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Polydactyly in the Central Pacific Gecko, *Lepidodactylus* sp. (Squamata: Gekkonidae)

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Abstract. We report the first known case of naturally occurring polydactyly in a gekkotan lizard. A single individual from Palmyra Atoll exhibited a triplication of digit III of the manus, resulting in seven normally-formed and apparently functional digits on the right hand. No obvious teratogenic sources are present on the atoll and the causal factors of polydactyly in *Lepidodactylus sp.* remain unknown.

Keywords. gecko, digits, skeletal abnormality, Palmyra Atoll, Line Islands

Polydactyly is widespread among limbed terrestrial vertebrates and is particularly common, or at least widely reported, in mammals (Todd, 1981; Pugsley, 1985; Brignolo et al., 2002; Strauss, 2002; Chapman, 2006; Moore et al., 2007) and amphibians (Dubois, 1974; Borkin and Pikulik, 1986; Lada, 1999; Vorobyeva, 1999; Lannoo, 2008). The occurence of polydactyly has also been reported in birds (Fox, 1989; Chandler, 1992; Trinkaus et al., 1999; Sakai, 2006), and chelonians (Martínez-Silvestre et al., 1998), but in other reptiles it appears to be rarer. Among lizards, examples of polydactylous individuals are uncommon, but they have been reported in chameleons (Cuadrado, 1996), iguanids (Pelegrin, 2007), and lacertids (Carretero et al., 1995). Frequencies of polydactyly among lizards have been reported to range from 0.2% in *Chamaeleo chamaeleon* (Cuadrado 1996) to 0.6% in *Tropidurus etheridgei* (Pelegrin, 2007), but such estimates are probably too high as they are invariably reported based only on populations from which polydactylous individuals have been recovered, rather than on random samples. In our own experience, from examining over 50,000 wild-caught and museum specimens of geckos, we have never previously noted a case of polydactyly and, to the best of our knowledge, no instances of naturally occurring polydactyly have been reported for any gekkotan lizard. We here report a case of polydactyly in a species of the gekkonid gecko *Lepidodactylus*.

A polydactylous gecko (CAS 243955) was collected between 19:54 h and 20:48 h on 28 September 2007 from the lagoon edge on a small, unnamed islet north of Tanager Islet, Palmyra Atoll, Line Islands (5.87538° N, 162.07476° W; North American Datum 83) by Robert N. Fisher and Stacie A. Hathaway. This gecko is a representative of the undescribed sexual paternal ancestor of the all-female parthenogenetic *Lepidodactylus lugubris*. This taxon has been previously mentioned as *Lepidodactylus* sp. by Ineich and Ota (1992), and Radtkey et al. (1995). On this islet, vegetated by *Cocos nucifera*, *L.* sp. co-occurs with *L. lugubris*, and these two species are the only lizards present. After preservation the specimen was photographed with a digital camera and x-rayed for 28 sec at 25 kV using a Faxitron closed cabinet x-ray system. Radiographs were imaged on Polaroid Type 55 film.

The specimen exhibits postaxial polydactyly of the right manus, where seven digits are present. Externally, all the digits appear normal (Fig. 1) and the subdigital scansors are typical in number and size for this species. All of the individual digits appear normal skeletally and each is subtended by a corresponding metacarpal bone of normal length. The additional digits are the apparent result of the triplication of digit III (Fig. 2). Thus, the phalangeal formula of the right manus of the specimen is 2-3-4-4-4-5-3. No other skeletal abnormalities appear to be present in the specimen and the left manus has the primitive phalangeal formula of 2-3-4-5-3, and both pedes exhibit the typical gekkotan condition of 2-3-4-5-4. No external evidence of polydactyly or other digital abnormalities was noted in more than 1000 other specimens of *Lepidodactylus* examined from Palmyra

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Figure 1. Dorsal view of the right manus of polydactylous *Lepidodactylus* sp. (CAS 243955) showing the normal appearance of the triplicated digit III. Scale bar = 1 mm.

Atoll during the period 2006–2008. Preaxial polydactyly occured in a number of basal Devonian tetrapods (Coates and Clack, 1990) and has been reported as an atavisitc or convergent condition in both living salamanders (Vorobyeva, 1999) and Mesozoic amniotes (Wu et al., 2003), and occurs fairly commonly in humans (Lannoo, 2008). A case of preaxial manual polydactyly has also been reported in *Tropidurus etheridgei* (Pelegrin, 2007), but all other reported instances of lizard polydactyly, including pedal polydactyly in the same tropidurine specimen, are postaxial, like that described here. Of the few instances reported of lizard polydactyly, only in *Podarcis pityusensis* has the osteological basis for the condition been investigated. In this case the presence of six digits on a single manus was the result of a duplication of digit IV from a single wide metacarpal, but the duplicated digit was lacking one phalanx (Carretero et al., 1995). This condition is actually one of brachydactly (normal number of metatarsals but abnormal number of digits), rather than true polydactyly, in which there are complete extra digits, including metacarpals. Likewise, the rudimentary, non-functional supernumerary toes of *Tropidurus etheridgei* (Pelegrin, 2007) suggest brachydactyly as well.

True polydactyly, with the duplication of the metacarpals and all distal elements is the most common type of skeletal abnormality seen in cases of "mass polydactyly" (Dubois, 1974; Borkin and Pikulik, 1986; Lada, 1999) reported in European anurans, but a variety of more distal duplications can also occur. For example, a *Testudo hermanni* with six digits on each manus and 8 and 9 on the pedes has been reported (Martinez-

Figure 2. Radiographic view of forelimbs of *Lepidodactylus sp.* (CAS 243955) illustrating the complete duplication, and normal phalangeal formula, of the duplicated third digit of the right manus and the normal manual skeleton of the left manus. Carpal structures are normally developed but unossified in both autopodia. Scale bar = 5 mm.

Silvestre et al., 1997) and a kestral (*Falco tinnunculus*) exhibited four extra toes on one foot and three on the other (Trinkaus et al., 1999).

In primates, in particular, polydactyly is often associated with a suite of malformations of genetic origin, such as chromosome trisomy (e.g., Pugsley, 1985; Brignolo et al., 2002; Moore et al., 2007) and a genetic basis has been suggested in other groups as well (Dubois, 1974), but in other organisms trematode parasites (Johnson et al., 1999, 2001), viruses (Borkin and Pikulik, 1986), and environmental contamination (Mizgireuv et al., 1984; Piha et al., 2006) have been implicated as teratological agents. Another possibility, suggested by experimental results in mice (Wanek et al., 1989), is that polydactyly could result as a regenerative response to very early limb bud damage in the embryo. However, as the regenerative capacity of lizards at later stages of development appears to be very limited (Bellairs and Bryant, 1985) and there are no obvious candidate teratogens on Palmyra Atoll, the actual causal factors of polydactyly in *Lepidodactylus* sp. remain unknown.

Although phalangeal loss, and even phalangeal gain (hyperphalangy), characterise a number of gekkotan taxa, and are common themes in squamate evolution (Russell and Bauer, 2008), hyperdactyly is unknown. Likewise, the extreme rarity of polydactyly as a skeletal abnormality in lizards suggests that there may be strong genetic, developmental and/or functional constraints on the generation or survival of lizards with extra digits.

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