

Pool frog (*Pelophylax lessonae*) CAMERANO 1882 (Anura, Ranidae), an addition to the Finnish amphibian fauna

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A population of pool frogs (*Pelophylax lessonae*) has been discovered in the municipality of Kaarina, southwestern Finland. The species had not previously been recorded from Finland. The frogs show the external characteristics of the northern clade of the species, which suggests that they are of different origin than the allochthonous edible frogs (*Pelophylax* kl. *esculentus*) that are also present in southwestern Finland.

Introduction

In the northern and central parts of Europe, the green frog complex consists of two species: the marsh frog (*Pelophylax ridibundus*) and the pool frog (*P. lessonae*), as well as the hybrid between these two species, the edible frog (*P. kl. esculentus*). The hybrids reproduce by means of hybridogenesis, in which one parental genome is completely discarded during gametogenesis, and only one parental set of uncombined chromosomes is transmitted to the next generation. The hybridogenetic system enables hybrids to reproduce in the presence of either one of the parental species (Berger 1973, Beebee 1996, Pough et al. 1998, Arnold & Ovenden 2002, Raggihianti et al. 2007). In some populations of *P. kl. esculentus* triploid individuals are found, which enables reproduction without either of the parental species (Günther 1975, Rybacki & Fog 1995, Christiansen et al. 2005, Kierzkowski et al. 2011). Such

is the case in Denmark and southernmost Sweden, where *P. kl. esculentus* is common but neither of the parental species is present (Gasc et al. 1997, Fog et al. 2001, Christiansen et al. 2005). *Ridibundus* – *esculentus* -systems, in which *P. kl. esculentus* reproduces with *P. ridibundus*, are known from Germany, the Baltic coast of Poland and the island of Bornholm, Denmark (Rybacki & Fog 1995, Fog et al. 2001, Mayer et al. 2013). More common, however, is the *lessonae* – *esculentus* -system, in which *P. kl. esculentus* coexists and reproduces with *P. lessonae* (Beebee 1996). The distributions of *P. kl. esculentus* and *P. lessonae* overlap in most parts of Europe, and their common distribution extends from France and Italy to Estonia and the European parts of Russia (Gasc et al. 1997).

As a rule *P. lessonae* is sympatric with *P. kl. esculentus*, but the isolated Scandinavian populations of *P. lessonae* are an exception. In Scandinavia *P. lessonae* is only known from about

60 locations within a restricted area at the Baltic coast of Uppland, central-Sweden (Sjögren 1991, Edenhalm & Sjögren-Gulve 2000, Nilsson 2013) and one location in Aust-Agder, southern Norway (Dolmen 1997, Direktoratet for naturforvaltning 2006). These populations are postglacial relicts, and totally isolated from the common distribution of the species complex (Edenhalm & Sjögren-Gulve 2000, Snell et al. 2005, Nilsson 2013). *P. lessonae* is red-listed as vulnerable (VU) in Sweden (Nilsson 2013) and critically endangered (CR) in Norway (Direktoratet for naturforvaltning 2006). The Scandinavian populations are, together with the now extinct native population of East-Anglia, Great Britain, referred to as the northern clade of *P. lessonae*, which differs morphologically and genetically from the mainland populations (Zeisset & Beebee 2001, Buckley & Foster 2005, Snell et al. 2005). In contrast to the continental populations of the species, where both males and females are usually bright green or grass green (Fig. 1), frogs of the northern clade are brown, with just a little olive green coloration on the head and flanks and a light green, white or yellow dorsal stripe. They also differ from the continental populations in terms of a pronounced

sexual colour dimorphism. The northern males are golden brown; while the dorsal colour of the female is nearly black (Sjögren 1991, Fog et al. 2001).

In Finland green frogs are not known to occur naturally. *P. ridibundus* has been found in the estuaries of the rivers Vantaa and Porvoo in the 1930's – 1950's, but these populations had become extinct by the 1960's (Suomalainen 1941, Terhivuo 1993). The next observation of green frogs in Finland was made on the island of Ruisalo in Turku in 2008. By 2012 green frogs had been reported from about 50 locations around the Turku region. The species was initially identified as *P. ridibundus* from a recorded sound sample in 2008, but subsequently all captured and examined individuals have been identified as *P. kl. esculentus*. The presence of *P. ridibundus* in Finland is uncertain (T. Hoogesteger, J. Rahkonen & A. Karhilahti, unpubl.). In June 2013 a population of *P. lessonae* was discovered in the municipality of Kaarina, southwestern Finland. This species has not been reported from Finland before. Although this population has apparently been known since 2009, it has previously not been identified as *P. lessonae*.



