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Congenital anomalies in morphology and colour in captive-bred vipers (Reptilia, Serpentes, Viperidae)

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Several congenital anomalies in morphology (kyphoscoliosis, tail-, eye-, tonguelessness, cyclopia, schistosomia etc.) as well as in colour (longitudinal striped pattern, albinism, etc.) in captive-bred true vipers (Viperidae), are described and compared with cases known from literature. Possible causes and prevention of the anomalies are discussed.

Aangeboren afwijkingen in morfologie en kleur bij in gevangenschap geboren adders - Dit artikel beschrijft aangeboren afwijkingen in zowel morfologie (kyphoscoliose, staart-, oog- en tongloosheid, cyclopia, schistosomia, etc.) als kleur (longitudinale strepen, albinisme, etc.) bij in gevangenschap geboren ware adders (Viperidae) en vergelijkt ze met gevallen uit de literatuur. Mogelijke oorzaken en preventie van de beschreven afwijkingen worden bediscussieerd.

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Keywords: congenital anomalies, snakes, vipers, Reptilia,Viperidae.

INTRODUCTION

Herpetologists and private snake keepers breed with several species of snakes. Sometimes the newborns suffer from congenital anomalies. These can concern morphology as well as colour and colour pattern, and produce characters that are not, or rarely, seen in nature. Case reports or systematic surveys of these anomalies are rare and do probably not correspond with the real number of congenital deformations that occur in captive-bred snakes. In the present study, some examples of the above mentioned anomalies are discussed. For reptiles, records of this kind are almost without exception from animals born in captivity. The actual act of delivery or newborn animals in the wild are rarely encountered and observed by man. Therefore, animals with severe and disadvantageous anomalies that are either born dead or die shortly after birth, are nearly almost missed in nature.

MATERIAL

The animals described here are captive-bred vipers from the collection of the author and friendly cooperating other breeders. Animals that spontaneously died or that have been euthanised are deposited in the herpetological collection of the Natuurmuseum Rotterdam (NMR; Natural History Museum Rotterdam). Catalogue numbers (NMR 9994.....) are given in the text.

MORPHOLOGY

1 spinal anomalies

1.1 kyphoscoliosis The most frequent morphological anomaly is the existence of vertical or horizontal deviations in the spine (congenital, not aquired, kyphoscoliosis). Deviations can be single or multiple and vary between only slightly curved up to almost 180°. In such extreme deviations, animals will suffer from problems with locomotion, coordination, eating, transportation of the food through the digestive tract, ecdysis, mating, etc. Captive-born animals with such deformations were either euthanised by cooling down and freezing, or they died spontaneously shortly after birth. Kyphoscoliosis was seen on every part of the trunk and tail but was more frequently found around the cloacal area and on the tail. Some animals only had the tip of the tail bent (tail-kink). Animals with this last phenomenon had problems with moulting the skin at that place; this sometimes led to the loss of the tail tip. Kyphoscoliosis was found by the author in the following species: *Vipera raddei* (NMR 9994-00305), *Vipera seoanei cantabrica*, *Vipera latastei latastei*, *Vipera ammodytes ammodytes*, *Vipera kaznakovi*, *Vipera wagneri* and also in the Colubrid *Elaphe situla*, and seems to be common among captive-bred snakes (Frye 1991; other breeders, pers. comm.). One specimen of *Vipera kaznakovi* born in 1989 with multiple alternating vertical deviations of the

