Rabies in Ferret Badgers, Southeastern China

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Ferret badger–associated human rabies cases emerged in China in 1994. We used a retrospective epidemiologic survey, virus isolation, laboratory diagnosis, and nucleotide sequencing to document its reemergence in 2002–2008. Whether the cause is spillover from infected dogs or recent host shift and new reservoir establishment requires further investigation.

Rabies is an acute encephalomyelitis caused by rabies or rabies-related viruses. Although dogs are the main reservoir worldwide, all mammals are believed to be susceptible. When rabies is widely distributed, affected wildlife may constitute a public health threat to local residents. For example, the Chinese ferret badger (Melogale moschata) has been associated with human rabies for several years, although diagnoses have not been confirmed (1–4). Rabies has also been reported in other subspecies, such as honey badgers (Mellivora capensis) and European badgers (Meles meles) in Africa and Europe. Transmission was presumed to occur independently among the population or as spillover from other reservoirs, such as jackals, dogs, or foxes (5,6). However, none of these animals have been reported to be associated with human deaths. The Chinese ferret badger, which dwells mainly in southeastern China, is a different subspecies than the badgers in Africa and Europe. These mustelids have several names in southern China—crab-eating mongoose, rice field dog, viviparid-eating dog, loach-eating dog, and white face weasel—mainly because of their omnivorous behavior and external appearance. Recently, human rabies associated with Chinese ferret badgers has seemed to reemerge.

Because the People’s Republic of China has no governmental surveillance network, few data exist on wildlife rabies in China, and therefore the natural behavior and habitats of Chinese ferret badgers are not clear (7). Most background information about this animal species in this report was obtained from local hunters. Chinese ferret badgers are solitary and nocturnal. Those observed during daylight are usually sick. The animals are distributed widely in China but are concentrated mainly in Anhui, Zhejiang, and Jiangxi provinces (Figure 1). However, the detailed population density of the badgers is largely unknown.

Ferret badger–associated human rabies cases in China were first reported in 1997 but had actually emerged in 1994 (1). During that year, 6 patients with clinical signs of rabies received a preliminary diagnosis at Huzhou Second Hospital, Huzhou District, Zhejiang. In 1995, a similar case was reported in the same hospital. Among the 7 case-patients, 6 were reported to have been bitten on the hands by ferret badgers. This could be the first alleged epizootic of ferret badger–associated human rabies. From 1999 through 2003, 4 ferret badger–associated human rabies cases were reported in Huzhou, and 14 cases were reported in Hangzhou (8,9), the capital district of Zhejiang. In 2004, 1 human case in Huzhou and 3 human cases in Hangzhou were recorded (10,11). From 1994 through 2004, 12 (60%) of 20 human rabies cases in Huzhou, and 17 (77%) of 22 human rabies cases in Hangzhou were associated with ferret badger exposure. Ferret badger–associated human rabies cases were frequently reported in local news (http://zjajcedcsy.zjwst.gov.cn/col71/info.htm?infoid=605, http://news.sina.com.cn/c/2003-07-08/09391300011.shtml, www.zj.xinhua.org/old/200212/4/100021681.htm, and www.jksoso.com/html/0F1A6B60.htm).

In Jing County, which is located in eastern Anhui and is adjacent to the western border of Zhejiang, 3 human rabies cases associated with ferret badger bites were reported...
successively in 1999, 2000, and 2001 (4, 12). An incorrect photograph of the ferret badger was cited in a previous brief report (3).

To determine whether ferret badger–associated rabies is reemerging in China, we conducted a retrospective epidemiologic survey in the affected regions from 2002 through 2008. To document ferret badger–associated rabies, we used virus isolation, laboratory diagnosis, and nucleotide sequencing.

The Study

During 2002–2004, many sick badgers were seen at the bases of mountains, on village roads, and within residential houses. At the same time, rabies in livestock was reported in the nearby villages. Concomitantly, the highest number of human rabies cases was recorded during that period. Local residents stated that dead animals were seen everywhere; however, accurate numbers and distribution of affected animals in these areas were difficult to estimate.

During 2005–2007, ferret badger hunters were recruited to help capture the animals for further investigation; 1–2 badgers were captured each week. The badgers were no longer commonly seen in the fields, probably the result of depopulation by the disease. Among the 58 specimens collected in Lin’an, Chun’an, and Jiande counties of Hang-

