EUROPEAN JOURNAL OF ECOLOGY

EJE 2018, 4(1): 30-40, doi: 10.2478/eje-2018-0004

Non-native Amphibian Pet Trade via Internet in Poland

Mikołaj Kaczmarski[1]*, Krzysztof Kolenda[2]

[1]*Institute of Zoology Poznan University of Life Sciences, Wojska Polskiego 71 C, 60-625 Poznań, Poland Corresponding author, E-mail: traszka.com@gmail.com*

[2]*Department of Evolutionary Biology and Conservation of Vertebrates, University of Wrocław, Sienkiewicza 21, 50-335 Wrocław, Poland*

ABSTRACT

Overharvesting and trade in amphibian populations is one of the causes of their global decline. Online trade not only encourages the exploitation of an increasing number of rare and endangered amphibian species from all over the world but also influences the spread of invasive species. The aim of our research was to investigate the amphibian pet trade conducted in online stores and portals in Poland and determine its potential impact on native species. Between November 2013 and October 2014, we regularly (on a monthly basis) checked sale offers on the websites of the 18 biggest pet shops in the country specialised in exotic animals, on a nationwide auction portal and on three exotic pet fan portals. During the study, we reported 486 offers of 112 amphibian species in online stores and on portals. Most of the offers involved one of the four families of amphibians: poison dart frogs (Dendrobatidae), tree frogs (Hylidae), true toads (Bufonidae) and true salamanders (Salamandridae). Our data show increased interest in amphibians as pets in Poland. At least half of the offered species are possible hosts for the chytrid fungus *Batrachochytrium dendrobatidis*. However, only one species, the American bullfrog *Lithobates catesbeianus* (Shaw, 1802), appears to be a potential invasive species. To summarise, the species offered in Poland that are characterised as threatened are predominantly those that are relatively easy to breed and that are popular as pets. Further studies are required to investigate the real threat to wild amphibian populations caused by the pet trade.

KEYWORDS

central Europe; chytrid fungus; CITES; exotic amphibians; species; wildlife trade

INTRODUCTION

The Internet has become an irreplaceable tool for facilitating communication, commerce and the acquisition of information all over the world (Freund & Weinhold 2004). It has also opened new doors for worldwide trade in exotic animals, which is already a well-established business (Broad et al. 2003; Lavorgna 2015; Harrison et al. 2016). Nowadays, a growing number of articles describe trade in live vertebrates (e.g. mammals, birds, reptiles or amphibians) as a global problem, with a negative impact on wild populations (Auliya et al. 2016a, b; Mori et al. 2017; Bergin et al. 2018). Although the number of live amphibians on the pet market is still much smaller than that of other vertebrates, interest in these animals as pets seems to be increasing (Pistoni & Toledo 2010; Prestridge et al. 2011; Carpenter et al. 2014; Rowley et al. 2016). Unfortunately, the greater part of traded amphibians still comprises animals caught in the wild (Herrel & van der Meijden 2014); moreover, international trade in these animals is not regulated for about 98% of species (Auliya et al. 2016b). This has led to mass overexploitation of populations and has accelerated the dynamics of decline in global amphibians (Collins & Storfer 2003; Stuart et al. 2004; Andreone et al. 2012; Robinson et al. 2015; Rowley et al. 2016).

Amphibians kept as pets may escape from captivity to the wild ecosystem or by being accidentally or deliberately released by private owners. This may contribute to an increased risk of spreading of non-native and invasive species (Prestridge et al. 2011; Measey et al. 2012). The potential impact on native species includes competition for food and habitat or the introduction of pathogens (Mooney & Cleland 2001; Picco & Collins 2008). Indeed, trade in amphibians is one of the main factors involved in the spread of infectious diseases caused by *Batrachochytrium dendrobatidis* (*Bd*) and *Batrachochytrium salamandrivorans* (*Bsal*) or by ranaviruses (*RVs*), which constitute a real threat to wild and captive populations (Fisher &

Garner 2007; Schloegel et al. 2009; Martel et al. 2014; Nguyen et al. 2017).

