Seasonal dynamics of sex hormone levels in *Elaphe dione* (Pallas 1773) (Colubridae, Reptilia) in the northern part of the range

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Abstract: We investigated seasonal changes in the plasma levels of sex hormones in males (testosterone) and females (progesterone and estradiol) of *Elaphe dione* (Pallas 1773). Snakes (21 males and 17 females) were captured from May to August 2022 on the Samarskaya Luka (Samara Region, Russian Federation). Some individuals (4 males and 11 females) after capture were kept under controlled laboratory conditions for two months, then they were released at the capture sites. Blood was sampled immediately after capture. In the snakes kept in laboratory conditions, blood was drawn no more than 2 times per month. In total, 88 samples were collected (55 from females and 33 from males, respectively). The concentration of the sex steroids in plasma was measured by an enzyme-linked immunosorbent assay. The progesterone concentration reached maximum values in pregnant females and then decreased after egg laying, while the estradiol levels gradually increased after the end of the mating season. The seasonal dynamics of male testosterone levels indicated a dissociated reproductive pattern, when the spring breeding period coincided with low androgen concentrations and testicular regression, while spermatogenesis occurred in the summer. We believe that our findings shed light on *E. dione* reproductive biology and could be helpful for possible conservation efforts in relation to this poorly studied species.
Keywords: Colubridae, *Elaphe dione*, progesterone, estradiol, testosterone

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REFERENCES

Bakiev A. G., Garanin V. I., Litvinov N. A., Pavlov A. V., Ratnikov V. Yu. *Zmei Volzhsko-Kamskogo kraya* [Snakes of the Volga-Kama Region]. Samara, Samara Scientific Center of the Russian Academy of Sciences Publ., 2004. 192 p. (in Russian).

Klenina A. A. *Uzhovye zmei* (*Colubridae*) *Volzhskogo basseina*: *pitanie*, *razmnozhenie*, *sostoyanie okhrany*. *Pod red. A. G. Bakieva* [Snake Snakes (Colubridae) of the Volga Basin: Nutrition, Reproduction, State of Protection. Ed. by A. G. Bakiev]. Togliatti, Kassandra, 2015. 106 p. (in Russian).

Klenina A. A., Bakiev A. G., Pavlov A. V. To the morphology of Colubrid snakes in the Middle Volga region. Message 1. Determination of the sex of young individuals. *University Proceedings. Volga Region. Natural Sciences*, 2019, no. 1 (25), pp. 61–71 (in Russian). https://doi.org/10.21685/2307-9150-2019-1-7

Peskov A. N., Baltushko A. M., Bakiev A. G., Eplanova G. V., Vekhnik V. P. On the phenology of reptiles of the Zhiguli Nature Reserve. In: *Reserve Business of Russia*: *Principles*, *Problems*, Priorities: *Materials of the International scientific conference*. Zhigulevsk, Bakhilova Polyana, Zhigulevsky State Nature Reserve named after I. I. Sprygin Publ., 2003, vol. 1, pp. 38–40 (in Russian).

Shlyakhtin G. V., Tabachishin V. G., Zavyalov E. V., Tabachishina I. E. *Animal World of the Saratov Region. Book 4. Amphibians and Reptiles*. Saratov, Saratov State University Publ., 2005. 116 p. (in Russian).

Yartsev V. V., Kuranova V. N., Absalyamova E. N. Male reproductive cycle in a population of the common lizard *Zootoca vivipara* (Squamata, Lacertidae) from

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Southeast of Western Siberia. *Current Studies in Herpetology*, 2019, vol. 19, iss. 1–2, pp. 56–67 (in Russian). https://doi.org/10.18500/1814-6090-2019-19-1-2-56-67

Aldridge R. D. Seasonal spermatogenesis in sympatric *Crotalus viridis* and *Arizona elegans* in New Mexico. *Journal of Herpetology*, 1979, vol. 13, pp. 187–192. http://dx.doi.org/10.2307/1563927

Aldridge R. D., Goldberg S. R., Wisniewski S. S., Bufalino A. P., Dillman C. B. The reproductive cycle and estrus in the colubrid snakes of temperate North America. *Contemporary Herpetology*, 2009, no. 4, pp. 1–31.

Almeida-Santos S. M., Abdalla F. M., Silveira P. F., Yamanouye N., Breno M. C., Salomao M. G. Reproductive cycle of the neotropical *Crotalus durissus terrificus*: I. Seasonal levels and interplay between steroid hormones and vasotocinase. *General and Comparative Endocrinology*, 2004, vol. 139, pp. 143–150. https://doi.org/10.1016/j.ygcen.2004.09.001

Bennett E. J., Jones S. M. Interrelationships among plasma progesterone concentrations, luteal anatomy and function, and placental ontogeny during gestation in a viviparous lizard (*Niveoscincus metallicus*: Scincidae). *Comparative Biochemistry and Physiology. Part A*: *Molecular and Integrative Physiology*, 2002, vol. 131, iss. 3, pp. 647–656. https://doi.org/10.1016/s1095-6433(01)00495-0