Fig. 1. *Pelophylax lessonae*, adults from a continental population. Estonia. 10.5.2008. Photo: Tom Hoogesteger.

Material and results

On 12th June 2013 nine adult individuals of *P. lessonae* were encountered in a pond in Kaarina, southwestern Finland (670:324, Grid 27°E). The pond is about 50 meters in diameter, shallow, eutrophic and sun-exposed. The area is close to human habitation, but the pond itself is associated with open meadow and woodland habitat. The frogs were very different in appearance from the *P. kl. esculentus* known from the Turku region (Fig. 2). The males were golden brown with just a little olive green coloration on the head and flanks. The females had additional dark markings on the sides of the head and flanks, and a very dark, almost black, dorsal coloration. Both sexes had a pale dorsal stripe. The frogs were very agile and difficult to approach. One female and one male were photographed *in situ* (Fig. 3), and three individuals, all adult males, were captured for identification. During a second visit to the site on 21st August 2013 only one individual, an adult female, was seen.

The frogs showed the diagnostic morphological characteristics that separate *P. lessonae* from the related *P. ridibundus* and *P. kl. esculentus* (Ar-

nold & Ovenden 2002, Fog et al. 2001). The observed frogs were smaller than the adult *P. kl. esculentus* known from southwestern Finland; the snout-vent length of the largest measured individual was 5.9 cm. The heel of the hind leg extended no further than the eye, when bent forwards. The hind parts of the femur had black and orange markings. The ventral sides were white with dark grey spots. The metatarsal tubercles (*callus internus*) of the captured frogs were larger than half the length of the first toe of the hind leg (*digitus primus*) and had a symmetrical, semicircular shape, which is characteristic of *P. lessonae* (Fog et al. 2001, Arnold & Ovenden 2002) The vocal sacs of the males were white (Fig. 4).

In most cases *P. lessonae* can be reliably separated from the related *P. ridibundus* and *P. kl. esculentus* by the size and form of *callus internus*, and by the length ratios of *tibia/callus internus* and *digitus primus/callus internus*. The *tibia/callus internus* ratios of the captured frogs were 4.92, 5.94 and 5.93, and the *digitus primus/callus internus* ratios were 1.44, 1.88 and 1.90 (Table 1), which are within the normal range of *P. lessonae* (Fog et al. 2001, Krizmanić 2008, Kierzkowski et al. 2011, Mayer et al. 2013) (Table 2). These val-

