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Trunk climbing among ground-dwelling European amphibians – first observation from Poland

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Abstract: Most European amphibian species are considered land-dwelling, associated with moving along the ground and as poor climbers. However, more recent research indicates that non-arboreal amphibians use nesting boxes and tree hollows in Central and Western Europe. This study describes the first observation of tree climbing by the common toad *Bufo bufo* (Linnaeus, 1758) and common frog *Rana temporaria* Linnaeus, 1758 in Poland. While conducting a night survey of newt mortality in the ‘Traszkowski Ratajskie’ protected area in an urban park in the city of Poznań, Poland, we detected the unexpected use of trees by two species of amphibians. In June 2020, we observed cases of *Bufo bufo* and *Rana temporaria* foraging on and using arboreal ambush sites. The toads were found at an average height of 124 cm above the ground, and the frogs at 35 cm, on the tree trunks and branches of two willows (*Salix* cfr. *alba* L.) and a dead silver birch specimen (*Betula pendula* L.). The willows had an extensive multi-stem structure, and exhibited signs of maturity and ageing (hollow-bearing trees with open cavities and crevices). This is the first observation of arboreal behaviour in *B. bufo* and *R. temporaria* in Poland. The climbing behaviour and use of tree sites were likely linked to the search for a humid shelter provided by the interior of the ageing trees, as well as to the foraging behaviour that we observed. Trees exhibiting signs of maturity usually have complex structures, and seem particularly important for amphibians during periods of drought, as both a suitable shelter and an area from which to ambush prey. We recommend focusing greater attention on the protection of mature, ageing trees, especially *Salix* spp. within a terrestrial buffer zone of at least 250 metres from ponds, as these are poorly researched components within amphibian habitats. This type of resource may be essential for long-term amphibian conservation due to site fidelity and the limited number of shelters in human-altered landscapes. The recently adopted EU Nature Restoration Law presents an opportunity to develop good practices in this area, particularly urban tree planting and habitat management.

Keywords: *Betula pendula*, *Bufo bufo*, *Rana temporaria*, *Salix* cfr. *alba*, urban area, ecosystem services

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Among the amphibian species in Europe, only tree frogs *Hyla* spp. Laurenti, 1768 are typically arboreal (Kirsch et al., 2021; Speybroeck et al., 2016). However, a few cases of climbing behaviour among

ground-dwelling amphibians have been observed, including the smooth newt *Lissotriton vulgaris* (Linnaeus, 1758) and great crested newt *Triturus cristatus* (Laurenti, 1768) in Denmark and England (Bringsøe, 2013; Lynn & Allain, 2022). A few cases of singular climbing behaviour of the common toad *Bufo bufo* (Linnaeus, 1758) were observed on an inflorescence of European goldenrod *Solidago virgaurea* L. or on branches of a young Norway spruce *Picea abies* (L.) H. Karst. (Bringsøe, 2016). The sheltering of toads in holes and tree forks in goat willow *Salix caprea* L. and common hazel *Corylus avellana* L. was observed in Germany (Krause et al., 2007). Moreover, a large-scale study was carried out in northern Spain, wherein 129 individuals of the Iberian spiny toad *Bufo spinosus* Daudin, 1803, 66 individuals of the common midwife toad *Alytes obstetricans* (Laurenti, 1768) and nine *Rana temporaria* Linnaeus, 1758 individuals were recorded (Gosa, 2003). Gosa (2003) also noted that numerous individuals utilised the tabular roots and low trunks of oak trees *Quercus* sp. of around a hundred years of age, and that those individuals repeatedly used the same trees. Recently, *B. bufo*, *R. temporaria*, *L. vulgaris* and *T. cristatus* occurrence in nest boxes, holes and tree cavities of eight tree species (especially *S. caprea*) was reported in Britain, but at a very low frequency (Petrovan et al., 2022).

Prior to the present study, the climbing habits of typically terrestrial, land-dwelling amphibians were

observed only in Central and Western Europe, and were rarely reported. This study describes the first observation of climbing behaviour by two anuran species in Poland.