Bertocchi M., Pelizzone I., Parmigiani E., Ponzio P., Macchi E., Righi F., Di Girolamo N., Bigliardi E., Denti L., Bresciani C., Di Ianni F. Monitoring the reproductive activity in captive bred female ball pythons (*P. regius*) by ultrasound evaluation and noninvasive analysis of faecal reproductive hormone (progesterone and 17β-estradiol) metabolites trends. *PLoS ONE*, 2018, vol. 13, iss. 6, article no. e0199377. https://doi.org/10.1371/ journal.pone.0199377

Bonnet X., Naulleau G., Bradshaw D., Shine R. Changes in plasma progesterone in relation to vitellogenesis and gestation in the viviparous snake *Vipera aspis*. *General and Comparative Endocrinology*, 2001, vol. 121, iss. 1, pp. 84–94. https://doi.org/10.1006/ gcen.2000.7574

Custodia-Lora N., Callard I. P. Progesterone and progesterone receptors in reptiles. *General and Comparative Endocrinology*, 2002, vol. 127, iss. 1, pp. 1–7.

Custodia-Lora N., Novillo A., Callard I. P. Regulation of hepatic progesterone and estrogen receptors in the female turtle, *Chrysemys picta*: Relationship to vitellogenesis. *General and Comparative Endocrinology*, 2004, vol. 136, pp. 232–240. https://doi.org/10.1016/ j.ygcen.2003.12.016

Endo D., Park M. K. Molecular cloning of P450 aromatase from the leopard gecko and its expression in the ovary. *The Journal of Steroid Biochemistry and Molecular Biology*, 2005, vol. 96, pp. 131–140. https://doi.org/10.1016/j.jsbmb.2005.02.015

Fergusson B., Bradshaw S. D. Plasma argini-ne vasotocin, progesterone, and luteal development during pregnancy in the viviparous lizard *Tiliqua rugosa*. *General and Comparative Endocrinology*, 1991, vol. 82, pp. 140–151.

Flemming A. F. Seasonal variation in plasma and corpus luteum oestradiol-17β and progesterone concentrations of the lizard *Cordylus p. polyzonus* (Sauria: Cordylidae). *South African Journal of Zoology*, 1994, vol. 29, iss. 2, pp. 87–92.

García-Valdez M. V., Chamut S., Jahn G. A., Arce O. E. A., Manes M. E. Plasmatic estradiol and progesterone variations during the reproductive cycle of captive female argentine red tegu lizards, *Tupinambis rufescens. Herpetological Conservation and Biology*, 2016, vol. 11, iss. 1, pp. 519–526.

Graham S. P., Earley R. L., Guyer C., Mendonça M. T. Innate immune performance and steroid hormone profiles of pregnant versus nonpregnant cottonmouth snakes (*Agkistrodon piscivorus*). *General and Comparative Endocrinology*, 2011, vol. 174, pp. 348–353.

Guillette L. J., Spielvogel S., Moore F. L. Luteal development, placentation, and plasma progesterone concentration in the viviparous lizard *Sceloporus jarrovi*. *General and Comparative Endocrinology*, 1981, vol. 43, iss. 1, pp. 20–29.

Hamlin H. J., Lowers R. H., Kohno S., Mitsui-Watanabe N., Amano H., Hara A., Ohta Y., Miyagawa S., Iguchi T., Guillette L. J. The reproductive hormone cycle of adult female American alligators from a barrier island population. *Reproduction*, 2014, vol. 147, iss. 6, pp. 855–863. https://doi.org/10.1016/j.ygcen.2011.09.015

Hammouche S., Gernigon-Spychalowicz T. H., Exbrayat J. M. Immunolocalization of estrogens and progesterone receptors within the ovary of the lizard *Uromastyx acanthinura* from vitellogenesis to rest season. *Folia Histochemica Cytobiologica*, 2007, vol. 45, suppl. 1, pp. 23–27.

Hau M. Regulation of male traits by testosterone: Implications for the evolution of vertebrate life histories. *BioEssays*, 2007, vol. 29, iss. 2, pp. 133–144. https://doi.org/10.1002/bies.20524

Ho S. M., Kleis-San Francisco S., McPherson R., Heiserman G. J., Callard I. P. Regulation of vitellogenesis in reptiles. *Herpetologica*, 1982, vol. 38, no. 1, pp. 40–50.

Taylor E. N., DeNardo D. F. Hormones and reproductive cycles in snakes. In: Norris D., Lopez K., eds. *Hormones and Reproduction of Vertebrates*: *Reptiles*. Massachucets, Academinc Press, 2011, pp. 355–372.

Taylor E. N., DeNardo D. F., Jennings D. H. Seasonal steroid hormone levels and their relation to reproduction in the Western Diamond-backed Rattlesnake, *Crotalus atrox* (Serpentes: Viperidae). *General and Comparative Endocrinology*, 2004, vol. 136, pp. 328–337. https://doi.org/10.1016/j.ygcen.2004.01.008

Tumkiratiwong P., Meesuk W., Chanhome L., Aowphol A. Reproductive patterns of captive male and female monocled cobra, *Naja kaouthia* (Lesson, 1831). *Zoological Studies*, 2012, vol. 51, pp. 692–700.