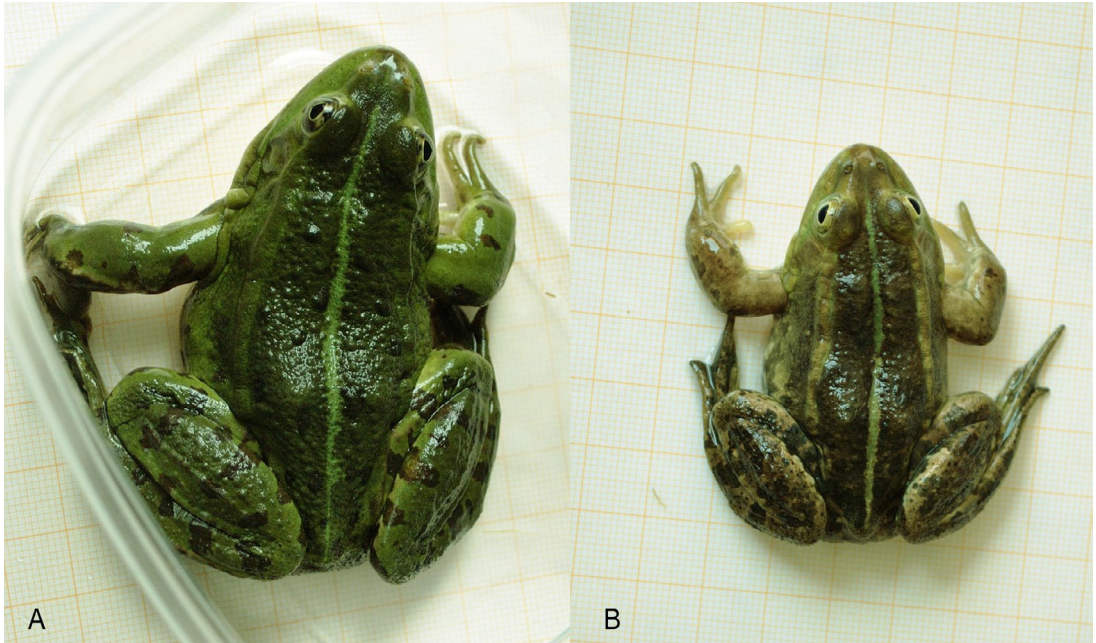


Fig. 2. A: *Pelophylax kl. esculentus*, adult male from Rusko, southwestern Finland. B: *Pelophylax lessonae*, adult male from Kaarina, southwestern Finland. Photos: Tom Hoogesteger.



Fig. 3.
A: *Pelophylax lessonae*, female. Kaarina, southwestern Finland. 12.6.2013.

B: *Pelophylax lessonae*, male. Kaarina, southwestern Finland. 12.6.2013.
Photos: Joel Rahkonen.



Fig. 4.
A: The hind foot of a male *Pelophylax lessonae* from Kaarina, southwestern Finland. *Callus internus* (C. i.) has the shape of a symmetrical semicircle.

B: Adult male *Pelophylax lessonae* from Kaarina, southwestern Finland, with air-filled vocal sacs.
Photos: Tom Hoogesteger.

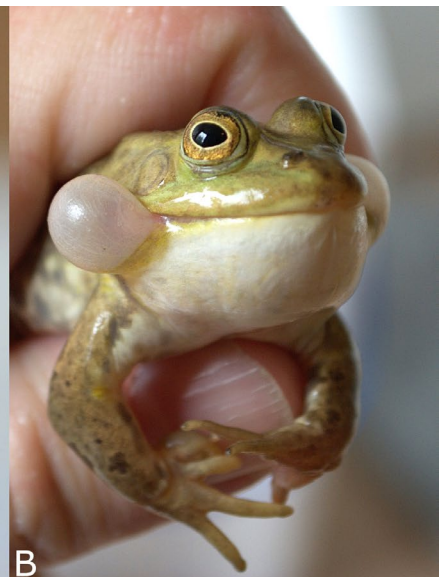


Table 1. Morphological characteristics and morphometrical indices for three adult *Pelophylax lessonae* from Kaarina, southwestern Finland. SVL = snout-vent length (mm), C. i. = *callus internus* length (mm), Tibia = tibia length (mm) and D. p. = *digitus primus* length (mm).

Individual	Sex	SVL	C. i.	Tibia	D. p.	Tibia / C. i.	D. p. / C. i.
No. 1	male	59,09	5,21	25,61	7,50	4,92	1,44
No. 2	male	58,16	4,36	25,91	8,19	5,94	1,88
No. 3	male	54,96	4,10	24,32	7,77	5,93	1,90

Table 2. Ranges of variation of two main morphometrical indices among three green frog taxa sampled in Poland (Kierzkowski et al. 2011) and Serbia (Krizmanić 2008).

Taxon	Source	Tibia / C. i.	D. p. / C. i.
<i>P. lessonae</i>	Poland	5,0–7,7	1,4–2,1
	Serbia	4,3–7,7	1,2–1,9
<i>P. kl. esculentus</i>	Poland	5,9–9,7	1,6–2,8
	Serbia	6,4–11,8	1,6–3,0
<i>P. ridibundus</i>	Poland	8,6–14,4	2,4–3,7
	Serbia	7,6–15,7	2,1–3,8

ues do not overlap with the observed values for *P. kl. esculentus* in Finland (*tibia/callus internus*: range = 6.62–9.37, n = 12; *digitus primus/callus internus*: range = 1.92–2.72, n = 12). The behaviour of the frogs was typical of *P. lessonae*. The frogs stayed in shallow water near the shoreline of the pond, whereas *P. ridibundus* and *P. kl. esculentus* are frequently encountered in the deeper parts of water bodies (Fog et al. 2001, Arnold & Ovenden 2002). The *P. lessonae* were not observed calling on 12th June 2013, while *P. kl. esculentus* were actively calling at nearby locations at this time.