In the present study, we evaluate the level of the amphibian pet trade in Poland, which is primarily driven by the Internet. At that time, the scale of the animal pet trade is greatest on online shops and exotic pet portals, partly because (1) auction portals prohibit trade in species listed in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and (2) between 2012 and 2016, Polish law strictly limited trade in live vertebrates at fairs, to the point of almost strictly forbidding it. Major objectives of our survey include compilation of a full species list for the amphibian pet trade in Poland based on pet stores and online portals and discussion of the potential impact of trade in exotic amphibians on native species.

1. MATERIALS AND METHODS

We collected information on non-native amphibians offered on websites in the 18 largest pet shops in Poland (central Europe), which is specialised in live exotic animals. The examined shops were located in 9 of the country's 16 voivodeships. We also conducted a survey of private sale offers placed on a nationwide auction portal and three main exotic pet online portals. Websites were checked regularly, once a month, between November 2013 and October 2014. Ads placed by the same seller several times a year or in different places (e.g. two portals) were considered to constitute a single record. We used Spearman correlation to find out if there is a relationship between number of offers and IUCN threat category (offers for the species with deficient data or not evaluated in IUCN were not included in this analysis). We also used the chi-square test to compare number of offers of CITES species with those not listed in CITES.

In order to determine which species might pose a potential threat to native populations, we checked which of them had been reported in the literature as a carrier of *Bd* (we used only *Bd* as the best described example of deadly pathogen with many known specific hosts) or as potentially invasive in Poland.

1.1. Taxonomy

The use of incorrect names (e.g. obsolete names or synonyms) amongst the species available in the pet trade causes a problem in taxonomic evaluation. There are no official databases with Polish names for exotic pets; moreover, some sellers do not use scientific names. Thus, because of some difficulties in taxonomy, all names used in ads were categorised according to Frost (2014). Taxa in offers that contained only Polish names and were not supplemented by a photograph, thereby preventing correct identification, were classified only to genus level.

2. RESULTS

In total, we recorded 486 sale offers of live amphibians in online stores and on portals: 474 of these were identified to species level and 12 to genus level. We recorded 19 families, including 112 species, of non-native amphibians involved in the commercial pet trade in Poland (for a full list, see Appendix 1). Amongst orders, Anura, represented by 94 species, was the most common and was found in 423 ads, whilst Caudata was represented by 17 species and recorded in 62 ads. There was only one ad involving Gymnophiona, represented by the Rio Cauca Caecilian *Typhlonectes natans* (Fischer, 1880). The amphibian families representing the most species offered were poison dart frogs (Dendrobatidae; 19 species, 112 ads), tree frogs (Hylidae; 13 species, 63 ads), true toads (Bufonidae; 12 species, 30 ads) and true salamanders (Salamandridae; 12 species, 33 ads). Table 1 lists the most popular species traded in Poland (more than 10 offers during the survey period).

Most of the advertised species are included in the lowest threat IUCN categories: 83 species (348 offers) are listed as LC (least concern) and 8 species (36 offers) are listed as NT