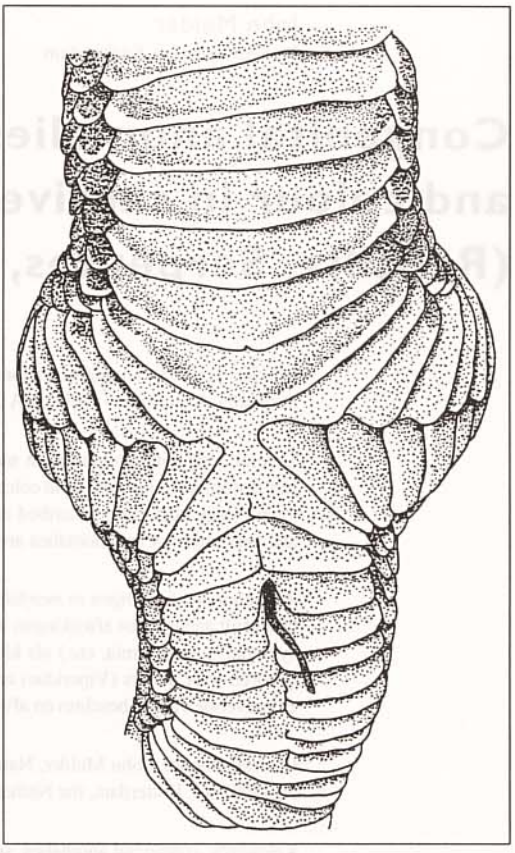
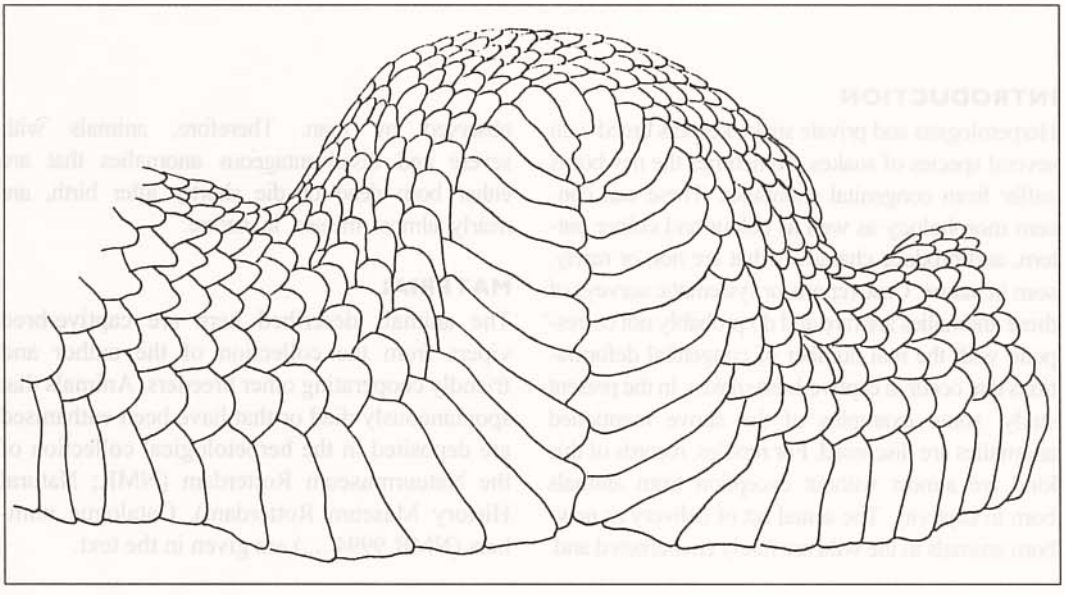


Figure 1 Ventral view of a *Vipera raddei raddei* (NMR 9994-00263/JM 0056) with kyphoscoliosis and abnormal arrangement of the ventral scales. [drawing: John Mulder]

Figure 2 Lateral view of the same animal as in figure 1. [drawing: John Mulder]



spine all along the body is still alive in the author's collection and has grown up without major problems. She even has been pregnant without visible troubles. A specimen of *Vipera wagneri*, which will be mentioned later on because of other anomalies (cyclopia, schistosomia), showed maximum kyphoscoliosis, viz. a total folding of a part of the trunk, with fusion of the ventral sides. Comparable animals were described by Frye (1991) as having partial axial skeleton fusion. A whole clutch (6 animals) of *Vipera raddei raddei* suffered from a special kind of kyphoscoliosis that is hard to explain. The deformation consisted of vertical angles in the spine that are quite acute and short, combined with fusion of the surrounding tissues probably during an early stage of development. This leads to a bulb in the body and a strange arrangement of the ventral scales. Fig. 1 shows the ventral side and Fig. 2 shows the lateral side of a specimen of this clutch (NMR 9994-00263/JM 0056) with a severe deformation of this kind. The body is in one line, both rostrally and caudally of the fused area. This anomaly was accompanied by an abnormal heavy birth weight (total length 194 mm, mid body width 12 mm).

1.2 coccygeal agenesis (taillessness)
A *Vipera latastei latastei* was born without a tail. Some days after the first meal the animal died and it was subsequently found in an advanced state of putrefaction. It remains unknown whether or not this specimen possessed a cloacal opening.

2 anomalies concerning the head (cranial anomalies)

2.1 shortening of the snout The head of a *Vipera xanthina* (NMR 9994-00260/JM 0053) showed some peculiar characters. The snout before the eyes was much shorter than normal, while the mandibula was not noticeably shortened (Fig. 3). The mouth closed perfectly. This gave the specimen a 'bull dog' appearance (Fig. 4). It never ate by itself and half a year after

