SHORT NOTES


CHROMOSOMAL EVIDENCE FOR THE DOUBLE ORIGIN OF VIVIPARITY IN THE EUROPEAN COMMON LIZARD, LACERTA (ZOOTOCA) VIVIPARA

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The results of a chromosomal analysis conducted in a relict, viviparous, Hungarian (Öcsa) population of L. vivipara, show that viviparity independently arose in this population. Chromosome characteristics of Öcsa, namely females displaying 2n=36 chromosomes with a ZW sex chromosome system and W shaped as microchromosome, all autosomes were also weakly CMA3 positive, except for a small autosome pair, whose telomeric NOR were intensely stained. Interestingly, the karyological characteristics of viviparous population of Öcsa are peculiar to the viviparous populations of Z. v. carniolica. The ZW sex chromosome system with W shaped as a microchromosome has been found in several other, unrelated, lacertid species and thought as derived from a primitive macrochromosome W, homomorphic to Z, by a multistep process, proceeding formerly by heterochromatinization and successively by progressive events of deletions (Odierna et al. 1993; Olmo et al. 1993; in den Bosch et al. 2003). In our case, this W processing might have occurred either once, consequently the Öcsa population groups within carniolica (our preferred hypothesis, since heterochromatin of their W is DAPI positive and Alu I resistant) or twice, then the population of Öcsa constitutes or belongs to a clade...
FIG. 1  Gross distribution of the five cytotypes of L. vivipara (Asian distribution not included) and the cladogram (modified from Odierna et al., 2001) showing their relationships and characteristics of W chromosome. Eastern viviparous populations ♂♂ ; Centroeuropean viviparous populations ♂♂ ; Pyrenean+Aquitanean oviparous populations ♂♂ ; L. v. carniolica oviparous populations ♂♂ ; Ocsa population ♂♂ ; Sex chromosome differentiation, starting from a hypothetic ancestor (h.a.), possessing 2n = 36 acrocentric chromosome, a ZW sex chromosome system, W homomorphic to Z, occurred according to two different modalities: by (1) heterochromatinization of the primitive W and progressive deletion events, shaping the W as microchromosome (the hatched line considers the possibility of an independent origin of the microchromosome W in the Ocsa population); by (2) a tandem fusion of the original W with an autosome to give rise to a Z,Z,W sex chromosome system, W shaped as a macrochromosome; afterwards, addition of interstitial (3) and telomeric (4) heterochromatin, as well as a pericentromeric inversion (5) occurred.

distinct from carniolica (Fig. 1). However, irrespective of whether the Ocsa population does or does not group within carniolica, ours results provide evidence that viviparity independently arose twice, in the population of Ocsa and elsewhere in the clade including Pyrenean+Aquitainean, Centro-European and Eastern populations. Females of these populations possess a Z,Z,W sex chromosome system, which is thought derived formerly by a tandem fusion of the primitive W with an autosome and successively by heterochromatinization and/or structural rearrangements (Fig. 1) (see also Odierna et al. 1993, 2001; Olmo et al. 1993). Multiple sex chromosome systems (Z,Z,W or X,X,Y) are quite rare in vertebrates, and in lacertids, in addition to L. vivipara, have been found only in the Pyrenean populations referred to the L. bonnali complex, a group unrelated to vivipara and characterised by a number of centric fusions (Odierna et al., 1996). Then, in L. vivipara the origin of Z,Z,W sex chromosome system constitutes a shared derived character for the Pyrenean-Aquitainean, Centro-European and Eastern populations and splits them off from the other populations with ZW sex chromosome system (carniolica and Ocsa). On the other hand, we also exclude that the microchromosome displayed by females of Ocsa should be either a B (supernumerary) chromosome or the result of an event of centric fission occurring in the subtelocentric W displayed by females of Pyrenean-Aquitainean, Centro-European and Eastern populations, or by product of the introgression of maternal markers from carniolica within a viviparous genome. B elements are randomly inherited and we found none of these elements in the Ocsa male, as well as in number of examined specimens of L. vivipara. Furthermore, supernumerary elements are quite rare among lacertids, since they have so far been found in only two species (Olmo et al. 1993). In the case of a centric fission, in addition to this kind of rearrangement we should also consider (1) the occurrence of the euchromatinization of the interstitial, heterochromatic C band that accompanies the subtelo centric W of both the clades and (2) that females of Ocsa possess a complex sex chromosome system of type Z,Z,W,W. However, neither centric fissions nor euchromatinization of heterochromatin events have so far been noticed among lacertids (Olmo et al., 1993), while a Z,Z,W,W sex chromosome system would constitute a novelty not only among lacertids but in vertebrates. Lastly, in the case of introgression of carniolica maternal materials within a viviparous genome, this may only spring from hybridization between females of carniolica with viviparous males; in this case the resulting offspring should be compulsory oviparous, since cross breeding experiments between oviparous and viviparous strains of L. vivipara showed that the parental female dictate the reproductive mode of the offspring (Arrayago et al. 1996).
In conclusion the adaptive value of viviparity (recently reviewed by Blackburn 2000) is further supported by our results, which point to an independent origin of viviparity in Ócsa and elsewhere in Europe.

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REFERENCES


Surget-Groba, Y., Heulin, B., Guillaume, C.P., Thorpe R. S., Kupriyanova, L. M. S., Vogrin, N., Maslak, R., Mazzotti, S., Venczel, M., Ghira, I., Odierna, G.,


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