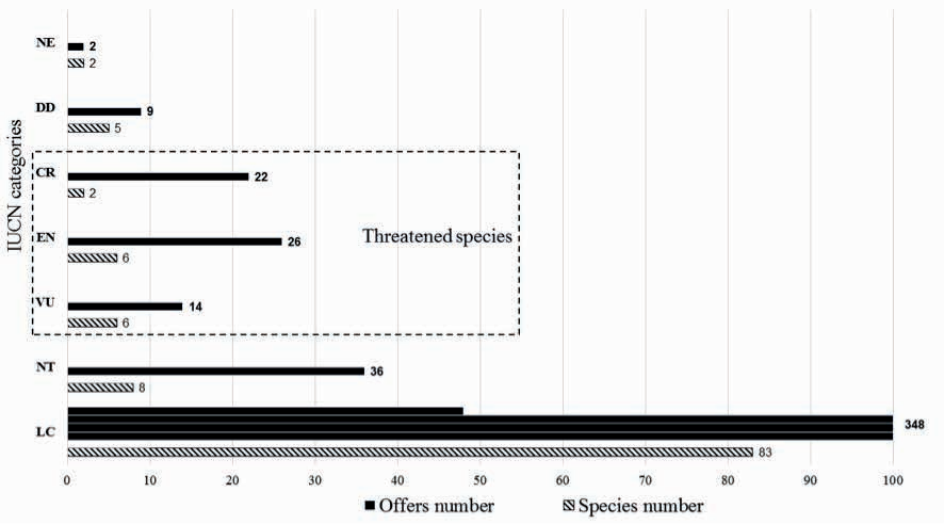

Figure 1. Participation of species in each IUCN category recorded in our survey. Most advertised species are included in the lowest category, LC (least concern; 74%), followed by NT (near-threatened; 7%), VU (vulnerable) and EN (endangered; 5% each), CR (critically endangered; 2%), DD (data deficient; 5%) and NE (not evaluated; 2%).

Table 1. The most popular amphibian species recorded in the study (species advertised 10 or more times) between November 2013 and October 2014.

Species	Families	Number of offers	Percentage share (%)
Dendrobates tinctorius	Dendrobatidae	26	5.3
Bombina orientalis	Bombinatoridae	22	4.5
Ceratophrys cranwelli	Ceratophryidae	20	4.1
Ambystoma mexicanum	Ambystomidae	18	3.7
Litoria caerulea	Hylidae	15	3.1
Dendrobates leucomelas	Dendrobatidae	14	2.9
Hyla cinerea	Hylidae	14	2.9
Ceratophrys ornata	Ceratophryidae	13	2.7
Dendrobates auratus	Dendrobatidae	12	2.5
Agalychnis callidryas	Hylidae	10	2.1
Epipedobates tricolor	Dendrobatidae	10	2.1
Hymenochirus boettgeri	Pipidae	10	2.1
Rhinella marina	Bufonidae	10	2.1
Other species		292	60.1

(near threatened). The remaining 21 species are classified in the following categories: VU (vulnerable, 14 offers), EN (endangered, 26 offers), CR (critically endangered, 22 offers), DD (data deficient) and NE (not evaluated; Fig. 1). We did not find a correlation between number of offers and threat categories ($r = 0.08$, $p > 0.05$). We also recorded significantly more offers concerning CITES-listed species (313 offers) than those not listed (151 offers) ($p < 0.05$). Amongst the advertised species, at least 61 (54.5%) species have been reported as *Bd* vectors, comprising 51 Anura (54%), 8 Caudata (47%) and 1 Gymnophiona (Appendix 1). In addition, one species, the American bullfrog *Lithobates catesbeianus* (Shaw, 1802), is considered as potentially invasive.

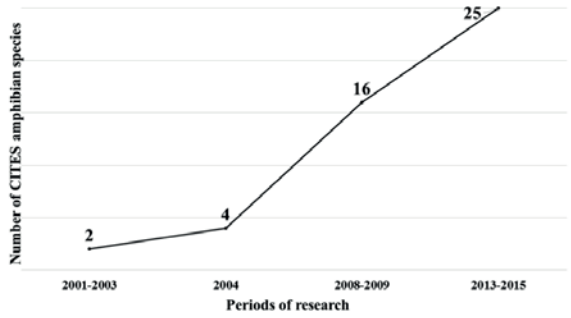

Figure 2. CITES amphibian species in Polish trade collected in 2013–2014, along with a comparison with earlier studies in 2001–2003 (Kepel et al. 2004), 2004 and 2008–2009 (Kepel et al. 2009).

3. DISCUSSION

We recorded a total of 112 species of amphibians, which, when compared to similar investigations, provided relatively large and diverse offer (Prestridge et al. 2011; Tapley et al. 2011; Magalhães & São-Pedro 2012; Sy 2014). During the research period, the Internet was the main distribution channel for exotic amphibians in Poland; thus, our results appear to be representative. However, they are probably only a sampling of the species involved in the long-term Polish amphibian trade. We realised that the current situation might have changed since our survey. Nevertheless, pronounced increased interest in amphibians as pets in Poland is clearly shown by a comparison of our data with previously published reports of the trade in CITES species (Kepel et al. 2004, 2009; Fig. 2).