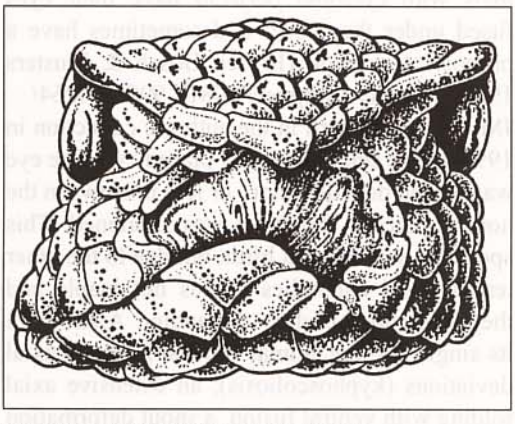
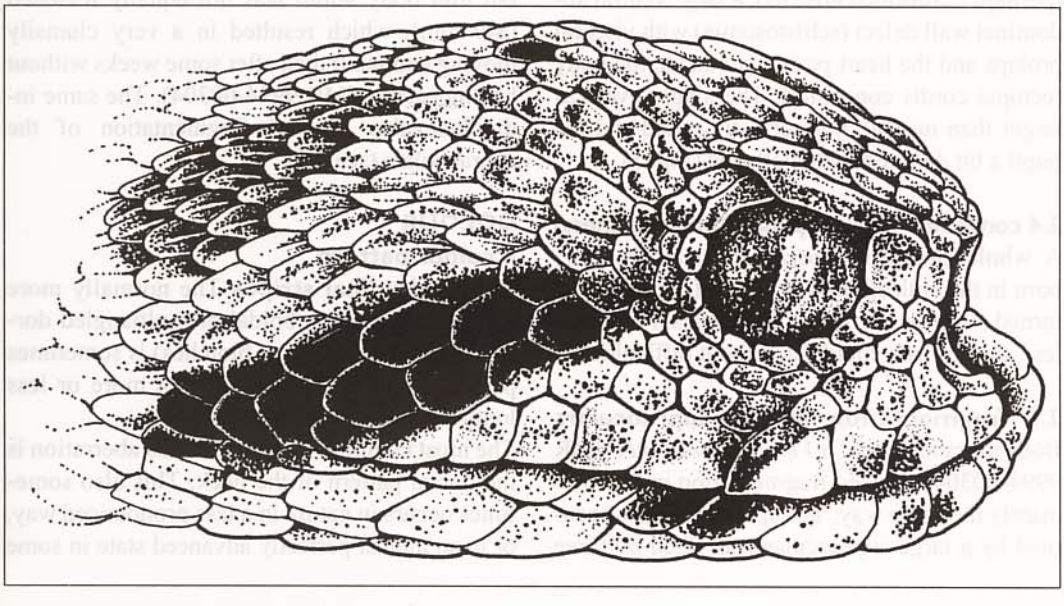


Figure 4 Frontal view of the same animal as in Fig. 3 (NMR 9994-00260 /JM 0053) [drawing: Leo Man in 't Veld]

Figure 3 Lateral view of the head of *Vipera xanthina* (NMR 9994-00260/JM 0053) showing shortening of the snout. [drawing: Leo Man in 't Veld/ John Mulder]



birth, after many forced feeding sessions, it died. The cyclopic specimen of *Vipera wagneri* described below (see cyclopia) also showed a shortening of the snout (Fig. 5).

2.2 anophtalmia (eyelessness) A juvenile *Vipera ammodytes* missing one eye (unilateral anophtalmia) was born in the collection of Mr. Vanderhaeghe (Metz, France). This specimen died during a holiday of the owner and unfortunately was lost. As a result, nothing is known about the nature of the anomaly and the morphological solution of scalation in this area.

2.3 cyclopia One of the most bizarre and even rare anomalies is the occurence of cyclopia, the existence of only one centrally placed eye. Animals with *cyclopia perfecta* have their eyes fused under the 'nose' and sometimes have a probosis formation (In den Bosch & Musters 1987). A *Vipera wagneri* (NMR 9994-00264/ JM 0057) was born in the author's collection in 1994 with a single centrally placed eye. The eye was placed dorsally, more or less in between the normal places. The snout was shortened. This specimen was alive at birth, but due to the other teratological anomalies it was not viable and therefore euthanised by the author. Apart from its single eye the animal showed multiple axial deviations (kyphoscoliosis), an extensive axial folding with ventral fusion, a snout deformation (shortening of the maxillae, with a pair of clefts (perhaps malformed nostrils), a large ventral abdominal wall defect (schistosomia) with visceral prolaps and the heart pumping outside the body (ectopia cordis congenita). The single eye was larger than normal, not perfectly round and the pupil a bit directed to the left side (Fig. 5).

2.4 congenital lingual aplasia (tonguelessness) A whole clutch of *Vipera lebetina schweizeri* born in the collection of R. Jooris (pers. comm.) turned out to be born without tongues. Nevertheless, the animals could eat without difficulties.

2.5 fragmentation of the supraoculars Both supraoculars of a *Vipera kaznakovi* (NMR 9994-00304) showed fragmentation in approximately the same way. The space normally occupied by a large supraocular was filled by three scales showing some similarity in size and shape to the preceeding canthals and adjacent scales of the pileus. The first of those three is the most divergent, and likely to be a loreal (the upper praeocular), which penetrates in between a canthal and 'supraocular' and thus helps in forming the horizontal part of the 'canthal ridge'. It were not simply supraoculars with extra internal fragmentation lines, in which case the scales build together more or less normal supraoculars. The latter occurs occasionaly (e.g. Brodmann 1987). For an uncommon anomaly like this it is strange that it occurs on both sides of the head. The snake's head was quite symmetrical this way.

