoproteus sp. (TUPHI1) previously found in the blood of a song thrush (Turdus philomelos) in Bulgaria. The sequence derived from the barred parakeet (BOLIN1) of the German outbreak was identical with H. minutus of the common blackbird (T. merula). In fact, different psittacine species of the German outbreak were infected with different Haemoproteus spp. Because all affected parrots had been bred in Europe and had no contact to imported birds, these results suggest that infection was the result of previously unknown cross-species transmission of Haemoproteus spp. between birds of only distantly related orders (8, 9).

Blood samples from surviving, asymptomatic animals from the German outbreak were tested cytologically and by nested PCR for the presence of Haemoproteus spp. PCR identified Haemoproteus sequences in the blood of 3 of 26 psittacines, although parasitic structures were not identifiable in blood smears. Retrieved sequences were identical with that of MEUND1, except for a single-nucleotide polymorphism in 1 sequence (MEUND3; Figure). A latent infection of these animals therefore seems possible and may constitute a potential risk for further horizontal transmission in aviaries by blood-sucking insects such as biting midges (Culicoides), the vectors for Haemoproteus spp. of passerine birds in Europe (2).

In conclusion, we identified the cause of a previously unexplained lethal disease of captive parrots in Europe, induced by numerous cyst-like megalomeronts in several organs, including the heart. Morphologically, the parasitic structures were strikingly similar to yet undetermined parasites of numerous previous outbreaks (5, 6). Genetically, the parasites had 99%–100% homology to known Haemoproteus spp. from wild European songbirds. The avian malaria parasites identified are highly prevalent in the native songbird population but generally do not cause overt disease or death in their natural hosts. In contrast, the cases reported here suggest that these parasites that have adapted to European songbirds may cause fatal outbreaks in native psittacines of Australia, New Zealand, and South America that are raised in captivity. These findings also show that preexisting pathogens may...
be a potential hazard for invading species. Avian malaria should therefore be considered a threat for exotic parrots in Europe until results of further epidemiologic and experimental studies are available. Because many European bird species have been introduced to the native range of the psittacines studied here, a concern has been expressed that these parasites already have become established in these areas and are affecting the natural populations.

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Fatal Human Case of Western Equine Encephalitis, Uruguay

To the Editor: The genus Alphavirus (family Togaviridae) comprises 29 viral species (1), grouped in at least 7 antigenic complexes by their serologic cross-reactivity (2). They are maintained in nature through enzootic cycles involving arthropods as vectors with subsequent amplification in small mammals or birds, and epizootic cycles between mosquitoes and large mammals such as horses or humans.

Few reports have been made of the circulation of alphaviruses in Uruguay. A serologic study conducted in 1970
Avian Malaria Deaths in Parrots, Europe

Technical Appendix

Technical Appendix Table. Complete list of animals in the affected aviaries, northern Germany and Switzerland, August 2010

<table>
<thead>
<tr>
<th>Site location (species)</th>
<th>No. animals died/total</th>
<th>Histologic detection of <em>Haemoproteus</em> spp.</th>
<th>PCR detection of <em>Haemoproteus</em> spp. in blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviary 1 (Germany), 52°16′N, 13°39′E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Budgerigar (<em>Melopsittacus undulatus</em>)</td>
<td>2/20</td>
<td>0/18</td>
<td>1/1</td>
</tr>
<tr>
<td>Cockatiel (<em>Nymphicus hollandicus</em>)</td>
<td>0/6</td>
<td>0/2</td>
<td>ND</td>
</tr>
<tr>
<td>Barred parakeet (<em>Bolborhynchus lineola</em>)</td>
<td>3/6</td>
<td>0/5</td>
<td>1/1</td>
</tr>
<tr>
<td>Eastern rosella (<em>Platycercus eximius</em>)</td>
<td>0/2</td>
<td>0/2</td>
<td>ND</td>
</tr>
<tr>
<td>Chicken (<em>Gallus gallus domesticus</em>)</td>
<td>0/4</td>
<td>0/4</td>
<td>ND</td>
</tr>
<tr>
<td>Aviary 2 (Switzerland) 47°25′N, 8°50′E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow-crowned parakeet (<em>Cyanoramphus auriceps</em>)</td>
<td>9/18</td>
<td>ND</td>
<td>5/5</td>
</tr>
<tr>
<td>Cockatiel (<em>Nymphicus hollandicus</em>)</td>
<td>0/6</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Domestic canary (<em>Serinus canaria</em>)</td>
<td>0/15</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

*ND, not done.
†Confirmed by PCR.

Technical Appendix Figure. Myocardium of yellow-crowned parakeet that is severely infected with numerous large megalomeronts of *Haemoproteus* spp. Note the thick eosinophilic hyaline wall of megalomeront with internal septation and myriads of spherical basophilic merozoites. Surrounding muscle fibers are degenerated, necrotic, and hemorrhagic (hematoxylin and eosin stain). Scale bar = 150 μm.