Discussion

The examined frogs show the external characteristics of the northern clade of *P. lessonae*, remaining populations of which were known only from Uppland, Sweden and Aust-Agder, Norway.

The Swedish metapopulation is only about 200 kilometers away from the now discovered population and at exactly the same latitude (60°N) (Gasc et al. 1997, Nilsson 2013). This part of the Baltic Sea has a continuum of islands between Sweden and Finland, with a maximum

of about 10 kilometers of open sea between islands. As *P. lessonae* tolerates brackish water and has been found even on small islets in the outer archipelago of coastal Uppland (Edenhamn & Sjögren-Gulve 2000, Nilsson 2013), the species could possibly have colonized southwestern Finland naturally from Sweden. If this is the case, it might be expected on the Åland islands and the Turku archipelago. Alternatively, the population could be a result of introduction. Nor can it be ruled out for certain that there could be a native, relict population of *P. lessonae* in Finland. Phylogeographic studies have suggested an eastern postglacial colonization route of the species to Scandinavia (Snell et al. 2005), which makes it highly likely that the species has occurred in Finland after the last ice age. The northern clade *P. lessonae* resemble the Finnish brown frogs (*Rana temporaria* and *R. arvalis*) in appearance so much that a non-expert could hardly tell the difference. *P. lessonae* also has a more terrestrial and secretive lifestyle and is less noisy than the other green frogs (Edenhamn & Sjögren-Gulve 2000, Fog et al 2001, Arnold & Ovenden 2002, Buckley & Foster 2005). This could have enabled a population to remain unnoticed for a long time, which is demonstrated by the fact that the Norwegian

native population was only discovered as late as 1986 (Dolmen 1997, Direktoratet for naturforvaltning 2006).

The *Pelophylax* kl. *esculentus* found in southwestern Finland could be the result of allochthonous *P. ridibundus* hybridizing with the native or Swedish origin *P. lessonae*, but this appears unlikely. The very green coloration of the *P. kl. esculentus* found in the Turku region suggests that their *lessonae*-haplotype is of continental rather than Nordic origin. The fact that neither of the parental species has been found together with *P. kl. esculentus* and the remarkable speed of colonization of new water bodies by these frogs suggests that southwestern Finland has been invaded by independently reproducing *P. kl. esculentus*. Also the range of variation in morphology of these frogs indicates the possible presence of triploid individuals (Fog et al. 2001, Kierzkowski et al. 2011), but this needs further investigation. A *ridibundus* – *esculentus* -system is an alternative possibility, although the presence of *P. ridibundus* in southwestern Finland has not been confirmed. Either way these frogs are undoubtedly of alien origin, as they could hardly have colonized Finland naturally from the southern parts of the Baltic Sea.

No other green frogs have been identified at the exact location where the *P. lessonae* were found, but the nearest known colony of *P. kl. esculentus* is only a few kilometers away. It is not known if other populations of *P. lessonae* exist in Finland and if hybridization with *P. kl. esculentus* has occurred. *P. lessonae* is listed on Annex IV of the EU Habitats and Species Directive as a species in need of strict protection (EEC 1992). Moreover, the Finnish *P. lessonae* seemingly belong to the unique northern clade, all known populations of which are endangered (Edenhamn & Sjögren-Gulve 2000, Direktoratet for naturforvaltning 2006, Nilsson 2013), and it might therefore be of especially high conservation value. The species requires special attention in Finland and should definitely not be considered an alien species without further investigation. The extent of distribution of the species in Finland and possible occurrence on the Åland islands and in the Turku archipelago must be examined more closely, and genetic analyses of the origin of the Finnish *P. lessonae* are needed before the population

is transformed by hybridization with the increasingly abundant *P. kl. esculentus*.

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