3 other morphological anomalies

3.1 schistosomia Except in the rare case of the cyclopic *V. wagneri* which had a large ventral body defect (see above), *'hernia funiculi umbilicalis'* is a more common manifestation of schistosomia. Most reptile breeders know cases in which the ventral wall is not closed at birth. This might be a minor problem because sometimes it closes by itself after some time (the animal probably having been born to early). Sometimes the defect is very large and abdominal organs or other tissue with large blood vessels lay outside the body. Such specimens normally die shortly after birth.

3.2 reduced length with bulky body shape A *Vipera kaznakovi* was born too short (11 cm), but mid body width was not equally lessened (8-9 mm), which resulted in a very clumsily moving animal. It died after some weeks without having eaten (NMR 9994-00304). The same individual also showed fragmentation of the supraoculars (see 2.5).

COLOUR

4 colour pattern

4.1 longitudinal stripes The normally more or less regular rhomboidal or multiangled dorsal pattern (or a chain of blotches) is sometimes partly or totally substituted by a more or less longitudinally striped pattern.

The most common location for this aberration is the dorsal pattern of the neck. This also sometimes occurs in nature in a less pronounced way, or in an almost perfectly advanced state in some

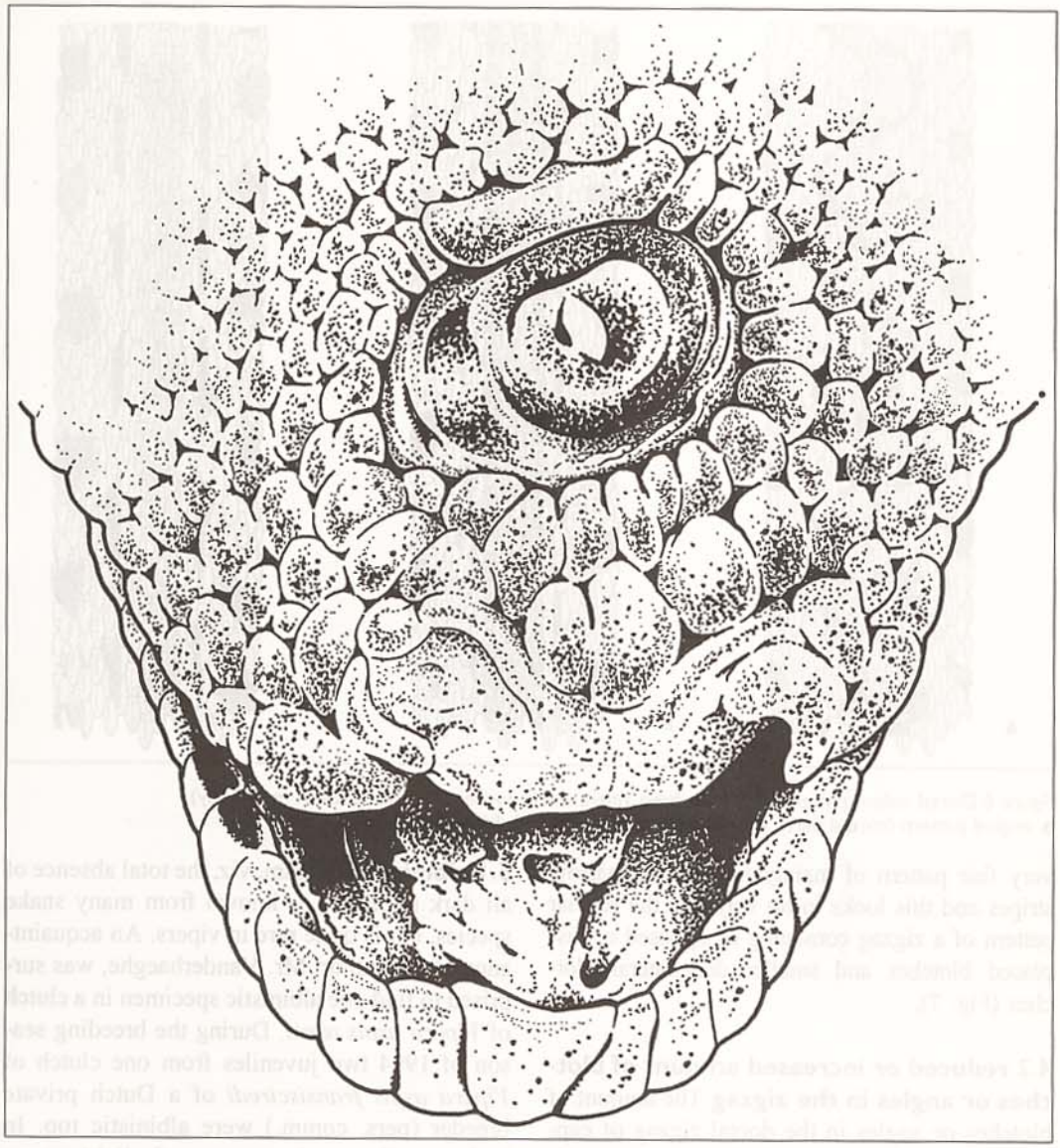


Figure 5 Fronto-dorsal view of the head of a cyclopic *Vipera wagneri* (NMR 9994-00264/JM 0057), also showing a shortening of the snout. [drawing: Leo Man in 't Veld]

populations of *V. seoanei* (Billing 1983; Bea et al. 1984) and *V. latifii* (Mertens et al. 1967).