The most popular amphibian family recorded in this study were poison dart frogs, amounting to approximately 46% of advertised amphibians (Table 1). Auliya et al. (2016b) described this family as 'the most wanted' pet amphibians. These anurans are generally small bodied, which, in combination with their attractive colouration and interesting behaviour, influences their popularity as pets (Gorzula 1996; Prestridge et al. 2011; Ruland & Jeschke 2016). The second most popular non-native amphibian in Poland, the Oriental fire-bellied toad *Bombina orientalis* (Boulenger, 1890), is regularly bred in captivity; nevertheless, many specimens originate from the wild (Carpenter et al. 2014; Herrel & van der Meijden 2014). Amongst salamanders, the most frequently offered species for sale, the Axolotl *Ambystoma mexicanum* (Shaw, 1789), is also

widely available in the pet trade in other countries. At present, all axolotls are bred in captivity (Schlaepfer 2005; Gerson 2012; Magalhães & São-Pedro 2012; Sy 2014). It is also worth emphasising the very small share of the Mantella frogs (*Mantella* spp.) in the pet trade in Poland in relation to the global trend (Carpenter et al. 2014). This may be related to the current preferences of breeders or the greater breeding requirements of these species.

We did not investigate aquarium store sales, but strictly aquatic species such as the Axolotl, the Oriental fire-bellied newt *Hypselotriton orientalis* (David, 1873), the African dwarf frogs *Hymenochirus* spp. and the African clawed frog *Xenopus laevis* (Daudin, 1802) are only occasionally offered and traded in Poland mainly as ornamental aquatic animals (M. Kaczmarski & K. Kolenda, unpublished data). To date, amongst these aquatic species, the import rate has been most precisely calculated in the United States (Herrel & van der Meijden 2014; Measey 2017), and all of these species have also been frequently reported as popular pets in many countries (Gerson 2012; Magalhães & São-Pedro, 2012; Sy 2014).

3.1. Threat categories and CITES species

Previous studies confirmed that amphibian trade was more likely to concern species threatened with extinction than common ones (Bush et al. 2014; Stuart et al. 2014). We didn't find correlation between the number of offers and threat categories. We suggest that trade in Poland does not have a significant negative impact on the most threatened species (IUCN categories VU, EN and CR), as we found only few of these species in recorded offers (Fig. 1, Table 1). Amongst these threatened species, only 7 of the 14 are not listed in the CITES Appendices (Table 2). We also recorded significantly more offers concerning CITES-listed species than those not listed. It is worth emphasising that we find relatively high shares of CITES-listed amphibians amongst all offers: 29% of frogs and 6% of salamanders. Compared to trade in the United States, the quota of CITES-listed frogs increased their share from 11% to 18% and salamanders decreased from 11% to 4% (between 1992 and 2005; see Tapley et al. 2011). However, as far as we know, controls on cross-border trade do not prevent the illicit trafficking of species from the CITES list (Nijman & Shepherd 2010; Pistoni & Toledo 2010; Nijman & Shepherd 2011). Nevertheless, beyond all doubt, CITES enables closer tracking of amphibian shipments in global trade (Carpenter et al. 2014). Importantly, despite the regulations associated with the CITES convention, poison dart frogs remained the most popular family in the pet trade for many years (Gorzula 1996; Nijman & Shepherd 2010; Pistoni & Toledo 2010; Prestridge et al. 2011; Carpenter et al. 2014). However, Schlaepfer et al. (2005) indicated that most of the most heavily traded amphibians were not regulated by CITES. A lack of restrictions is one of the reasons for the continued access to individuals obtained from the wild (Stuart et al. 2014; Rowley et al. 2016; but see Challender et al. 2015). Inclusion in CITES restrictions on wild-caught species (e.g. the Kaiser's

Table 2. Threatened species advertised in Poland between November 2013 and October 2014 (in alphabetical order). Data on threat status of amphibians were provided from the IUCN Red List (IUCN 2017; http://www.iucnredlist.org [Accessed 15 November 2017]). CITES: 'A II' = Appendix II; '–' = not listed in any appendices; for IUCN abbreviation categories, see the description under Fig. 1.

