ABSTRACT: Objective – To determine the extent of rickettsial infections prevalence of potential vector ticks in the rural population of Dhofar, Oman. Method – Human sera (n = 347) were obtained from six rural localities (school children, farmers, outpatients) in Dhofar, Sultanate of Oman. Sera were tested by immunofluorescence for the presence of antibodies reacting with Rickettsia conorii antigen. Results – More than half the samples (59%) gave positive reactions (titres of at least 1:64). Ticks (n=707) were collected from cattle, camels and goats (n=102) and included A miliyonna variegatum, Hyalomma a. anatolicum, H. dromedarii, H. rupies and Rhipicephalus spp., all of which can potentially transmit rickettsiae to humans. Conclusion – The results suggest that rickettsial infections are common among the rural population of Dhofar.

KEY WORDS: Rickettsia, antibodies, immunofluorescence, vector ticks, cattle, camels, goats, Dhofar, Oman
test (IFA) using *Rickettsia conorii*-Spot IF (bioMérieux Deutschland GmbH, Nürtingen, Germany). Principally, the serum is placed on a *Rickettsia conorii*-Spot IF antigen fixed slide. Antibodies fixed to this antigen are revealed by a fluorescein labelled anti-human globulin. A positive reaction is indicated by fluorescence of *R. conorii* on the slide, visible under an ultraviolet (UV) microscope.

Sera were diluted in two-fold series from 1:16 to 1:256 and applied to the slides. These were incubated in a moist chamber for 30 minutes at 37°C, washed twice for five minutes each time in Tris (0.01M)-buffered (pH 7.2) saline (PBS) with 0.05% Tween 20, dipped in distilled water and drained. They were then incubated as above in a moist chamber with fluorescein (FITC)-conjugated goat antibodies against human IgG (Behringwerke, Marburg, Germany) diluted 1:100 in PBS with 0.01% Evans Blue. Slides were washed as above and coverslips mounted with Fluoprep (bioMérieux). The results were read in a fluorescence microscope at ×400 magnification. According to the manufacturer, only fluorescent reactions with patient serum dilutions of at least 1:40 can be considered positive. In this study, fluorescent reactions obtained at dilutions of 1:64 or higher were taken as a positive reading. Confirmatory determinations were done for some random samples of sera and yielded identical results.

Ticks were collected from livestock at Dhalqut, Madinat Al-Haq, Tawiattair and Shab Al-Saeeb areas through the cooperation from the animal’s owners and veterinary practitioners. In addition, the skins of freshly slaughtered camels, cows and goats were searched for ticks at Salalah municipality slaughter house, where animals are brought from various localities in Dhofar. Care was taken to obtain tick specimens from several sites including the ears, groin and anal area. Ticks from each animal were stored separate and preserved in 70% ethanol. Ticks were determined with respect to species, development stage and sex.

**RESULTS AND DISCUSSION**

Table 1 shows that between 42% and 66% of human sera from each locality gave a positive reaction. The results obtained from children were not detectably different from those obtained from adults. The data show that more than half (59%) of those individuals tested had antibodies against *R. conorii*. This suggests that *Rickettsia* infections are common among the rural population of Dhofar. The situation appears similar to that in the Nile river delta of Egypt, where up to 96%, 81% and 37% of the school age children were found seropositive for *R. burnetii*, *R. typhi* and *R. conorii*, respectively.4

<table>
<thead>
<tr>
<th>Population</th>
<th>Locality</th>
<th>No. of sera tested</th>
<th>No. of sera with positive reaction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>School children</td>
<td>Sudh</td>
<td>64</td>
<td>31 (48)</td>
</tr>
<tr>
<td></td>
<td>Dhalqut</td>
<td>71</td>
<td>47 (66)</td>
</tr>
<tr>
<td></td>
<td>Tawiattair</td>
<td>54</td>
<td>34 (63)</td>
</tr>
<tr>
<td></td>
<td>Rakhyut</td>
<td>67</td>
<td>41 (61)</td>
</tr>
<tr>
<td>Outpatients</td>
<td>Madinat Al-Haq</td>
<td>60</td>
<td>39 (65)</td>
</tr>
<tr>
<td>Farm workers</td>
<td>Salalah</td>
<td>31</td>
<td>13 (42)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>347</td>
<td>205 (59)</td>
</tr>
</tbody>
</table>