case 1

Vipera raddei raddei

Young with dorsal pattern aberrations were born from perfectly normal parents. Some of them had a considerable part of their dorsal zigzag as a stripe (Fig. 6b). This was only present in the rostral part of the body. One specimen showed a different type of colour pattern anomaly. The zigzag was transformed into a narrow, slightly undulating, central stripe all along the body. The dark outline, which is normally in contact with the total zigzag or with the outer windings of it (Fig. 6a), now formed a double line of small interrupted longitudinal stripes (Fig. 6c).

case 2

Vipera lebetina schweizeri

Almost all captive-bred specimens of this subspecies seen by the author show an aberrant dorsal colour pattern. For example specimen JOR 93037 (Collection R. Jooris, Belgium) shows a

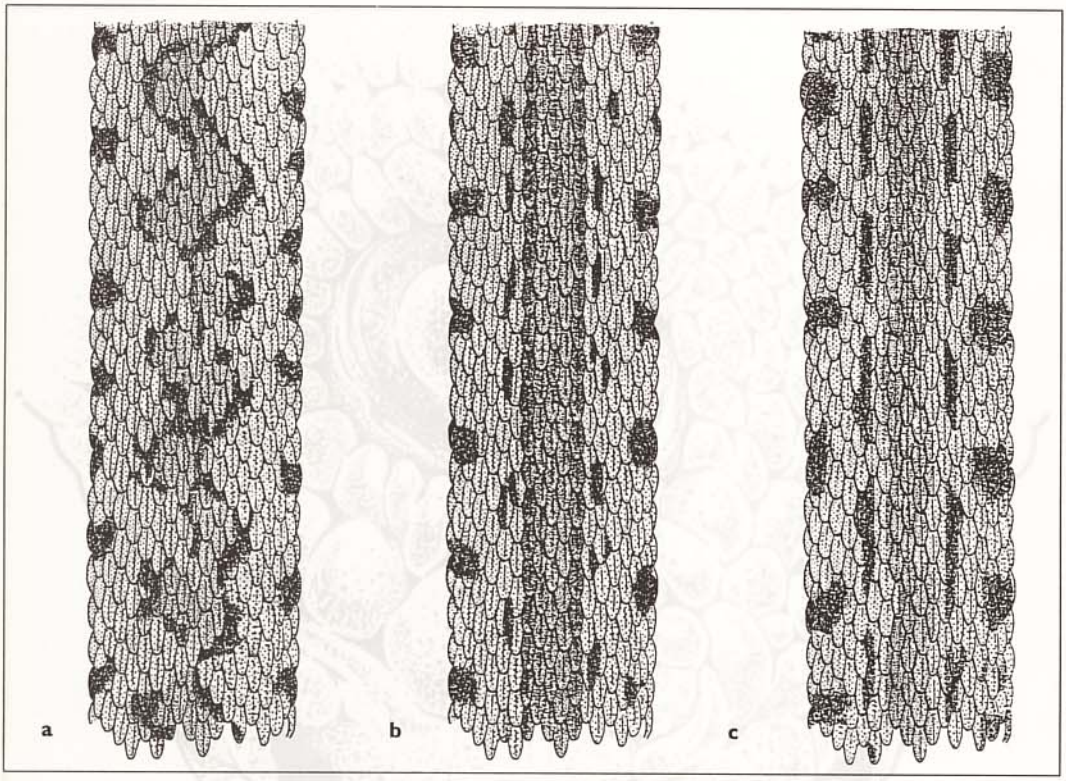


Figure 6 Dorsal colour pattern of captive-bred *Vipera raddei raddei*. **a** normal pattern (mid body). **b** striped pattern (rostral part). **c** striped pattern (mid body). [drawings: John Mulder]

very fine pattern of mainly longitudinal narrow stripes and this looks in no way like the regular pattern of a zigzag consisting of opposed or displaced blotches and smaller dorsolateral blotches (Fig. 7).

4.2 reduced or increased amount of blotches or angles in the zigzag The amount of blotches or angles in the dorsal zigzag of captive-bred snakes apparently is not always the same as that of their parents. However, so far no systematic survey of this phenomenon has been done by the author.

5 colour

The colour of snakes can be very variable. For instance in one population of snakes (in this case vipers) animals are to be found with darker or lighter brownish, greyish or reddish colours and all kinds of intergrades. Also black (melanistic) specimens are found on a regular basis in some (sub)species or populations. Apart from these polymorphic phenotypes real congenital aberrations occur occasionally.

