SHORT COMMUNICATIONS

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A CASE OF BLUE COLORATION AND COLOR CHANGE IN *Pelophylax esculentus* (LINNAEUS, 1758) (ANURA: RANIDAE) IN DENMARK

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One blue female *Pelophylax esculentus* was recorded in the outskirts of Copenhagen, Denmark, in August 2017. Minor green areas persisted. After capture and subsequent handling its base coloration darkened from what was first observed. No other individuals with blue coloration were found. Blue coloration is an anomaly due to lack of or reduction of xanthophores. This is a first record of truly blue-colored *P. esculentus* in North Europe though two cases from Central Europe are known. Within the genus *Pelophylax* blue individuals have been reported in various species at irregular intervals. The darkening agent α-melanocyte stimulating hormone (α-MSH) may well have been the reason why this individual turned darker after handling.

Keywords: *Pelophylax esculentus*; blue color; anomaly; darkening; stress; Amager, Copenhagen, Denmark.

In most of its range *Pelophylax esculentus* reproduces hemiclonally with one of its parental species, *P. lessonae* or *P. ridibundus*, but viable populations of diploid and triploid hybrids in which no individuals of the parental species have been found, exist in the northern part of the range including Denmark though *P. ridibundus* also occurs on the remote Danish islands Bornholm and Christiansø in the Baltic Sea (Christiansen et al., 2005). A similar situation with absence of both parental species exists in adjacent parts of southern Sweden and apparently in northern Germany and they may be the only regions inhabited by true all-hybrid populations without parental-species genotypes ever found, according to Christiansen et al. (2005) though other all-hybrid populations have been reported. Lada et al. (1995) also recorded that condition in populations west of Belgorod in Central Chernozem Region, western Russia. Hence it is generally considered a klepton, i.e., *Pelophylax* kl. *esculentus*, but in much of Denmark and in adjacent countries it may be considered a full species, *P. esculentus*. Here it is easily identified by morphological means because it is the only member of the genus present.

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At daytime on 20 and 21 August 2017 one blue female *P. esculentus* (SVL 61 mm) was detected and photographed in the eastern outskirts of Copenhagen, Denmark. The locality was a big pond with a surface of approx. 650 × 150 m on the island of Amager, more specifically in the area Amager Fælled (55.6504° N 12.5849° E, 2 m elev.). During the past week other observers had also watched and photographed that particular individual. In no other individuals at that locality blue or bluish coloration was seen by any of us, neither this year or previously.

Most of the normal green coloration on the dorsal and lateral sides had been replaced with bright blue coloration. The blue patches predominated the anterior and lateral surfaces though the snout was green. The left side of the body had larger blue areas than the right. The dorsolateral folds were as in other individuals in that population, i.e., brown on the top and black in the lower parts. The upper parts had black spots, some with brownish shade. That coloration also applied to the mask behind the eye (Figs. 1 and 2). The throat and belly were whitish to cream-colored with brown to black spots as in other individuals.

Fig. 1. The blue *Pelophylax esculentus* photographed *in situ* with dorsal and left side exposed.

Fig. 2. The blue *Pelophylax esculentus* photographed *in situ* with dorsal and right side exposed.

The frog was captured, measured, photographed and then released. Figure 3 was taken approx. 10 min after the capture. Over the course of handling its base coloration darkened from what was first observed and photographed. The darkening was especially conspicuous on the dorsal sides, including those of the hind legs, whereas the lateral color change proved insignificant. The dark brown to black spots on the upper sides including the hind legs and feet turned to a great extent blackish blue.

Blue coloration is an anomaly due to lack of or reduction of xanthophores or yellow pigments in green individuals (Henle et al., 2017). This phenomenon occurs sporadically and reasonably seldom in *P. esculentus* and other members of the genus throughout their geographical ranges in the Palearctic.

This is a first record of truly blue-colored *P. esculentus* in North Europe. Due to the difficulty to identify

Fig. 3. The blue *Pelophylax esculentus* has been captured and is held in a hand for approx. 10 min. Notice that the blue and green colorations on the upper sides including those of the hind legs have turned darker blue and darker green.

P. esculentus in Central Europe where it coexists with its parental species, apparently only two cases of blue individuals of *P. esculentus* are known in that region. In the department Cher, Central France, several blue *P. esculentus* were recorded (Bogaerts, 2003). Near Braunsweig in Lower Saxony, Germany, one blue individual was photographed by (Henle et al., 2017; Miralles, personal communication, 2017). It is highly likely that it belonged to *P. esculentus* because *P. lessonae* and *P. ridibundus* are very rare and restricted to specific habitats in the Braunsweig area (Vences, personal communication, 2017).

In the Kaliningrad Oblast on the coast of the Baltic Sea, Russia, green individuals of *P. esculentus* and *P. lessonae* with a bluish tint were reported by Litvinchuk et al. (2015).

One individual of *P. ridibundus* (SVL 73 mm) whose head and anterior part of the body was bright blue was found in Kiev, Ukraine (Nekrasova, 2002, 2014). The colors did not change during more than half a year in captivity. Nekrasova (2014) reported that one bright blue and one turquoise *P. lessonae* were recorded in the Ukrainian river Uday. Turquoise green individuals of *P. esculentus* were regularly observed in the Kiev region. Furthermore individuals with varying degree of blue coloration were reported among all three genotypes of an R-E-L population system. It is speculated that chemical compounds and agents causing water pollution might have evoked changes in the chromatophores.

In Central Europe reports of individuals of uncertain taxa with varying degrees of blue coloration have been found. In Germany where *P. esculentus*, *P. lessonae*, and

P. ridibundus are well-known, such records of blue or bluish *Pelophylax* spp. have been made in the federal states of North Rhine-Westphalia, Baden-Württemberg and Bavaria (Douglass, 1891; Fischer, 1923; Vogt, 1981; Hachtel and Schäfer, 1997; Sowig et al., 2007; Schmidt and Hachtel, 2011). In the Netherlands where *P. esculentus* and *P. lessonae* are common, unidentified blue or bluish individuals, i.e., *Pelophylax* spp., have been observed in the provinces of Friesland, Groningen, North Brabant, and Limburg (Anonim, 1950, 1951; Hermans, 1951; Hofstra, 1997). In a small population of *P. perezi* in the province of Huelva, Southwest Spain, several bright turquoise blue individuals of a small population were mentioned by González de la Vega (1994). Two individuals of *P. perezi* with extensive and bright blue coloration were recorded near Barcelona, Northeast Spain, by Martínez-Silvestre et al. (2016). In one of them a little green coloration was visible on the hind legs. From the Beijing region of northeastern China Liu (1931) described seven blue *P. plancyi* of less than two year age and one partly blue *P. nigromaculatus*.

My observation of the blue *P. esculentus* turning darker after being handled was echoed by Hofstra (1997) as handling of several blue individuals of *Pelophylax* sp. recorded in Friesland, the northern Netherlands, caused obvious darkening or turning even nearly black. In *Dryophytes cinereus* (= *Hyla cinerea*) it has been observed that stress causes changes in the chromotophores as the frogs turn darker because melanosomes are dispersed (Nielsen, 1978). Isoldi et al. (2010) have described the response of dermal melanophores to the darkening agent α-melanocyte stimulating hormone (α-MSH) in *Xenopus laevis*. In amphibians, the hormone is a potent skin darkening agent, dispersing melanin granules (melanosomes) throughout the cytoplasm of dermal melanophores. I consider that α-MSH might have been responsible for the blue *P. esculentus* in Denmark turning dark after handling.

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