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**Research Report**
**Seasonal differences in ventricular proliferation of adult *Gallotia galloti* lizards**
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## ABSTRACT

Lizards present neuronal production throughout the telencephalon in their adult state, both naturally and after experimentally induced brain lesions. As in birds, lizards present seasonal behavioural variations. In birds, such variations have been shown to alter neuronal production. In birds and mammals, lack of stimuli or exposure to stress interferes with adult neurogenetic capacity. The effect of this type of study has not been performed with lizards. In the present study we used bromodeoxyuridine to label dividing cells in the ventricular walls of *Gallotia galloti* lizards during all four seasons and we investigated the effect of captivity on such proliferation. We found that *G. galloti* presented a particular distribution that differed from that previously described in other reptiles with respect to regions of greater or lesser proliferative rate. In addition, proliferative rate varied seasonally, with greater production of cells in Spring and low production in Autumn and Winter. Proliferative rate was significantly lower throughout the telencephalon and during all seasons in those lizards kept in captivity as compared with wild animals, even though photoperiod and temperature were similar to natural conditions. Our results indicate that cell production in lizards is species-dependent, varies with seasons and is significantly reduced in captive animals.

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**1. Introduction**

Adult neurogenesis is a well documented process in mammals and songbirds, but less in reptiles and much less in lizards. New cells originate in specific regions of the brain, migrate and integrate in pre-existing circuits as mature neurons. In mammals two neurogenetic regions have been identified: Olfactory Bulb (OB) and Dentate Gyrus of the hippocampus (Kaplan and Bell, 1984; Cameron et al., 1993; Lois and Alvarez-

Buylly, 1994). In birds, adult neurogenesis has been described in most of the major subdivisions of the telencephalon (Nottebohm and Alvarez-Buylly, 1993). However, proliferation is concentrated in the ventral and dorsal reaches of the lateral wall of the lateral ventricle (Alvarez-Buylly et al., 1990).

In reptiles, adult neurogenesis has been described in all telencephalic regions, including the olfactory bulb (OB), rostral forebrain, all cortical areas, dorsal ventricular ridge (DVR), septum (Sp), striatum and nucleus sphericus (NS) (Font E. et

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**Table 1 – Summary of the different telencephalic regions in reptiles, their mammalian homologues and the putative function/behaviour associated**

	Telencephalic regions of reptile	Mammalian homologous brain region	Putative function/behaviour	References
Pallial regions	OB, OT	OB, OT	Olfaction	Martinez-Garcia et al. (1991)
	AON	–	Olfaction	–
	LC	Olfactory cortex (piriform and entorhinal)	Receive Olfactory inputs from main Olfactory nucleus	Martinez-Garcia et al., 1986; Hoogland and Vermeulen-Vanderzee, 1995
	DC	The CA1 region and subiculum of hippocampus	–	Martinez-Garcia et al., 1990; Font C. et al., 1997
	DMC	The CA3 region of hippocampus	Related to limbic system	Martinez-Guijarro et al. (1990)
	MC	Dentate gyrus of hippocampus	Learning, memory and orientation. Related with limbic system	Olucha et al., 1988; Luis de la Iglesia and Lopez-Garcia, 1997a,b
	DVR	Pallial amygdala and claustrorpiriform components	Multisensorial inputs. The main information—processing center of reptile brain	Bruce and Neary, 1995; Striedter, 1997
	NS	Posteromedial cortical amygdala	Receive olfactory inputs from accessory olfactory nucleus	Martinez-Garcia et al. (2002)
Subpallial regions	Sp	Septum	Part of limbic system	Font et al., 1995; Font C. et al., 1997, 1998
	VA	Striatum and accumbens	Motor activity. Part of the limbic system	Russchen and Jonker, 1988; Butler and Hodos, 1996

OB: olfactory bulb; OT: olfactory tract; AON: anterior olfactory nucleus; LC, DC, DMC and MC: lateral, dorsal, dorso-medial and medial cortex; ADVR: anterior dorsal ventricular ridge; NS: nucleus sphericus; Sp: septum; VA: ventral area.

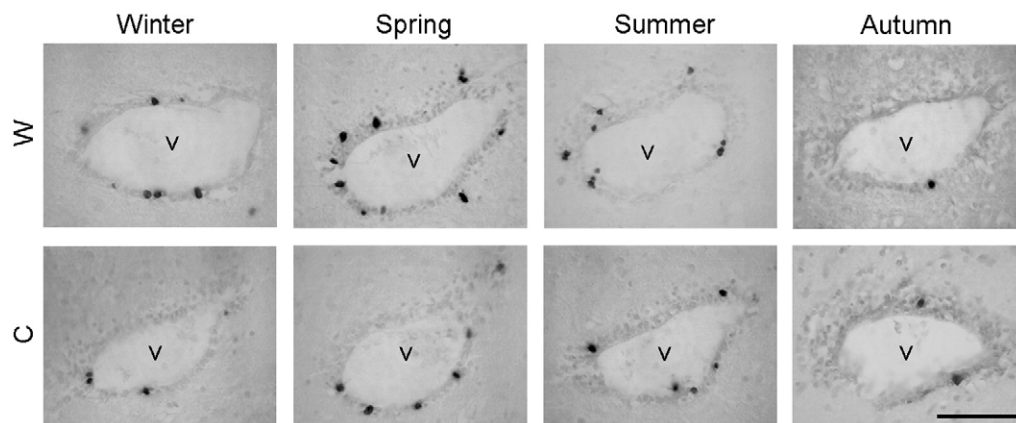
al., 1997; Lopez-Garcia et al., 1988; Perez-Canellas et al., 1997; Perez-Canellas and Garcia-Verdugo, 1996; Table 1). The rate of neuronal production varies greatly among these telencephalic regions. Moreover, striking interspecies differences have been noted in the rate and distribution of adult neurogenesis: the greatest proliferative activity has been detected in the medial cortex (MC) in *Tarentola mauritanica* (Perez-Canellas and Garcia-Verdugo, 1996), in the nucleus sphericus (NS) in *Podarcis hispanica* (Font et al., 2001) and in the dorsal ventricular ridge (DVR) in *Trachemis scripta* (Perez-Canellas et al., 1997). The reasons for this apparent discrepancy are unknown.

Lizards, as well as birds, show seasonal behavioural variations (courting and mating in Spring, egg-laying and hatching in Summer, etc.), but in lizards they have not been

related to adult neurogenesis. Interestingly, in songbirds, adult neurogenesis is regulated in a seasonal way (Alvarez-Buylla et al., 1990). Mainly based on these findings we postulated the possibility of seasonal variations in adult lizard neurogenesis.

In mammals, stress and lack of environmental stimuli negatively affect adult neurogenesis (Gould et al., 1997, 1998; Brown et al., 1993). This fact leads us to postulate that conditions of captivity, normally not specified in studies on reptiles, could affect the proliferative rate.

We studied seasonal influence on VZ cellular proliferation, the first step of neurogenesis, during all four seasons in adult wild (group W) and captive lizards (group C). We expected to find a peak in proliferation in Spring and Summer, associated



**Fig. 1 – Photographs of BrdU-positive cells in the VZ of the AON of groups W and C during the different seasons. V, ventricle; scale bar, 50  $\mu$ m.**

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