The feasibility of using introduced lizards as indicators of environmental contamination

Kym Rouse Campbell¹, Todd S. Campbell²

¹ Biological Research Associates, 3910 U.S. Highway 301 North, Suite 180, Tampa, FL 33619, USA
e-mail: kcampbell@biologicalresearch.com
² Department of Biology, Box 3F, University of Tampa, 401 West Kennedy Boulevard, Tampa, FL 33606-1490, USA

Abstract. Introduced species can provide valuable opportunities for applied research once they have become established with little possibility of eradication. They have been used as indicators of environmental contamination in aquatic ecosystems for many years. However, in terrestrial ecosystems, introduced species have not been utilized as sentinels of environmental quality. We review the feasibility of using species of lizards that have been introduced, are closely related to species that have been introduced, or have the potential of being introduced to the United States, as indicators of heavy metal contamination. Metal concentrations in lizards were compared from the few available studies, including one recently conducted on the introduced brown anole Anolis sagrei in southern Florida. Brown anoles, tropical house geckos Hemidactylus mabouia, sand lizards Lacerta agilis, common viviparous lizards Lacerta vivipara, common wall lizards Podarcis muralis, and starred agamas Laudakia (Agama) stellio stellio were shown to be suitable indicators of heavy metal pollution because differences were found in metal levels in lizards from different locations within a given region, and lizards from sites presumed to be contaminated by heavy metals contained higher metal concentrations than those from locations that were uncontaminated.

Key words: Cadmium; chromium; introduced species; lead; lizards; metal accumulation; pollution indicator.

Introduction

Introduced species rank second only to habitat destruction (Wilson, 1992) in their effects on native species, communities, and ecosystems (Parker et al., 1999), and losses from damage and control efforts have reached $137 billion per year (Pimentel et al., 2000). Prevention, eradication, or control is clearly advisable (Mack et al., 2000; Myers et al., 2000) to stop further biotic homogenization of the Earth (McKinney and Lockwood, 1999). However, once established with little possibility of eradication, introduced species provide myriad opportunities for valuable basic
and applied research and impose few logistical and ethical obstacles relative to those faced by researchers studying even the most common native species.

Introduced species have been used as indicators of environmental contamination in aquatic ecosystems for many years. Since the early 1970s, Asian clams (Corbicula fluminea), which have been introduced throughout most of the United States and Europe, have been successfully used as environmental quality indicators and have been shown to be suitable surrogate organisms for predicting the effects of environmental contaminants on native, often endangered, freshwater mussels (Doherty, 1990; Milam and Farris, 1998; Gunther et al., 1999; Andrès et al., 1999; Soucek et al., 2001). Introduced zebra mussels (Dreissena polymorpha) have also been used as successful indicators of environmental contamination in freshwater aquatic ecosystems in Europe and North America (Mersch et al., 1992; Secor et al., 1993; Roe and MacIsaac, 1998; Cope et al., 1999; Camusso et al., 2001; Smolders et al., 2002).

Conversely, introduced species have not been utilized as environmental quality indicators in terrestrial ecosystems. In the United States, 34 species of introduced reptiles, including many species of lizards, had established populations in the state of Florida as of 1997 (Butterfield et al., 1997), and more species have become established since then (Meshaka et al., 1997; Krysko et al., 2003; Enge and Krysko, 2004). Eight species of Caribbean Anolis lizards are established in South Florida (Butterfield et al., 1997; Meshaka et al., 1997).

The brown anole (Anolis sagrei), a native of Cuba and the Bahamas (Williams, 1969), was introduced to at least six different locations in South Florida in the 1940s (Lee, 1985). Since then, it has spread throughout peninsular Florida and into southern Georgia, Louisiana, and Texas (Campbell, 1996, 2003). Similar to Asian clams and zebra mussels, characteristics that make the brown anole such a good invader also make it suitable for use as an indicator of environmental contamination. Brown anoles are prolific and reach densities of up to 10,000 lizards ha$^{-1}$, making them the most abundant terrestrial vertebrate in Florida (Campbell, 2000). They are adaptable to a wide variety of habitat types, can easily live in contaminated areas that have degraded habitat, and prefer areas that have been disturbed by humans.

Tropical house geckos (Hemidactylus mabouia) have established populations in several counties in South Florida and continue to expand their range (Butterfield et al., 1993; Meshaka et al., 1994; Klowden, 2002; Townsend et al., 2002; Townsend and Krysko, 2003). Common wall lizards (Podarcis muralis) were introduced into Cincinnati, Ohio around 1950 and have become established in and around the metropolitan area (Brown et al., 1995; Hedeen and Hedeen, 1999; Deichsel and Gist, 2001). They have recently expanded their range into Kentucky (Ferner, 2002). Italian wall lizards (Podarcis sicula campestris) have reproducing populations in Long Island, New York, where they were introduced in 1967 (Burke et al., 2002). Western green lizards (Lacerta bilineata) were introduced to Southwest Topeka, Kansas in the late 1950s; they have an established population confined to a few blocks (Kalyabina-Hauf and Deichsel, 2002).