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Short communication

Medicinal leeches (*Hirudo medicinalis*) attacking and killing adult amphibians

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Although the relative importance of different factors regulating amphibian populations is not very well understood, predation and parasitism are thought be important elements in shaping amphibian life-histories and, perhaps, population dynamics (Beebee 1996). However, relatively little is known about the impact of parasitic infections on fitness of individual amphibians (but *see*: Goater & Ward 1992, Strijbosch 1980, Tocque 1993), or their impact on amphibian population dynamics and persistence. With this note, we wish draw attention to one particular parasite, the medicinal leech (*Hirudo medicinalis*), which might be a locally important source of mortality for adult amphibians.

The medicinal leech feeds on vertebrate blood, and the long-held view in the literature has been that mammals are their main hosts and mammalian blood is required for successful reproduction (e.g. Forselius 1952). However, field observations (Table 1) together with recent serological investigations (Wilkin & Scofield 1990, Keim 1993) indicate that adult amphibians may constitute an important resource for medicinal leeches. In two serological studies, 86% and 24% of examined leeches were found to have fed on amphibians (Wilkin & Scofield 1990, Keim 1993, respectively). Although these numbers do not provide any indications about the consequences of leech parasitism for amphibians, published anecdotal observations testify to potentially drastic effects. Populations of frogs, toads and newts in different parts of Europe have been reported to suffer dramatic mortality following leech attacks (Table 1). For instance, Sahlin (1930) reports medicinal leeches infecting both spawning common frogs (*Rana temporaria*) and moor frogs (*R. arvalis*) in 'large numbers' in southern Sweden. Similar observations are available from more recent times: Hoffmann (1960) reported common toads (*Bufo bufo*) in one particular pond in Luxembourg being so heavily parasitised by medicinal leeches that no female survived to reproduce during the five-year period the pond was monitored. Likewise, attacks leading to the death of large numbers of smooth newts (*Triturus vulgaris*) have been reported in two studies (Table 1). Many of these observa-

Fig. 1. A moor frog (*Rana arvalis*) female being killed by medicinal leeches on Gotland 28 March 1999. This individual was found few meters away from a pond on bare ground and it was still alive when the picture was taken. Photo: Mattias Sterner.

tions date back to the early and mid-part of the 18th century, when medicinal leeches were more abundant throughout Europe (Elliot & Tullett 1984, Sawyer 1981). Leech parasitism on frogs and toads, however, still continue in areas were medicinal leeches are present, as is indicated by serological studies and our own observations. In what follows, we will first describe a few previously unpublished cases of leech parasitism on frogs from the Swedish island of Gotland where medicinal leeches are, in contrast to the impression given by many older sources (e.g. Elliot & Tullett 1984), still relatively abundant (personal observations) as compared with many places in Fennoscandia where they are practically extinct (Dolmen *et al*. 1994). We will then briefly discuss the potential implications of these observations for amphibians, and detail gaps in our current knowledge of leech-amphibian interactions.

Our first observation is dated 28 March 1999, when ca. 50 spawning adult moor frogs of both sexes in southern Gotland (ca. 57°00´N, 18°13´E) were observed to be heavily infected with medicinal leeches. Several freshly dead moor frogs with distinct leech scars (*see* Sawyer 1986) were found from the chorus site, and some of these were still infected with leeches (Fig. 1). Several of those infected, but still alive, were in seemingly poor condition after the attacks as indicated by their phlegmatic movements and behaviour. In fact, many of the frogs were not considered viable enough to be collected for the purposes of crossing experiments, the reason for which the fieldwork at this site was being conducted. A couple of the individuals with bite marks that were held in a plastic box provided with moist moss died overnight, apparently as result of leech attacks. On the same site and date, a common toad female was observed being attacked by a large medicinal leech. The toad quickly swam ashore and climbed out of the water — peeping aloud (typical distress call female common toads; J. Merilä pers. obs.) apparently highly distressed by the attack!

Our second observation was on 3 April 2002, when five freshly killed moor frogs with leech bite marks where found from a chorus site about 40 km NW of the first locality. As in the case described above, the attacks had taken place during the beginning of the spawning season at the time when the first spawn clumps had been laid. As we have not conducted any systematic field-observations on either frogs or leeches on Gotland, it is not possible to judge whether these attacks are of more or less common occurrence. However, given that the cases of parasitism have been observed in the course of those few occasions when they have been possible to observe, there is a reason to hypothesize that parasitic attacks are even more common than the available literature suggests (*see* Table 1).

These findings provoke an obvious question: how frequent are these attacks and what are the individual- and population-level consequences of leech infections on amphibians? According to the evidence reviewed above, it appears that the direct and indirect costs (e.g. increased predation risk, lowered fecundity and mating success due to blood loss-mediated weakening) can be severe, and consequently, there should be strong selection pressure for amphibians to evade these costs in localities where leeches are abundant. Potential mechanisms for evasion include selection of breeding habitats lacking medicinal leeches and shifts towards (even) earlier breeding to avoid leeches that prefer warm temperatures. Note that once infected, at least common toads appear to unable to remove leeches: Hoffmann (1960) reports amplexing pairs climbing out from the pond with large numbers of leeches remaining attached until the toads were literally sucked dry of blood.

