Use of backpack radio-transmitters on lizards of the genus *Aspidocelis* (Squamata: Teiidae)

Radio-transmitters are used widely in field studies when tracking animals under natural conditions, especially when the spatial or temporal location of individuals provides information for behavioral studies and the weight of the transmitters has minimal adverse effects on their behavior. Radio telemetry has been used in ecological studies in lizards (e.g., Richmond, 1998; Warner et al., 2006; García-Bastida et al., 2012) and various methods have been proposed for securing the radio-transmitters (e.g., Fisher and Mut, 1995; Goodman, 2005; Goodman et al., 2009); not all methods, however, are suitable for the different sizes, shapes, or habits of the lizards under study.

Lizards of the genus *Aspidoscelis* are slender, highly active, and agile, so the use of external equipment that is too heavy can compromise their activity and survival. For example, species in this genus usually seek refuge among rocks and holes in the ground, and the addition of an object strapped to their body might limit their mobility to enter or leave the shelters. Moreover, during annual periods of inactivity these lizards become fossorial in their habits, and therefore require the use of some lightweight material for attaching an external transmitter.

Herein we describe a simple, inexpensive, and lightweight material that can be used for attaching an external radio-transmitter for telemetry field studies on lizards. This method involves a modification of that proposed by Gerner (2008) for the gecko *Phelsuma guentheri*, and is based on the use of a simple backpack, of low cost and high reliability, in which light-weight material is used. The placement of the backpack on the lizards apparently did not interfere with their normal behavior, such as foraging, the use of shelters, or mobility. In our original study, we monitored the use of shelter sites in *Aspidoscelis* spp.

Methods

From April to August 2015, we tracked four male *Aspidoscelis* sp. (mean body mass = 43.8 g; mean snout–vent length (SVL) = 118.4 mm; Table 1), near Tonatico, Estado de México, Mexico. The material used to make the backpacks consisted of a black latex band (SYRVET® syrflex cohesive starting line technology) made of a soft and elastic material, and manufactured for veterinary use. A commercial roll measuring 4,570 mm (length) × 100 mm (width) provides enough material for 45 backpacks. We cut the band into squares (100 mm × 100 mm), and later each square was cut into an X shape, which left four arms (70 mm × 10 mm) wide and four inner triangles (80 mm); we cut off and discarded three of the triangles, but one triangle was not removed (Fig. 1); we then made two cuts of 50 mm in this triangle and folded it twice (Fig. 1), adhering each fold with cyanoacrylate glue. This place is where the radio-transmitter attaches to the backpack, with the X-shaped arms used as straps on the back of the lizard. The radio-transmitter (Telenax® TCX-007BR, 5-month battery, weight 2 g, 216mHz) is positioned so that the antenna runs along the body from the top (Fig. 2). On average, the equipment (backpack and radio-transmitter) weighed 3.12 g (Table 1).

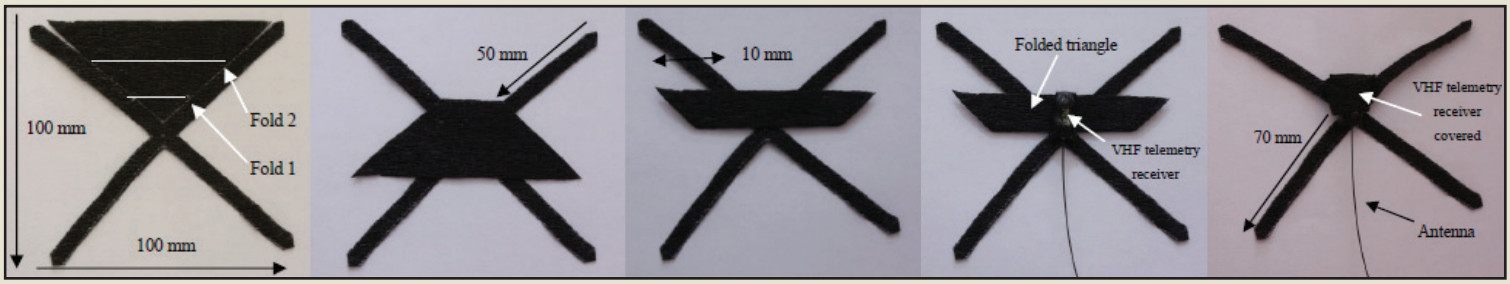

Fig. 1. The design and assembly of the backpack, with the attached radio-transmmiter VHF, for use in telemetry studies.
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Table 1: Measurements of lizards of the genus *Aspidoscelis* and weight of the backpack and radio-transmitter.

