and vinegar mixture, locally known as kinilaw. Other methods of fish preparation were tinola (boiled), ginataan (stewed in coconut milk), and sinugba (charcoal-grilled). All echinostome-infected patients had a history of having eaten snails, kuhol and kiambu-ay, prepared raw with coconut milk and lime juice (kinilaw), especially when found in greater abundance during the rainy season.

Human echinostome infection results from ingestion of metacercariae that encyst in secondary intermediate hosts, usually freshwater snails, tadpoles, or fish. *E. malayanum* uses various species of gastropod mollusks for primary and secondary intermediate developmental stages (2–5). Certain species of fish may also serve as secondary intermediate hosts (2). Several mollusks that may serve as primary and secondary intermediate hosts have been identified in the Philippines, including *Lymnaea (Bullastra) cumingiana*, *Radix quadrasi ilocanum*, and *Physastra hungerfordiana* for *E. malayanum*, and *Pila luzonica* for *E. ilocanum* (6,7).

To our knowledge, this is the first report of *E. malayanum* infections in the southern Philippines. Local eating habits are a strong factor in echinostome infections. The general lack of awareness by health staff and the community was a big factor in the poor identification of the disease. Clinical and laboratory staff and healthcare providers need training about echinostome infections and other intestinal foodborne trematode infections. Similar environmental, sanitary, and eating practices in the region suggest that the same parasites should be considered to be widespread in the area. Redirecting vital resources of the local health and government units of the Caraga region to the periphery and building local capacity will help empower authorities to provide public health services in rural areas, strengthen public health programs, and further develop public health infrastructure. Moreover, a successful control program against chronic intestinal parasitoses could serve as a paradigm for local health system development of effective control measures for other endemic diseases.

**Acknowledgments**

We express sincere gratitude for the support, cooperation, and assistance provided by the Local Government Unit/Rural Health Unit of Santa Monica, Surigao del Norte, Provincial Health Office, DOM-PHT Surigao del Norte, V.L. Makabali Memorial General Hospital, and the generous residents of Santa Monica.

**Vicente Y. Belizar,**† **Giovanni G. Geronilla,**† **Marilyn Benedith M. Anastacio,**† **Winifreda U. de Leon,**† **Adriano P. Suba-an,**‡ **Arlene C. Sebastian,**§ and **Michael J. Bangs¶**

*National Institutes of Health, Manila, the Philippines; †University of the Philippines Manila, Manila, the Philippines; ¶Health Development, Caraga Region, Butuan City, the Philippines; §Rural Health Unit, Santa Monica, the Philippines; and ¶Navy Region Northwest, Silverdale, Washington, USA

**References**

1. World Health Organization. Bench aids for the diagnosis of intestinal parasites. Geneva: the Organization; 1994. Plate 3.
2. Monzon RB, Kitiagoon V, Thammapalerd N, Temcharoen P, Sornmani S, Viyanant V. Ecological observations on *Lymnaea (Bullastra) cumingiana*. Southeast Asian J Trop Med Public Health. 1993;24:563–9.
3. Garrison PE. A new intestinal trematode of man. Philippine Journal of Science. 1908;B3:385–93.
4. Waikagul J. Intestinal fluke infections in Southeast Asia. Southeast Asian J Trop Med Public Health. 1991;22(Suppl): 158–62.
5. Radomyos P, Radomyos B, Tangtronchitr A. Multi-infection with helminths in adults from northeast Thailand as determined by post-treatment fecal examination of adult worms. Trop Med Parasitol. 1994;45: 133–5.
6. Radomyos B, Wongsaoraj T, Wilairatana P, Radomyos P, Praevanich R, Mee som boon V, et al. Opisthorchiasis and intestinal fluke infections in northern Thailand. Southeast Asian J Trop Med Public Health. 1998;29:123–7.
7. Belizarov VY, de Leon WU, Bersa MJ, Baird JK, Bangs MJ. A focus of human infection by *Haplorchis taichui* (Trematoda: Heterophyidae) in the southern Philippines. J Parasitol. 2004;90:1165–9.

**Zoonotic Pathogens in Ixodes scapularis, Michigan**

To the Editor: *Ixodes scapularis*, the black-legged tick, is the predominant vector of reportable human vectorborne disease in the United States. It transmits agents that cause Lyme borreliosis, human anaplasmosis, and human babesiosis. *I. scapularis*–borne disease is becoming more frequent as this tick expands its range from tick-endemic foci in the northeastern and upper midwestern United States.