During a survey of newt mortality on pedestrian and bike paths after dusk (at 22:00) on 28 June 2020, the surroundings of all the largest trees were carefully inspected using torches. The study was conducted in the 'Traszk Ratajskie' protected area within an urban park in the city of Poznań (W Poland; 52°23'32"N, 16°58'29"E). This is an isolated urban site of approximately 5 ha that was established to protect the amphibian population – mainly *L. vulgaris* and its breeding habitat. This area is covered with a scattered park stand not exceeding 40% canopy cover, consisting of native and foreign tree species. The remaining open areas include walking paths and extensively used flower meadows, partially mowed under environmental guidelines. The newt population breeds in two small water bodies that dry out periodically, and the tram embankment is the key terrestrial habitat and hibernation shelter for it (see Kaczmarski & Kaczmarek, 2016; Kaczmarek et al., 2018). Outside the protected area, the *B. bufo* population breeds in an old clay pit pond surrounded by a dense tree stand, 300 metres west of the newts' ponds.

We observed foraging and use of arboreal ambush sites by *B. bufo* and *R. temporaria*. Twelve *B. bufo* and



Fig. 1. Three adult *Bufo bufo* recorded on one of the *Salix* cfr. *alba* trunks

two *R. temporaria* were detected on the tree trunks and branches of willows *Salix* cfr. *alba* L. (Fig. 1) and on a dead standing trunk of silver birch *Betula pendula* L. Both willows were mature and ageing specimens – among the oldest trees in the study area – with many trunks (5 and 6, with an average diameter at breast height \pm sd of 168 ± 34 cm and 116 ± 17 cm, respectively) inclined at an angle, numerous crevices and a few tree cavities, and were partially decayed and moss-covered. The *B. bufo* individuals were found on these trees at a height of 40 to 220 cm above the ground (124 cm on average), while the *R. temporaria* were found at 30 to 40 cm (Table 1). We observed toads exhibiting hunting behaviour (ambushing, foraging) and directly eating insects, isopods and slugs, which had emerged en masse after heavy rain a few hours earlier. The toads did not try to escape despite our presence, and continued their activity. No amphibians were captured or disturbed, except by the torch illumination, due to the many threats present at the study site (small, isolated population in a limited area, within an intensively used city park under growing anthropic pressure). Despite a detailed check, we did not find toads on the other trees; this may be related to the different shapes of their trunks and other characteristics (slope, tree forks, open or hidden cavities and/or crevices, the presence of moss). During this field session, we did not detect any other adult toads within the terrestrial habitats in the protected area. However, we observed a group of foraging wild boars (*Sus scrofa* Linnaeus, 1758), comprising several adults with at least 20 piglets, as well as many square metres of fresh boar soil disturbance. To date, despite numerous surveys in this area, we have not been able to observe this type of

behaviour again. However, we did not undertake purposeful research on the described topic.

This is the first detection of group arboreal behaviour in *B. bufo* and *R. temporaria* detected simultaneously on just two *Salix* cfr. *alba* and one *B. pendula* (cf. Table 2). We assume that the observed arboreal behaviour described here was induced by weather factors such as heavy rain after drought periods, and the availability of moist shelters on partially deadwood branches and/or inside mature trees. The amphibians most likely left their hiding places to hydrate and feed on invertebrates, whose activity suddenly increased shortly after the rain. However, the factors that induced this behaviour are probably more complex (c.f. Bringsøe, 2016; Gosa, 2003; Petrovan et al., 2022). For example, the amphibians could also have been seeking refuge from the simultaneously observed wild boars (Jolley et al., 2010).