Lizards		Equipment			% (Lizard Body Mass/Total Weight of Equipment)
SVL (mm)	**Body Mass (g)**	**Backpack Weight (g)**	**Radio-transmitter Weight (g)**	**Total Equipment Weight (g)**	
122.77	48	0.674	2.4730	3.147	2.6
122.53	54	0.692	2.4730	3.165	2.6
110.45	27.37	0.642	2.4115	3.0535	2.8
117.93	46	0.656	2.4565	3.1125	2.6

We placed the backpack around the around a lizard's neck, which left the transmitter on the upper part of the body, with one set of straps anterior to the arms and the other set posterior to the arms and on the upper part of the body (Fig. 2), where the straps can stick in velcro form. When necessary we shortened the straps of the backpack with scissors, and then applied a drop of glue on the straps to prevent the backpack from shifting on the back of the lizard. We did not place any glue directly on the lizard.

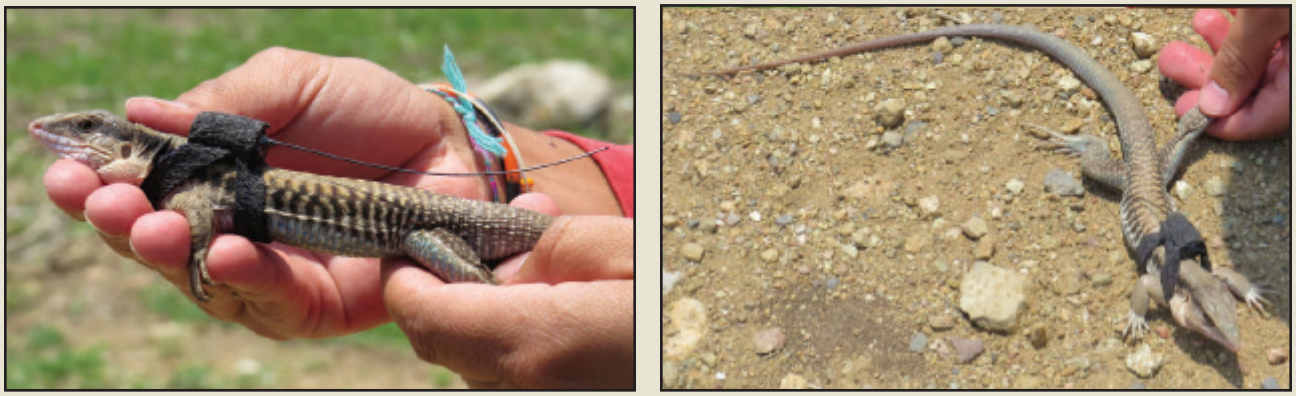

Fig. 2. The backpack used to secure the VHF radio-transmitters in lizards of the genus *Aspidoscelis*.
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Because *Aspidoscelis* are extremely active lizards and appear to be easily stressed, it helps to use two people to place the backpack on a lizard: one to hold the lizard and another for the placement of the backpack. This process lasts about 10 min, whereas removing the backpack only requires cutting the straps, so it can only be done once.

After releasing the lizards, we monitored them daily for seven consecutive days to assess their behavior. We attempted to find any qualitative evidence of rejection, discomfort, or negative effect on the mobility of the lizard, which might be associated with the use of backpack-transmitter. We monitored and evaluated the functionality of the backpack during observational intervals that lasted 1 hr. Previously we had made such observations to locate the areas inhabited by these lizards and their places of refuge, and then continued with the telemetric studies weekly for four weeks.

Results

We used the equipment (backpack and radio-transmitter) in four adult lizards for four weeks. During this time, the backpacks we assembled were resistant to sun exposure and moisture. The overall weight of the equipment averaged 3.12 g (Table 1). Three backpacks remained attached to the lizards, but one backpack (with the radio-transmitter) was located inside of a hole used as temporary shelter. The backpack likely had fallen off the lizard because it was not adjusted properly.

None of the four lizards showed any apparent behavior patterns resulting from the placement of the backpacks, and we did not encounter any lizards entangled in vegetation or where they might not be able to access their places of refuge. We also did not find evidence of degradation in health in the lizards, and none died during four weeks of tracking.

Discussion

Although we followed the design of the backpack described by Gerner (2008), we modified it by changing the material, and we also used certain characteristics proposed by other authors (Warner et al, 2006; Goodman et al., 2009; Price-Rees and Shine, 2011; García-Bastida et al., 2012), because they provided some advantages. For example, we used a latex band; a durable material designed for veterinary use, because it is permeable and lighter in weight than other materials, and also is inexpensive. When stretched, the latex band adapted to the body of the lizards, allowing them to move freely.