In order to search for potential vectors for *R. conorii*, the ticks, collected from 102 animals (cows, camels and goats), were screened for species with a known ability to transmit this pathogen (Table 2). A total of 707 adult ticks were identified, which might contribute to the natural epidemiological cycle of *R. conorii* on the following basis: (i) All these tick species use domestic stock as regular hosts for one or more stages in their life history and are, therefore, likely to come into contact with humans. (ii) *Amblyomma variegatum* and *Hyalomma rufipes* are known vectors of *R. conorii*; immature stages of *A. variegatum* frequently, and adults of *H. rufipes* occasionally, attack humans.9,14 (iii) *H. anatolicum* ssp. is a known vector for *R. conorii*, and *H. dromedarii* was reported to be (one out of 70 specimens) infected with spotted fever group rickettsiae.5 Both *H. anatolicum* ssp and *H. dromedarii* attack humans.14 The genus *Rhipicephalus* includes *R. sanguineus*, one of the main vectors of *R. conorii*. This species has often been confused with *R. turanicus* which is known to attack humans, but the status of *R. turanicus* as a vector for *R. conorii*, is uncertain15 and needs to be elucidated.16,17 *Rickettsia massiliae*, a species closely related to *R. conorii*, has also been isolated from *R. turanicus*.18 In addition to *R. turanicus*, *R. camicasi* belongs
to the R. sanguineus group of species and both are morphologically similar: it is difficult to distinguish their males and their engorged females are almost indistinguishable from each other. The involvement of R. camicasi in disease epidemiology is unknown. Both R. turanicus and R. camicasi are found in Oman. In view of the problems encountered in identifying vectors of R. conorii in the R. sanguineus group, the identification of Rhipicephalus to species level was not attempted.

This report confirms the earlier records of tick species in Oman by Hoogstraal. It amply demonstrates the presence of ticks on domestic stock with the potential to transmit spotted fever group rickettsiae to humans. This, together with the rural life style of the local population, is compatible with a high prevalence of seropositivity in humans. However, the following three points deserve further investigation:

First: whereas the serological data demonstrate a substantial prevalence of rickettsial infections, the cut-off titre set in immunofluorescence determines the sensitivity and specificity of the results as was suggested by comparative Western blotting performed with specific protein antigen. Thus, the true prevalence of R. conorii infections might be lower than the percentages of seropositivity.

Second: according to the manufacturer, the test antigen is not specific for R. conorii and the exact taxonomic status of the rickettsiae present in Dhofar remains to be determined. R. conorii is antigenically diverse and, in addition to R. conorii, several new spotted fever group rickettsial strains have recently been described from ticks including A. variegatum and R. turanicus from the Mediterranean and Africa. We cannot also exclude the possibility that R. typhi or R. prowazakii, which are not transmitted by ticks, might occur in Dhofar and cross-react in the serologic test.

Third: it cannot be deduced from the mere presence of antibodies, whether infections with rickettsiae represent a significant source of disease in Dhofar, as serology also detects asymptomatic cases of spotted fever as well as persisting antibodies. Observation of the possible clinical spectrum of the disease should clarify this point.

CONCLUSION

To our knowledge, this report is the first serological study of rickettsial infections in the Oman and, together with the tick survey, demonstrates that transmission of such infection is possible and does occur. Quantitative epidemiological aspects require further studies. The population of Dhofar has appreciable seroprevalence rates for brucellosis and toxoplasmosis, which are also transmitted from domestic animals to humans. However, the recently improved living conditions and health services in Dhofar should significantly reduce the prevalence of these pathogens, and the diseases transmitted from livestock to humans in this region should reduce correspondingly.

ACKNOWLEDGEMENTS

We are grateful to the medical and veterinary practitioners and technical staff in the study localities, especially Dr M. A. A. Shaban, Director of Health Affairs, Dhofar and to all individuals who provided samples. We thank Prof. J. E. Keirans (U.S. National Tick Collection, Statesboro, GA, U.S.A.) for confirming the identity of tick specimens, Ms. Angelika

### Table 2

<table>
<thead>
<tr>
<th>Host (numbers sampled)</th>
<th>Tick species (numbers collected)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amblyomma variegatum</td>
</tr>
<tr>
<td>Cattle (77)</td>
<td>35</td>
</tr>
<tr>
<td>Camels (21)</td>
<td>32</td>
</tr>
<tr>
<td>Goats (4)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
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</tbody>
</table>

Table 2: Ticks collected from domestic stock and implicated in the transmission of Rickettsia in Dhofar, Oman.
Thomschke (Department of Infectious and Tropical Medicine, University of Munich, Germany) for the gift of a positive control serum. This study was supported in part by a travel grant from the Faculty of Theoretical Medicine, University of Heidelberg.

REFERENCES


