Fleas are hematophagous arthropods and serve as vectors for microbial pathogens of medical and veterinary importance. There is increasing interest in the role of *Ctenocephalides felis* fleas in the epidemiology of flea-transmitted pathogens, and recent studies have implicated this flea as a vector of *Rickettsia felis*. This new pathogenic agent, which was first detected in southeastern Europe in 1990 as the ELB agent from midgut epithelial cells of *C. felis* cat fleas, has been identified in dog fleas and rats, as well as humans. Since the only known rickettsioses in Cyprus are Murine (including *R. typhi*, *R. conorii*, and *R. conorii* var. *marina*) androps (C. felis) species, the detection of *R. felis* in cat and dog fleas raises important questions about the identity of the tick-borne spotted fever group rickettsiae found on the island. This is the first report of a second flea-borne rickettsia on the island. The study adds to the accumulating data on *Rickettsia felis* in Cyprus and the first report of Murine typhus caused by *R. felis* in Cyprus. Murine typhus caused by *R. felis* was believed to be the only flea-transmitted rickettsiosis present in Cyprus. This is the first report of this pathogen in southeastern Europe.

### Short Report: First Detection of *Rickettsia felis* in *Ctenocephalides felis* Fleas Parasitizing Rats in Cyprus

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Abstract. *Rickettsia felis* was identified by polymerase chain reaction amplification and DNA sequencing analysis in *Ctenocephalides felis* fleas parasitizing rats in Cyprus. Murine typhus caused by *R. felis* was believed to be the only flea-transmitted rickettsiosis on the island. This is the first report of this pathogen in southeastern Europe.

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Since the only known rickettsioses in Cyprus are Murine typhus and Mediterranean spotted fever, *R. conorii* and *R. typhi* antigens were the only antigens used for laboratory diagnosis and in epidemiologic studies. Serologic cross-
reactivity between rickettsial species is not easy to identify. In some cases, differences in titers among tested antigens help identify the causative rickettsia.\textsuperscript{14}

Since the clinical symptoms for infection with \textit{R. felis} are similar to those for other rickettioses,\textsuperscript{13} and antibodies to \textit{R. felis} show cross-reactivity with \textit{R. conorii} and \textit{R. typhi} antigens, cases of infections with \textit{R. felis} in Cyprus may have been misdiagnosed as Mediterranean spotted fever or murine typhus. This is further supported by the findings of a seroepidemiologic study of pathogens transmitted by wild rodents conducted in Cyprus in 2001–2003, which showed a high seroprevalence of antibodies against rickettsiae (38.4% against \textit{R. typhi} and 32.9% against \textit{R. conorii}) (Psaroulaki A. and others, unpublished data). Again, only commercial antigens were used in the study and the presence of antibodies against \textit{R. felis} in rats could not be confirmed. However, analysis of the results by a geographic information system showed that the distribution of \textit{C. felis} corresponded to the distribution of rats seropositive for rickettsiae. (Figure 1).

\textit{Rickettsia felis} has been detected in several countries in \textit{C. felis} fleas parasitizing cats, dogs, and opossums. There is only one report of rats hosting \textit{C. felis}.\textsuperscript{15} Since 5.6% of the fleas removed from rats were infected with \textit{R. felis}, contact with \textit{C. felis} fleas carried by rats would account for \textit{R. felis}

\begin{table}[h]
\centering
\caption{Distribution of rodents, fleas, and \textit{Rickettsia felis} in the five districts of the government-controlled area of Cyprus}
\begin{tabular}{|l|c|c|c|c|c|c|c|c|}
\hline
District & No. of rodents & No. of \textit{Rattus norvegicus} & No. of \textit{Rattus rattus} & No. of \textit{Mus musculus} & No. of rats infested by \textit{Ctenocephalides felis} & No. of \textit{C. felis} collected & No. of \textit{C. felis} positive for \textit{R. felis} (%) \\
\hline
Nicosia & 210 & 35 & 172 & 3 & 60 & 9 & 64 & 9 (14) \\
Famagusta & 23 & 0 & 23 & 0 & 16 & 7 & 61 & 2 (3.27) \\
Larnaka & 191 & 5 & 186 & 0 & 117 & 19 & 77 & 2 (2.59) \\
Limassol & 138 & 119 & 19 & 0 & 49 & 16 & 48 & 1 (2.08) \\
Paphos & 63 & 61 & 2 & 0 & 1 & 0 & 0 & 0 \\
Total & 625 & 220 & 402 & 3 & 243 & 51 & 250 & 14 (5.6) \\
\hline
\end{tabular}
\end{table}

**Figure 1.** Geographical distribution of \textbf{A}, Rats seropositive to \textit{Rickettsia conorii}; \textbf{B}, rats seropositive to \textit{Rickettsia typhi}; \textbf{C}, \textit{C. felis} fleas; and \textbf{D}, \textit{C. felis} infected with \textit{Rickettsia felis} in Cyprus, as determined using geographic information system technology, Microsoft Access\textsuperscript{20} (Microsoft, Redmond, WA), and ArcView version 8.1 (Environmental Systems Research Institute, Redlands, CA) The shaded areas indicate regions with infected rats and fleas.
infection in humans and animals. If one considers that C. felis is a common ectoparasite of cats and dogs in Cyprus and that this flea, which often feeds on humans, was found infected with R. felis in eight different regions of the island, we believe that this pathogen poses a high risk to human and animal health.

The results of this study suggest that R. felis may be prevalent in clinical cases in humans in Cyprus and should be considered in the differential diagnosis of typhus-like illnesses, especially following a flea bite. Further studies should be conducted to identify R. felis infections in human and mammalian hosts in Cyprus and to determine the prevalence and the clinical spectrum of this infection on the island by using more specific diagnostic tests. The role of rats and C. felis fleas in the epidemiology of R. felis needs further investigation.

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