5.1 albinism Albinism, viz. the total absence of all dark pigments, is known from many snake species, but is quite rare in vipers. An acquaintance of the author, Mr. Vanderhaeghe, was surprised to find one albinistic specimen in a clutch of *Vipera aspis aspis*. During the breeding season of 1994 two juveniles from one clutch of *Vipera aspis fransisciredi* of a Dutch private breeder (pers. comm.) were albinistic too. In both cases the specimens were of a light orange coloration, not showing any brown or black, and had red eyes. This can also be called amelanism as only the occurrence of melanin is inhibited.

5.2 'lightness' Captive-bred *Vipera lebetina schweizeri* (nowadays also known as *Macrovipera schweizeri*) are not common, but the author's specimens and all the specimens seen in other collections had a strange light whitish colour, not presenting the total range of colours known for this subspecies in the wild. The specimen mentioned in the 'striped pattern' paragraph also had this aberration.

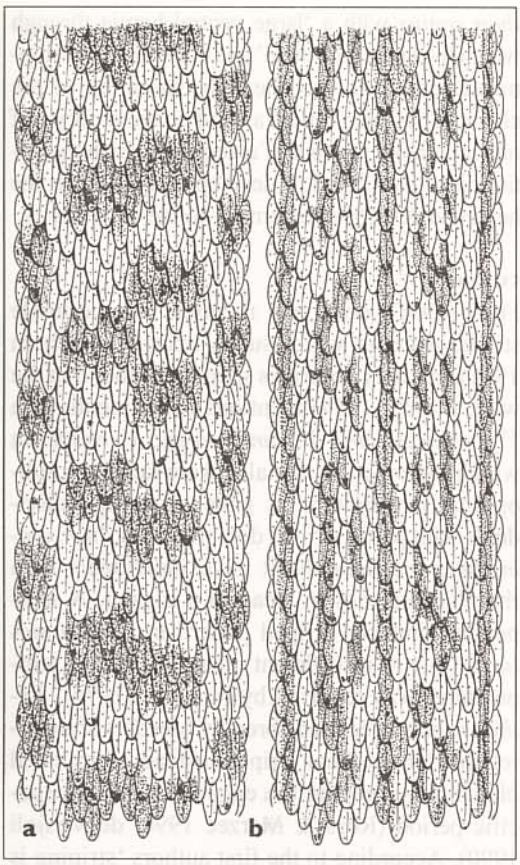


Figure 7 Dorsal colour pattern of *Vipera lebetina schweizeri*. **a** normal colour pattern. **b** striped colour pattern of a captive-bred animal (JOR 93037, Collection R. Jooris, Belgium). [drawings: John Mulder]. (Figs. 1-5 & 7b drawn after specimens preserved in alcohol 70 %; figs. 6abc & 7a drawn after live animals)

2.3 'missing a colour fraction' *Vipera kaznakovi* is a colourful species. In nature its ground colour can consist of all kinds of yellow, orange or red. The pattern is brown in juveniles and darkens until black with advancing age or growth. Captive-bred specimens often do not show this yellow or orange ground colour, having only some beige or whitish colour instead (pers. obs.; Brodmann 1987; other breeders, pers. comm.).

DISCUSSION

morphology

It could be asked whether the described anomalies are heritable or just phenotypical. In the last case, it will be interesting to determine the causes of these phenotypical anomalies. The conditions of the artificial environment for captive breeding could be the cause of many of these anomalies. Also, inbreeding is mentioned as a reason for developmental aberrations. It must be said that inbreeding is almost unavoidable in captivity.

Several authors mention environmental stress (epigenetic influences) during embryonic development as causing teratological anomalies. Wrong temperature, dessication, fungal attack of eggs, and X-rays are mentioned. Insecticides (e.g. against the common blood sucking mites) must also be suspected. Ross & Marzec (1990) speak of 'windows' of risk in embryonic development, but they also consider birth defects to occur spontaneously sometimes.

In the case of spinal anomalies the following remarks can be made. Experiments of Vinegar (1974) and Naulleau (1983) showed temperature induced multiple kyphoscoliosis, in *Python molurus* and *Vipera aspis* respectively, due to insufficient or extreme high mean temperatures during incubation or gestation. Eggs of a *Python molurus bivittatus* that were exposed to 6 hours of 96°F (=35.5°C) developed multiple spinal deformities (Ross & Marzec 1990). In another case a *Python regius* exposed to excessive temperature during incubation gave birth to a specimen with the following characters: absence of the eye, defect of the maxilla and multiple spinal anomalies. It died shortly after birth. X-rays to confirm pregnancy are under suspicion for causing multiple spinal defects (Ross & Marzec 1990).

The author's female *Vipera raddei raddei* which gave birth to a clutch of newborns with kyphoscoliosis gave birth to perfectly healthy offspring in the years before under comparable conditions, she never gave birth again after it.