| Isolate or strain | GenBank accession no. | Glycoprotein | Region of origin | Host | Year isolated |
|-------------------|-----------------------|--------------|------------------|------|--------------|
| BD06              | EU549783              | EU549783     | Hebei            | Dog  | 2006         |
| CTN-33            | DQ787145              | DQ767896     | Shandong         | Dog  | 1957         |
| G07               | EU828655              | EU828656     | Hebei            | Dog  | 2007         |
| GN07              | EU828653              | EU828654     | Guangdong        | Dog  | 2007         |
| Guangxi_YL66      | DQ666287              | EU267744     | Guangxi          | Dog  | 2006         |
| Guizhou_A10       | DQ666288              | EU267745     | Guizhou          | Human| 2004         |
| Guizhou_A103      | DQ666290              | EU267747     | Guizhou          | Dog  | 2004         |
| Guizhou_Ox5       | DQ666296              | EU267751     | Guizhou          | Dog  | 2004         |
| GOX1              | DQ866105              | NA           | Guangxi          | Dog  | 2006         |
| GXWXp             | DQ866121              | NA           | Guangxi          | Dog  | 2006         |
| Hebei0(H)         | EU267777              | EU267752     | Hebei            | Human| 2007         |
| Henan_Hb10        | DQ666297              | EU267753     | Henan            | Dog  | 2004         |
| Henan_Sq59        | DQ666306              | EU267759     | Henan            | Dog  | 2004         |
| Hubei070308       | EF611081              | EF643518     | Hubei            | Buffalo| 2007       |
| Hunan_DK13        | DQ666307              | EU267762     | Hunan            | Dog  | 2004         |
| Hunan_Wg12        | DQ666308              | EU267763     | Hunan            | Dog  | 2004         |
| Hunan_Xx33        | DQ666317              | EU267769     | Hunan            | Dog  | 2004         |
| Jiangsu_Wx1-06    | DQ666321              | EU267773     | Jiangsu          | Dog  | 2004         |
| Jiangsu_Wx0(H)    | DQ666320              | EU267772     | Jiangsu          | Human| 2004         |
| MRV               | DQ875050              | DQ875050     | Henan            | Mouse| 1987         |
| WJ07-1            | EU828657              | EU828658     | Hebei            | Dog  | 2007         |
| Yunnan_Md06       | EU095330              | EU253477     | Yunnan           | Dog  | 2006         |
| Yunnan_Qi07       | EU275245              | EU275240     | Yunnan           | Dog  | 2007         |
| Yunnan_Tc06       | EU275243              | EU275242     | Yunnan           | Dog  | 2006         |
| Zhejiang_Wz0(H)   | EF556197              | EF556198     | Zhejiang         | Human| 2007         |
| ZJ-LA             | FJ598135              | FJ197565     | Zhejiang         | Ferret badger| 2008   |
| ABLV              | NC003243              | AF006497     | Australia        | Bat  | 1996         |
| ERA               | AF406695              | EF206707     | France           | Vaccine strain| 2003   |
| HEP-Flury         | AB085828              | AB085828     | Japan            | Vaccine strain| 2003   |
| Mokola            | NC006429              | NC006429     | France/USA       | Bat  | 1997         |
| Nishigahara       | AB010494              | AB044824     | Japan            | Vaccine strain| 1998   |
| Ni-CE             | AB128149              | AB128149     | Japan            | Vaccine strain| 2007   |
| PV                | M13215                | M13215       | France           | Vaccine strain| 1993   |
| RC-HL             | D16331                | D16330       | Japan            | Vaccine strain| 1994   |
| SAD-B19           | M31046                | M31046       | USA              | Vaccine strain| 1990   |
| SHBRV-18          | AY705373              | AY705373     | USA              | Bat  | 1996         |
| SRV9              | AF499686              | AF499686     | Clone of SAD-B19 | Vaccine strain| 2006   |

*NA, not available; boldface indicates the isolate reported in this article.
zhou, none of the brain tissue samples were positive for rabies by standard direct fluorescent assay. Serum samples from the 63 animals captured in the 3 counties mentioned above did not have detectable rabies virus–neutralizing antibodies according to the fluorescent antibody virus neutralization test (Table 1).

During 2007–2008, the population of the ferret badgers in the same regions seemed to recover, and rabies infection in badgers began to increase. Since the summer of 2008, sick and dead badgers have been seen by local residents inside houses, in the fields close to the residential areas, and on the roads in Hangzhou District. Of the 71 brain samples collected in 2008, 4 had positive direct fluorescent assay results. Of 30 serum samples, 5 had positive results for rabies virus–neutralizing antibody (Table 1). In addition, a human rabies case was recorded in April 2008 in Lishui County, Zhejiang. Our most recent retrospective epidemiologic investigation of human rabies cases from the end of 2007 through 2008 showed that in Wuyuan County, Jiangxi, adjacent to Hangzhou, Zhejiang, 4 of 5 recorded human rabies cases were caused by badger bites.

Phylogenetic analysis using the nucleoprotein and the glycoprotein genes (Table 2) demonstrated that the ferret badger rabies virus isolate (ZJ-LA, isolated from a badger in Lin’an County of Hangzhou, Zhejiang) had 89.0% homology with a local dog rabies virus isolate (Zhejiang Wz0) and overall 86.5%–95.9% homology with other isolates from China (Figure 2). The ZJ-LA strain had the highest homology with a dog rabies virus isolate (GN 07, from Guangning County, Guangdong Province) and a vaccine strain CTN-33 (originally from a person who died of rabies in Ji’nan, Shandong Province, in 1957). Because dog-associated human rabies has been reported only sporadically in Zhejiang Province, whether the ferret badger–associated rabies is a spillover event from dogs, or the animals now serve as a natural reservoir in the rabies-endemic area, needs further investigation.

Conclusions

Rabies in ferret badgers occurred during 2 alleged epizootics (1994–1995 and 2002–2004) in southeastern China (Figure 1) (13). Our preliminary data suggest another probable epizootic of rabies in ferret badgers during 2007–2008. Rabies in ferret badgers is becoming a greater public health threat to humans in eastern Anhui, middle to western Zhejiang, and northern Jiangxi provinces in China.

Because no practical rabies vaccine has been developed for wildlife in China, a rabies epidemic in ferret badgers is almost inevitable without intervention, and the threat to public health is immediate. Lack of communication and
cooperation among the Chinese Center for Disease Control and Prevention, Ministry of Agriculture, and wildlife services from the Bureau of Forestry makes the situation more complicated than canine rabies control. Whether rabies in ferret badgers is a spillover event from rabid dogs or whether ferret badgers serve as a natural reservoir remains to be addressed. In addition to more detailed epidemiologic investigations, control and elimination of rabies in dogs is a primary suggestion to test the latter hypothesis.

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