Despite Michigan’s proximity to large tick-endemic areas (Wisconsin and Minnesota to the west and Indiana to the south), active and passive surveillance data indicated that the only populations of *I. scapularis* established in the state before 2002 were in Menominee County in the Upper Peninsula (1,2). However, wildlife sampling and tick dragging in 2002–2003 suggested that *I. scapularis* had begun to invade southwestern Michigan (3), with nearby populations in northwestern Indiana (4) as the putative source.
Because we suspected these invading ticks were bringing zoonotic pathogens into southwestern Michigan, we assessed pathogen prevalence within the state’s invading and endemic *I. scapularis* populations. Over a 1.5-week period in April–May 2006, we collected adult *I. scapularis* by drag sampling at 3 recently invaded sites in southwestern Michigan and 2 tick-endemic sites in Menominee County. We targeted adult *I. scapularis* in the spring because this life stage has had 2 chances of becoming infected and because the adult questing peak in Michigan is greater in spring than fall (2,3).

All collected ticks were bisected aseptically, and total DNA was extracted from half after overnight lysis (DNeasy Tissue Kit; QIAGEN, Valencia, CA, USA). We used 3 PCRs to assay for *Borrelia burgdorferi*, *B. lonestari*, and *B. miyamotoi* (5); *Anaplasma phagocytophilum* (6); and *Babesia* spp., including *Babesia microti* and *Babesia odocoilei* (7). *Borrelia*-positive and *Babesia*-positive ampiclons were purified and sequenced for species identification.

Tick densities were highest overall at tick-endemic Menominee County sites; in southwestern Michigan, they were highest at those sites closest to the putative source of the Indiana invasion. We collected 28 adult and 1 nymphal *I. scapularis* and 2 adult *Dermacentor variabilis* from tick-endemic sites. Of the adult *I. scapularis*, 17 (60.7%) were positive for *B. burgdorferi*, 4 (14.3%) were positive for *A. phagocytophilum*, and 2 (7.1%) were positive for *Babesia odocoilei* (Table). We also collected 91 adult and 10 nymphal *I. scapularis* and 5 adult *D. variabilis* from newly invaded sites. Of the adult *I. scapularis*, 43 (47.3%) were positive for *B. burgdorferi*, 1 (1.1%) was positive for *A. phagocytophilum*, and 4 (4.4%) were positive for *Babesia odocoilei*. All 4 *Babesia odocoilei*-positive ticks were co-infected with *B. burgdorferi* (this rate of co-infection was significantly greater than random expectation; p = 0.046, by Fisher exact test).

Within the tick-endemic area, comparison with prior survey data (8) indicated that the *B. burgdorferi* infection rate in adult ticks increased from 31.3% in 1992 to 60.7% in the present survey (p=0.001, by Fisher exact test). A similar increasing trend was evident in the invasion area, where prevalence increased from 37.0% in 2002–2003 (at a collection site 5 km south of our southernmost site; [3]) to 47.3% in 2006. This latter trend was only marginally statistically significant due to small sample size and the short period between surveys (p = 0.046, by 1-tailed Fisher exact test).

The data imply a risk for Lyme borreliosis and human anaplasmosis in areas endemic for and recently invaded by *I. scapularis*. For example, Lyme disease incidence in the tick-endemic zone has increased significantly over the past 10 years (from 0.33 to 1.53 cases per 10,000 persons during 1997–2006; r² = 0.56, p = 0.01). Incidence in the invasion zone has

| Site | Life stage | No. ticks infected or co-infected (%) |
|------|------------|--------------------------------------|
|      |            | *B. burgdorferi* | *A. phagocytophilum* | *B. odocoilei* | *B. burgdorferi* and *A. phagocytophilum* | *B. burgdorferi* and *B. odocoilei* |
| E-1  | A          | 9 (56.3) | 1 (6.3) | 1 (6.3) | 1 (6.3) | 0 |
| E-2  | A          | 8 (66.7) | 3 (25.0) | 1 (8.3) | 1 (8.3) | 1 (8.3) |
| N    | 1          | 1 (100.0) | 0 | 0 | 0 |
| I-1  | A          | 2 (50.0) | 0 | 0 | 0 |
| N    | 2          | 0 | 0 | 0 | 0 |
| I-2  | A          | 9 (60.0) | 0 | 1 (5.6) | 0 | 1 (5.6) |
| N    | 8          | 2 (25.0) | 1 (12.5) | 0 | 1 (12.5) | 0 |
| I-3  | A          | 32 (46.4) | 1 (1.4) | 3 (4.3) | 0 | 3 (4.3) |
| N    | 28         | 17 (60.7) | 4 (14.3) | 2 (7.1) | 2† (7.1) | 1† (3.6) |
| All endemic sites | A | 43 (47.3) | 1 (1.1) | 4 (4.4) | 0 | 4‡ (4.4) |
| N    | 10         | 2 (20.0) | 2 (20.0) | 0 | 1† (10.0) | 0 |