Taillessness in reptiles is a very rare deformation. Mathur & Goel (1974) reported a tailless embryo of a lizard and Frye (1991) reported seven hatchlings of a desert tortoise that were affected with multiple developmental defects including taillessness. Hiller (1990) presented a captive-bred European pond tortoise *Emys orbicularis* with multiple anomalies. One of these was brachycaudia, a shortening of the tail to the extreme. This author could not even tell whether or not this specimen had a cloacal opening. Trutnau (1994)

mentions tailless crocodiles caused by temperature fluctuations during embryonic development. A picture of an eyeless *Vipera ammodytes* was published by Biella (1983). No details can be seen on the picture, neither can information be found in the text. This was probably a bilateral eyeless specimen as nothing was said about unilaterality. A unilateral anophthalmic (eyeless) *Elaphe longissima* was mentioned by Heimes (1994). In this animal the external part of the orbit was covered by some big scales. Eyelessness can be genetically linked as was the case in a breeding colony of *Pituophis melanoleucus* (Frye 1991).

Chiszar et al. (1983) mention a congenital alingual *Vipera russelli*, which could eat on its own, albeit with some problems. A clutch of *Liasis boa* incubated by a herpetologist at 82-84°F instead of the normal 90°F produced young with congenital tonguelessness as well as lethal esophageal defects (Ross & Marzec 1990).

Cyclopic snakes, and reptiles in general, are very rarely reported. Benick (1933) recorded a juvenile *Natrix natrix* which died just before hatching. Instead of one centrally placed eye it had two centrally placed and conjoining eyes. Other head characters also were aberrant, e.g. shortened upper jaw, reduced amount of head scales and no external nostrils. This is a case of 'arhinencephaly' according to In den Bosch & Musters (1987). These authors also extensively describe the first (and maybe only) case of real cyclopia perfecta in snakes. This specimen of *Natrix maura* had its eye under a proboscis-like nose, which resulted in a really monstruous rostral morphology. Matz (1994) shows a frontal close up picture of the head of a *Vipera xanthina* showing more or less the same characteristics as the author's specimen of *V. wagneri*, viz. a medially placed eye (larger than normal and than in the author's case), shortened upper mandible and abnormal head scale organization. In this case 'clefts' in the upper mandible are not present. The cyclopic *V. wagneri* in the present study was part of a clutch of 7 (1 normal animal and 5 unfertilized eggs). The mother had been under very hot conditions (extremely hot summer of 1994) but this was only at the very end of the gestation period.

Ross & Marzec (1990) report a schistosomic *Python regius* with a 'large ventral hernia through which the heart protruded' and call this a 'developmental error'. It was the only specimen of the clutch. They also report a dead snake embryo of one month old (cut out of an egg) in which the entire distal half failed to develop and in which the heart had developed externally to the body cavity.

colour

Frye (1991) does not mention non-heritable striped patterns, which surely exist (McEachern 1991), but only describes specimens found in the wild. Flärdh (1984) mentions experiments with *Vipera aspis atra*, *V. xanthina* and *V. raddei* in which the pregnant females were kept in a suboptimal temperature. It gave offspring individuals with partly striped dorsal pattern. In *V. ammodytes meridionalis* it gave individuals with rhombic blotches in stead of a zigzag. A temperature-induced striped pattern in *Python molurus* (due to insufficient mean incubation temperature) was reported by Vinegar (1974). *Python regius* specimens bred by breeders show irregular longitudinal stripes instead of rounded blotches by keeping the eggs too cold in a specific period (Ross & Marzec 1990; de Vosjoli 1990). According to the first authors 'striping is a common minor birth defect that may be caused by exposing the gravid female to suboptimal temperatures'. 'Occasionally more severe birth defects are associated with striping' and 'Reports of striping in boids exist in which the temperature was slightly above the recommended gestation temperature'. Most embryos of a temporarily desiccated clutch of eggs of an *Elaphe guttata* died, but three of the eggs hatched. The newborns showed longitudinally very narrow blotches (McEachern 1991). Nothing is said about their number of blotches. From another clutch of *Elaphe guttata* the eggs suffered fungal attack soon after being laid. Two juveniles showed irregular longitudinal stripes, a third one was badly deformed and failed to survive (McEachern 1991). The irregular longitudinal stripes were different from the known heritable regular stripes which occur in breeding collections.

Schweizer (1932 & 1935) writes about captive-born *Vipera lebetina schweizeri*. Most of the specimens had aberrations in their colour pattern and were of a light colour too. In 1932 he still

thought it was some kind of juvenile colour but one of the animals reached a length of 420 mm in two years and still had this aberrant colour pattern. Until that time the author had seen almost 100 specimens in the wild, most of them of this length category, and had never seen a colour pattern like this. While the incubation temperature could be a reason for the colour aberrations in *V. lebetina schweizeri*, it is not sure whether the temperature used is too high or too low. Most breeders use temperatures normal for related (sub)species (ca. 28-30°C).

Albinism is a heritable aberration which occurs with a regular frequency. The missing of the yellow or orange ground colour in captive-bred *Vipera kaznakovi* could be due to a lack of carotene in the food. In this case experiments with carotene or canthaxantin in their food or drinking-water should give good results.