Sahlin (1930) noted that while early breeding common and moor frogs in a southern Swedish locality were heavily attacked by leeches, later spawning edible frogs (*R. esculenta*) escaped leech attacks despite the fact that leeches were seen swimming among spawning edible frogs. He suggested this was because leeches had already satiated with the blood of common and moor frogs by the time edible frogs spawned. Hence, another interesting facet of the leech-frog interaction is the way the local amphibian community composition might affect the individual amphibian species fitness. Consequently, detailed ecological studies focusing on effects of leeches on amphibians could be rewarding, as could studies focusing on the role of amphibians for leeches. As noted by Sawyer (1986), it is quite possible that the decline of medicinal leech populations in Europe could (at least partly) be related to decline of their amphibian hosts.

Finally, it is worth noticing that despite the decline of the European medicinal leech populations, parasitism on amphibians might have increased in the remaining leech populations. Although juvenile leeches are believed to reside mainly on amphibian hosts (Boisen Bennike 1943), mammalian blood is believed to be preferred by the larger leeches due its higher energy content (Sawyer 1986, Davies & McLoughin 1996). Consequently, the decline in numbers of free-ranging cattle, together with increased use of troughs instead of ponds for watering them,

Table. 1. A synopsis of reports on medicinal leeches attacking adult amphibians. Year = year of observation. '–' indicates negative observation, '.' indicates information that is lacking.

				Type of impact‡				
Species	Country	Year	Method††	K	W	I	Notes	Reference
Triturus vulgaris	England	1961	D	x	.	x	18/20 newts infected	Litton 1962
	England	1983–1984	D	x	x	.	66 killed	Wilkin & Scofield 1990
Bufo bufo	Luxembourgh	1956–1960	D	x	x	x	All individuals in a pond killed in 5 years	Hoffmann 1960
	Sweden	1999	D	–	–	x	One specimen	this study
Rana esculenta	Poland	.	D	.	.	x	–	Vojtkova & Roca 1996
	Sweden	ca. 1950	D	x	.	.	'uncommon on esculenta'	Forselius 1952
Rana ridibunda	England	1983–1984	D	–	–	x	only 1/50 infected	Wilkin & Scofield 1990
	England	1984–1985	I	.	.	x	86% of leeches feed on *Rr* (n = 124)	Wilkin & Scofield 1990
Rana r–l–e†	Austria	1977	I	.	.	x	31% of leeches feed on *Rr–l–e* (n = 45)	Keim 1993
	Hungary	1977	I	.	.	x	20% of leeches feed on *Rr–l–e* (n = 15)	Keim 1993
	Croatia	1977	I	.	.	x	5% of leeches feed on *Rr–l–e* (n = 43)	Keim 1993
	'Germany'*	1977	I	.	.	x	32% of leeches feed on *Rr–l–e* (n = 72)	Keim 1993
Rana temporaria	Sweden	ca. 1930	D	x	x	x	–	Sahlin 1930
	Poland	.	D	.	.	x	–	Vojtkova & Roca 1996
Rana arvalis	Sweden	ca. 1930	D	x	x	x	–	Sahlin 1930
	Sweden	1999–2002	D	x	x	x	> 50 infected, > 8 killed	this study
'Frogs'	England	ca. 1915	D	x	.	.	'in numbers'	Blair 1927

† *Rana ridibunda–esculenta–lessonae* complex.
†† D = direct observation, I = indirect observation based on analyses of gut contents of leeches.
‡K = killed, W = weakened, I = infested
*Commercially purchased leeches: origin uncertain

has reduced the availability of mammalian blood to leeches (Mann 1955, Elliot & Tullett 1984). Lack of the preferred host might have caused leeches to switch to feed mainly on amphibians, as is indicated by the serological studies (Wilkin & Scofield 1990, Keim 1993). In fact, Davies and McLoughin (1996) suggested that the decline of the medicinal leech in Europe could explained by their lowered growth, and hence fecundity, attributable to foraging on predominately on amphibian blood with a lower energetic value than mammalian blood.

Taken together, direct observations on leeches attacking adult amphibians and indirect observations based on examination of leech gut contents, indicate that amphibians are an important resource for leeches. Unfortunately, quantitative data on individual and population level consequences of leech parasitism for amphibians is still lacking, or is, at best, highly anecdotal. Hence, quantification of frequency of leech attacks in amphibians living in ponds harbouring medicinal leech populations could provide interesting insights on the possible role of leeches on amphibian population dynamics. Studies focusing on numerical associations between amphibian host and parasitic leech populations could shed light to another interesting question, namely, whether the decline of medicinal leech populations in many parts of Europe could be associated with decline or disappearance of their amphibian host populations?

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