*E*: endemic site; A, adult; N, nymph; I, invaded site.
†Nonsignificant level of co-infection; p = 0.378–0.640, by Fisher exact test.
‡Significant level of co-infection; p = 0.046, by Fisher exact test.
been much lower (mean 0.03 cases per 10,000 persons over same period) but appears to be increasing. Further increases in tick population size, infection, and co-infection can be expected as the invasion continues (9). Thus, medical practitioners in southwestern Michigan should be aware of the changing increasing risk for tick-borne diseases and consider disease resulting from these pathogens during diagnosis.

Acknowledgments

We thank M. Rosen, K. Boatman, and G. Hamer for field and laboratory assistance; H. Goethert and S. Telford III for providing positive control Babesia microti and Babesia odocoilei DNA; the private landowners in Menominee County for their cooperation; and the Michigan Department of Natural Resources for access to field sites.

This study was supported by the Department of Fisheries and Wildlife, Michigan State University; cooperative agreement no. CI00171-01 from the Centers for Disease Control and Prevention (graduate assistantship to S.A.H.), and grant 4T35 RR017491-04 from the National Institutes of Health (fellowship to C.C.B.).

References

1. Walker ED, Stobierski MG, Poplar ML, Smith TW, Murphy AJ, Smith PC, et al. Geographic distribution of ticks (Acari: Ixodidae) in Michigan, with emphasis on Ixodes scapularis and Borrelia burgdorferi. J Med Entomol. 1998;35:872–82.
2. Strand MR, Walker ED, Merritt RW. Field studies on Ixodes dammini in the Upper Peninsula of Michigan. Vector Control Bulletin of North Central States. 1992;1:11–8.
3. Foster E. Ixodes scapularis (Acari: Ixodidae) and Borrelia burgdorferi in southwest Michigan: population ecology and verification of a geographic risk model [master's thesis]. East Lansing (MI): Michigan State University; 2004.
4. Pinger RR, Timmons L, Karris K. Spread of Ixodes scapularis (Acari: Ixodidae) in Indiana: collections of adults in 1991–1994 and description of a Borrelia burgdorferi–infected population. J Med Entomol. 1996;33:852–5.
5. Bunikis J, Garpmo U, Tsao J, Berglund J, Fish D, Barbour AG. Sequence typing reveals extensive strain diversity of the Lyme borreliosis agents Borrelia burgdorferi in North America and Borrelia afzelii in Europe. Microbiology. 2004;150: 1741–55.
6. Zeidner NS, Burkot TR, Massung R, Nicholson WL, Dolan MC, Rutherford JS, et al. Transmission of the agent of human granulocytic ehrlichiosis by Ixodes spinipalpis ticks: evidence of an enzootic cycle of dual infection with Borrelia burgdorferi in northern Colorado. J Infect Dis. 2000;182:616–9.
7. Armstrong PM, Katavolos P, Caporale DA, Smith RP, Spielman A, Telford S III. Diversity of Babesia infecting deer ticks (Ixodes dammini). Am J Trop Med Hyg. 1998;58:739–42.
8. Walker ED, Smith TW, DeWitt J, Beaudo DC, McLean RG. Prevalence of Babesia burgdorferi in host-seeking ticks (Acari, Ixodidae) from a Lyme disease endemic area in northern Michigan. J Med Entomol. 1994;31:524–8.
9. Steiner FE, Pinger RR, Vann CN, Abley MJ, Sullivan B, Grindle N, et al. Detection of Anaplasma phagocytophilum and Babesia odocoilei DNA in Ixodes scapularis (Acari: Ixodidae) collected in Indiana. J Med Entomol. 2006;43:437–42.
10. Stafford KC III, Carter ML, Magnarelli LA, Ertel SH, Mshar PA. Temporal correlations between tick abundance and prevalence of ticks infected with Borrelia burgdorferi and increasing incidence of Lyme disease. J Clin Microbiol. 1998;36: 1240–4.

The opinions expressed by authors contributing to this journal do not necessarily reflect the opinions of the Centers for Disease Control and Prevention or the institutions with which the authors are affiliated.