Bufo bufo inhabits forested areas with coniferous, deciduous and mixed woodland, especially in oak-hornbeam and other altered woodland habitats (urban areas, parks and rural gardens, and often in dry habitats well away from standing water). *Rana temporaria* prefers damp places near ponds and marshes or in long grass, but hibernates mainly in running waters or the mud at the bottom of ponds (Speybroeck et al., 2016). It should be emphasised that both species are large for an amphibian, a trait commonly associated with moving along the ground, and seem to have poor climbing abilities. This is typical for non-specialised, mostly ground-dwelling species (Vassallo et al., 2021). *Bufo bufo* females are larger than males, growing up to 15 cm in length and with a body mass of up to 160 g (versus 10 cm/40 g in males). In *R. temporaria*, on the other hand, females reach over 11 cm in length and weigh up to 45 g, while males are slightly smaller (Speybroeck et al., 2016). Neither species have discs on their toes, as in *Hyla* spp., nor other structures that facilitate climbing (e.g. long legs). Hence it seems that the use of trees by these ground-dwelling species has been overlooked thus far by researchers (Bringsøe, 2016; Petrovan et al., 2022). However, growing evidence indicates that true toads (Bufonidae), although they seem to be robust, relatively massive and quite sluggish, cope very well with the exploration of trees and other high spaces – even when the way to them leads through near-vertical surfaces (Vassallo et al., 2021, but cf. Petrovan et al., 2022). Gosa (2003) suggests that tree sheltering and climbing behaviour in anuran amphibians is linked to a search for humidity provided by moss growing on oak, and is much more common in dry than in humid seasons. Therefore, our scarce knowledge about amphibians' use of cavities, crevices, nest boxes or tree branches is due to the lack of sufficient research on such objects and behaviour, and toads' presence in tree hollows

Table 1. The observations of common toads *Bufo bufo* and common frogs *Rana temporaria* with tree species and approx. height above the ground at which the individual was located

Age	Tree species (tree number)	Height (cm)
<i>Bufo bufo</i>		
adult	<i>Salix</i> cfr. <i>alba</i> (1)	70
adult	<i>Salix</i> cfr. <i>alba</i> (1)	110
adult	<i>Salix</i> cfr. <i>alba</i> (1)	190
adult	<i>Salix</i> cfr. <i>alba</i> (1)	180
adult	<i>Salix</i> cfr. <i>alba</i> (1)	170
adult	<i>Salix</i> cfr. <i>alba</i> (1)	100
juvenile	<i>Salix</i> cfr. <i>alba</i> (1)	220
adult	<i>Salix</i> cfr. <i>alba</i> (2)	150
adult	<i>Salix</i> cfr. <i>alba</i> (2)	100
adult	<i>Salix</i> cfr. <i>alba</i> (2)	100
juvenile	<i>Betula pendula</i>	40
adult	<i>Betula pendula</i>	60
<i>Rana temporaria</i>		
adult	<i>Salix</i> cfr. <i>alba</i> (1)	30
adult	<i>Salix</i> cfr. <i>alba</i> (1)	40

should not be treated as an artefact or anomaly but as a strategy (potentially of a seasonal nature) that requires further investigation (Petrovan et al., 2022). This is particularly relevant in the case of a species as closely associated with forest habitats as *B. bufo* (Salazar et al., 2016).

Generally, trees provide many ecosystem services and play major roles as key habitats in the life of many amphibian species, especially in the tropics (Basham et al., 2022; Fouilloux et al., 2021; Gould et al., 2024), although woody plants are also important niches in temperate climates (Dupuis et al., 1995; Kaczmarek et al., 2023; Vuorio et al., 2015). The research on this topic is not very advanced and is still growing (Burrow & Maerz, 2022). Based on our literature review, it is worth noting that six ground-dwelling European amphibian species have been observed on at least 14 different taxa of trees, mainly comprising deciduous species (Table 2). From

our perspective, this list is still incomplete and requires further research, and some species of trees are more preferred by amphibians. In a recent study in Britain, 35% of amphibian records on trees were observed on *S. caprea*, despite the low frequency of this species in the entire dataset (1.1%), which suggests the positive selection of this tree species by amphibians (Petrovan et al., 2022). Other preferred species include sycamore *Acer pseudoplatanus* L. and common oak *Quercus robur* L. (Petrovan et al., 2022). Additionally, many amphibian species are dependent on below-ground tree parts, woody debris or trunks lying on the ground regardless of the tree species, and use them as a moist, safe shelter or a feeding place (Burrow & Maerz, 2022; Evans et al., 2020; Indermaur & Schmidt, 2011). Our observations are additional evidence emphasising the role of trees as crucial habitat resources for many species (Gould et al., 2024; Le Roux et al., 2014; Przepióra & Ciach,