The use of the backpack on the lizards showed no apparent adverse effects on their behavior, as they exhibited such habitual behaviors as escaping, searching for shelter, and foraging. The use of the backpack transmitter was necessary for locating overwintering sites and areas of shelter in *Aspidoscelis*, because like in many reptile species these lizards are difficult to locate on account of their elusiveness (Goodman et al., 2000). With use of the backpack we were able to locate two hibernation sites for *Aspidoscelis*. Our proposed backpack radio-transmitter could be used for other purposes involving telemetry, whereas the design easily can be easily adapted to other lizard species that are different from *Aspidocelis* in body size, habits, and ecology.

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Víctor Mundo-Hernández[1], Marcela Martínez-Haro[1], Miguel Ángel Balderas-Plata[2], Xanat Antonio Némiga[2], and Javier Manjarrez[4]

[1]*Posgrado en Ciencias Ambientales, UAEMEX, Paseo Colón esquina Paseo Tollocan s/n, Toluca Estado de México, Mexico. Email*: victormundoh@gmail.com (VMH, Corresponding author)

[2]*Facultad de Geografía, UAEMEX, Cerro Coatepec s/n Ciudad Universitaria, Toluca Estado de México, Mexico. Emails*: mabalderasp@uamex.mx and xantonion@uaemex.mx

[3]*Centro de Investigación en Recursos Bióticos, UAEMEX, carretera Toluca-Ixtlahuaca km 14.5 San Cayetano, Toluca Estado de México, Mexico. Email*: jsilva@ecologia.unam.mx

A new locality for *Ctenosaura pectinata* (Wiegmann, 1834) (Squamata: Iguanidae) in central Mexico, with implications for its conservation

The natural distribution of spiny-tailed iguanas (genus *Ctenosaura*), which includes 18 species, is exclusive to Mesoamerica and extends from Mexico to Panama (Köhler, 2002; Buckley et al., 2016). The Black Spiny-tailed Iguana (*C. pectinata*) is an oviparous lizard endemic to Mexico, with a broad distribution extending along the Pacific coast from Sinaloa through Chiapas, including the Río Balsas Basin in central Mexico and two islands in the Pacific Ocean (Köhler, 2002); this species also has been introduced into Texas and Florida, in the United States (Kraus, 2009). The state of Michoacán is a major center of herpetofaunal diversity in Mexico, in which three species of iguanids occur: *Iguana iguana*, *C. clarki,* and *C. pectinata*; the latter species occurs in three physiographic regions: Coastal Plain, Balsas-Tepalcatepec Depression, and Sierra Madre del Sur (Alvarado-Díaz et al., 2013). According to Mexican law, *C. pectinata* currently is considered threatened (SEMARNAT, 2010), and is categorized as a priority species for conservation (SEMARNAT, 2014); in Michoacán it also was assessed an Environmental Vulnerability Score (EVS) of 15, placing it in the lower portion of the high vulnerability category (Alvarado-Díaz et al., 2013). Genetic and morphological evidence suggests high variation throughout its distributional range (Zarza et al., 2008, 2016). Also, due to multiple uses for this species in rural communities (e.g., as food, pets, medicinal practices, and handicrafts), this iguanid is both culturally and economically important, resulting in many conservation challenges (Zarza et al., 2016).

During a herpetological survey, on 17 September 2 at 1435 h 016, at Mesas de Enandio, Municipio de Zitácuaro, Michoacán, Mexico (19.34975°N, -100.454194°W; WGS 84; elev. 1,429 m; Fig. 1), we captured an adult male *C. pectinata* (345 mm snout–vent length, 634 mm tail length). The individual was photographed (Colección Fotográfica de Herpetología, Facultad de Ciencias, Universidad Autónoma del Estado de México, Photo Voucher CFH 13; Fig. 2) and released. The iguana was found perched on a log in an area of tropical dry forest that also contained an abundance of guava crops.

To our knowledge, the nearest previously recorded localities for this species are 92.6 km (airline distance) to the S in Huetamo, Michoacán (Reyna-Alvarez et al., 2010), and 27.3 km (airline distance) to the SE in Santo Tomás de los Plátanos, Estado de México (Köhler, 2002). Our record is significant because (1) it establishes needed locality information for this species of concern, as outlined by Buckley et al. (2016); (2) it represents a new municipality record for Michoacán; (3) this new locality presently is not included in its known geographic distribution (Köhler, 2002), including the predicted distribution for *C. pectinata* (Buckley et al., 2016); (4) it represents the most inland record for *C. pectinata* in central Mexico, including the state of Michoacán (Köhler, 2002); and (5) peripheral and newly discovered populations might show exclusive phenotypic traits that makes them valuable for conservation (Lesica and Allendorf, 1995).