Environmental factors for efficiently baiting red foxes in agricultural areas in eastern Hokkaido, Japan

Ayaka Ishida¹, Kenichi Takahashi², Kohji Uraguchi² and Tatsuo Oshida¹*¹

¹ Laboratory of Wildlife Biology, Obihiro University of Agriculture and Veterinary Medicine, Obihiro 080-8555, Japan
² Hokkaido Institute of Public Health, Sapporo 060-0819, Japan

Alveolar echinococcosis is a zoonotic disease caused by tapeworm, *Echinococcus multilocularis*. This disease is widespread in the northern hemisphere (Eckert et al. 2001; Soulsbury et al. 2010). On Hokkaido Island, Japan (Fig. 1), this parasite has the red fox (*Vulpes vulpes*) as principle definitive host and rodents, such as the Bedford’s red-backed vole (*Myodes rufocanus*) and the grey red-backed vole (*M. rutilus*), as main intermediate hosts (Yamashita and Kamiya 1997). The infection rate among red foxes in Hokkaido is around 40% since the 1990’s (Takahashi et al. 2005; Nonaka et al. 2006). In recent years, around 20 human cases were annually reported as newly diagnosed alveolar echinococcosis (Hokkaido Institute of Public Health 2011), making it important to establish intervention strategies, especially administration of anthelmintics to red foxes (Takyu et al. 2013). In Switzerland, administration of anthelmintics successfully decreased *E. multilocularis* prevalence in red foxes (Hegglin et al. 2003). Schelling et al. (1997) reported that prevalence of the cestode in red foxes, initially 32% in Germany, had fallen to 4%, after baiting campaigns. Also, in Germany, Romig et al. (2007) reported that *E. multilocularis* prevalence in red foxes was reduced from 64% to 15% by baiting foxes with the anthelmintic praziquantel. In Hokkaido, red foxes were baited with praziquantel in Koshimizu (Tsukada et al. 2002), Nemuro (Takahashi et al. 2002, 2013), Otaru (Nonaka et al. 2006; Inoue et al. 2007) and Kutchan (Oku 2012). All of these trials showed that baiting against *E. multilocularis* in foxes reduced the prevalence among foxes.

Red foxes in Hokkaido are thought to prefer natural foods to artificial foods, as long as natural foods are available in their environment (Tsukada 2005). In Hokkaido, red fox diet consists of various items such as small mammals, birds, insects, fruits and carcasses of large mammals, and varies seasonally and regionally (Yoneda 2005; Uraguchi 2008, 2009). Also, their home range size varies from 100 to 800 ha in Japan, depending on habitats (e.g., Uraguchi 2009). Judging from these ecological characteristics, to establish an effective baiting method, it is important to identify environmental factors in their habitats affecting bait consumption by red foxes. Red foxes often appear in agricultural areas (e.g., Bermejo and Guitian 2000; Lavin et al. 2003), providing many opportunities for contact between humans and red foxes. In Germany, three quarters of alveolar echinococcosis patients were farmers (Kern et al. 2004). Therefore, it is important to place fox bait containing the anthelmintic praziquantel in agricultural areas (e.g., Takyu et al. 2013).

The Tokachi District is a typical agricultural area in Hokkaido. In this district, Takyu et al. (2013) reported that the red foxes are most frequently photographed by automatic camera traps at baiting sites in spring and less often in summer and autumn. They suggested that domestic cats may more frequently consume fox baits than red foxes. Environmental factors, which are important for baiting red foxes, are still unclear. Our goal was to confirm whether red foxes are attracted by fox baits, and to identify efficient environmental factors attracting red foxes to bait placed in agricultural area. We used automatic digital cameras with infrared sensors to obtain information on fox bait consumption by red foxes in Tokachi District. We examined monthly differences in bait disappearance and in numbers of red foxes and other animals appearing at baiting sites.

**Methods**

**Study area and study sites**

This study was carried out in the agricultural area of Kawanishi, Obihiro City, Tokachi District, eastern Hokkaido, Japan (42°51′N, 143°10′E, see Fig. 1). Its average temperature and precipitation are 6.5°C and 920.4 mm, respectively (Japan Meteorological Agency, http://www.jma.go.jp/jma/menu/report.html). In the study...