Table 2. List of the observations of ground-dwelling European amphibian species recorded on various trees and some other plant species in Europe. Plant species nomenclature was adopted based on the source text

Amphibian species	Plant species	Approx. heights above the ground	Amphibian activities	Source
<i>Alytes obstetricans</i>	<i>Quercus</i> sp.	av. of 34 cm, max 135 cm	sheltering (72–82% for moisture during dry season)	Gosa 2003
<i>Bufo spinosus</i>		av. of 39 cm, max 197 cm		
<i>Rana temporaria</i>		av. of 14 cm, max 30 cm		
<i>Bufo bufo</i>	<i>Malus domesticus</i>	110 cm	sheltering	Bringsøe 2016 after Störr (2003)
<i>Bufo bufo</i>	<i>Salix caprea</i> <i>Corylus avellana</i>	50 to 200 cm	sheltering on tree forks	Krause et al. 2007
<i>Triturus cristatus</i>	<i>Quercus</i> sp.	50 cm	climbing	Bringsøe 2013
<i>Lissotriton vulgaris</i>	<i>Alnus</i> sp. <i>Picea</i> sp. <i>Fraxinus excelsior</i> <i>Quercus robur</i> <i>Syringa vulgaris</i> <i>Impatiens parviflora</i> * <i>Juncus conglomeratus</i> or <i>effusus</i> * <i>Rumex</i> sp.	av. of 77 cm max. 180 cm	foraging sheltering	
<i>Bufo bufo</i>	<i>Picea abies</i> <i>Solidago virgaurea</i> *	200 cm 55 cm	climbing foraging	Bringsøe 2016
<i>Lissotriton vulgaris</i> <i>Triturus cristatus</i>	Few fern species: <i>Athyrium filix-femina</i> , <i>Dryopteris filixmas</i> , <i>Polystichum polyblepharum</i> <i>Anthriscus sylvestris</i> <i>Urtica dioica</i>	15 to 50 cm	climbing	Lynn & Allain 2022
<i>Bufo bufo</i> # <i>Rana temporaria</i> # <i>Lissotriton vulgaris</i> <i>Triturus cristatus</i> #	<i>Acer pseudoplatanus</i> <i>Betula pubescens</i> <i>Salix capraea</i> <i>Betula pendula</i> <i>Corylus avellana</i> <i>Salix capraea</i> <i>Alnus glutinosa</i> <i>Quercus robur</i>	av. of 134 cm, max. 280 cm 65 cm	sheltering	Petrovan et al. 2022
<i>Bufo bufo</i>	<i>Salix</i> cfr. <i>alba</i>	av. of 124 cm, max. 220 cm	climbing foraging	This study
<i>Rana temporaria</i>	<i>Betula pendula</i>	30 and 40 cm		

* – herbs, # – also inside nest box.

2022), including temperate-climate terrestrial amphibians, which are not customarily associated with this resource (Petrovan et al., 2022).

We recommend focusing greater attention on the protection of ageing trees – especially *Salix* sp. – as a poorly researched element within amphibian habitats, particularly near amphibian breeding sites within a terrestrial buffer zone of at least 250 metres from ponds. The recently adopted EU Nature Restoration Law presents an opportunity to develop good practices in this area, particularly regarding urban tree planting and habitat management. The preservation of even a single old-growth tree (exhibiting signs of tree maturity and decay, often multi-stem structures) may be essential for long-term amphibian conservation due to site fidelity in altered, urbanised areas and more natural habitats. Removing such specimens should be limited or implemented only in exceptional situations that pose a real threat to safety based on a proper risk assessment method (cf. Suchocka et al., 2023). On the other hand, during the wildlife inventory process, experts in the fields of, for example, herpetology or dendrobiology should survey mature, ageing trees. Such surveys should mainly be conducted during the amphibians' post-breeding season (Bringsøe, 2016) and, importantly, after dusk, during favourable weather conditions (suitable humidity and temperature or after rain) under which amphibians emerge from their tree hiding places. Although meeting these conditions may be difficult, constituting a methodological problem, it may also offer an opportunity for the participation of citizen scientists.

Author contributions

MK: fieldwork, data interpretation, drafting.
AMK: fieldwork, data interpretation, and critical revision of the manuscript.

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