CONCLUSIONS

A Both morphological anomalies and those concerning colour and colour pattern occur regularly in captive-bred vipers.

B Although some anomalies can be heritable, a wrong incubation temperature in a certain stage of development seems to be the main cause of some anomalies, as experiments proved temperature induced individuals with kyphoscoliosis, striped pattern aberrations and other anomalies.

C Other environmental stresses like desiccation, fungal infection and X-rays probably also cause developmental defects. Certain sensitive periods in the beginning of the embryonic development ('windows of risk') seem to occur, but these are hard to prove without extensive research.

D Very little is known from animals born in the wild, except some colour aberrations like albinism and striped colour pattern, which are probably heritable mutations.

E For successful breeding with, and thus proper care for, reptiles it is important to keep the environmental temperature of gravid animals within reasonable normal values or to give them the possibility to choose the right temperature. Eggs (which can not choose for themselves) are to be kept in appropriate temperatures and relative humidities normal for the (sub)species and in accordance with their ecological needs.

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REFERENCES

Bea, A., S. Bas, F. Braña & H. Saint Girons, 1984 - Morphologie comparée et répartition de *Vipera seoanei Lataste*, 1879, en Espagne - Amphibia-Reptilia 5: 395-410.

Benick, L., 1933 - Über unsere Ringelnatter, *Tropidonotus n. natrix* L. - Zool. Anz. 101: 294-299.

Biella, H.-J., 1983 - Die Sandotter *Vipera ammodytes* - Die Neue Brehm-Bücherei 558. A. Ziemsen Verlag, Wittenberg Lutherstadt.

Billing, H., 1983 - Polymorphismus bei *Vipera berus seoanei* -herpetofauna 5(24): 31-33.

Bosch, H.A.J. in den & C.J.M. Musters, 1987 - Scalation and Skull Morphology of a Cyclopian *Natrix maura* - Journal of Herpetology 21(2): 107-114.

Brodmann, P., 1987 - Die Giftschlangen Europas und die Gattung *Vipera* in Afrika und Asien - Kümmerly & Frey, Bern.

Chiszar, D. et al., 1983 - Predatory Behavior in a Congenitally Alingual Russell's Viper (*Vipera russelli*). 2. Trail-Following Behavior - Bull. Maryland Herp. Soc. 19(1): 15-23.

Flärdh, B., 1984 - Ovanlig färgteckning hos huggormen *Vipera b. berus* (Linnaeus) - Fauna och Flora 79(2): 66-68.

Frye, F.L., 1991 - Reptile Care. An Atlas of Diseases and Treatments. Vol. II. - T.F.H. Publications, New Jersey.

Heimes, P., 1994 - Morphologische Anomalien bei Äskulapnattern (*Elaphe longissima*) im Rheingau-Taunus - Salamandra 30(4): 268-271.

Hiller, A., 1990 - Eine Europäische Sumpfschildkröte *Emys orbicularis* (Linnaeus, 1758) mit angeborener letaler Mißbildung - Salamandra 26(2/3): 215-217.

Mathur, J.K. & S.C. Goel, 1974 - A Note on a Tailless Embryo of the Lizard *Calotes versicolor* - Brit. Journ. Herpetol. 5(2): 420-422.

Matz, G., 1994 - Teratology. In: Bauchot,R.(Ed.) - Snakes. A Natural History - Sterling Publishing Co., Inc. New York.

McEachern, M.J., 1991 - A Color Guide to Corn Snakes Captive-Bred in the United States - Advanced Vivarium Systems, Lakeside, California.

Mertens, R., I.S. Darevsky & K. Klemmer, 1967 - *Vipera latifii*, eine neue Giftschlange aus dem Iran - Senck. biol. 48(3): 161-168.

Naulleau, G., 1983 - Tératologie chez *Natrix natrix* et *Vipera aspis* - C.R. 1er Coll. Intern. Pathologie Reptiles et Amphibiens, Angers: 245-249.

Ross, R.A. & G. Marzec, 1990 - The Reproductive Husbandry of Pythons and Boas - Institute for Herpetological Research, Stanford, California - Garner Printing, Inc. Des Moines, Iowa.

Schweizer, H., 1932 - Über *Vipera lebetina lebetina* und *Natrix natrix schweizeri* der Zykladeninsel Milos - Blätter für Aquarien- und Terrarienkunde 1932: 358-364.

Schweizer, H., 1935 - Beitrag zur Reptilienfauna der Inselgruppe v. Milos (Cycl.) - Blätter für Aquarien- und Terrarienkunde 1935: 8-15.

Trutnau, L., 1994 - Terraristik - Eugen Ulmer GmbH & Co., Stuttgart.

Vinegar, A., 1974 - Evolutionary Implications of Temperature Induced Anomalies of Development in Snake Embryos - Herpetologica 30: 72-74.

Vosjoli, P. de, 1990 - The General Care and Maintenance of Ball Pythons - Advanced Vivarium Systems.

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