Species	Family	CITES	IUCN	Number of offers
Agalychnis annae	Hylidae	A II	EN	1
Ambystoma mexicanum	Ambystomidae	A II	CR	18
Atelopus spumarius	Bufonidae	–	VU	1
Epipedobates tricolor	Dendrobatidae	A II	EN	10
Excidobates mysteriosus	Dendrobatidae	A II	EN	1
Hyperolius puncticulatus	Hyperoliidae	–	EN	6
Leptopelis uluguruensis	Artholeptidae	–	VU	2
Leptopelis vermiculatus	Artholeptidae	–	VU	4
Mantella aurantiaca	Mantelidae	A II	CR	4
Neurergus crocatus	Salamandridae	–	VU	3
Phyllobates terribilis	Dendrobatidae	A II	EN	3
Phyllobates vittatus	Dendrobatidae	A II	EN	5
Ranitomeya benedicta	Dendrobatidae	–	VU	3
Rhacophorus annamensis	Rhacophoridae	–	VU	1

mountain newt *Neurergus kaiseri* Schmidt, 1952) may put pressure on breeding and conservation (Mobaraki et al. 2013). This kind of process – the tightening of the law – commonly results in price increases and may reduce the field-collection of individuals but largely it seems to be dependent on the capabilities of breeding the species in captivity. On the other hand, in relation to the difficult-to-breed species, increased protection may lead to a significant increase in field capture rates (Tapley et al. 2011) and accelerated demands for rare and expensive species, which is described as the Allee effect (Harris et al. 2013).

3.2. The pet trade as a potential threat to native species

In recent years, the list of *Bd*-susceptible amphibians has increased rapidly (Olson et al. 2013). Gerson (2012) stated that 26% of 173 amphibian species was imported into Canada between 2002 and 2010 and destined for the aquarium and pet trade tested positive for *Bd*. Our results revealed that at least 54.5% of species offered for sale are potential hosts for *Bd*; however, we expect the actual number to be higher as a result of small sample sizes or lack of data for many listed species (Appendix 1). To determine the real prevalence of infections in captive amphibians, a widespread programme aimed at detecting this and other fatal pathogens (e.g. *Bsal* and *RVs*) should be conducted across the country.

Monitoring of *Bd* and *Bsal* in captive collections (public institutions, the pet trade and private breeders) in the Czech Republic showed that about 5% and none of amphibians were infected with *Bd* and *Bsal*, respectively (Havlíková et al. 2015, Baláž et al. 2018). These pathogens, along with *RVs*, were also found in Germany amongst amphibians in captivity (Mutschmann et al. 2000; Stöhr et al. 2013; Sabino-Pinto et al. 2015; Nguyen et al. 2017). Simultaneously, *Bd* infections in native amphibian populations were discovered in both countries, whilst *Bsal* were found only in Germany (Ohst et al. 2013; Baláž et al. 2014, 2018; Spitzen-van der Sluijs et al. 2016). Fairs in the Czech Republic and Germany are also considered an important source of exotic amphibians subsequently shipped to Poland. Thus, we suggest two possible entry routes for pathogens transmission, which are not mutually exclusive: (1) cross-border trade and (2) progressive spread of the pathogen across Europe. Indeed, during a pilot study, *Bd* was found in two localities in southwestern Poland, including one on the Czech border (Kolenda et al. 2017).

From our species list, only the American bullfrog, which is already established in Europe seems to be a potentially new coloniser in Poland (Kopecký et al. 2016). There are introduced populations in Germany in climates similar to Poland (Santos-Barrera et al. 2009). The American bullfrog has been identified as a threat to European fauna (Kopecký et al. 2016; European Environment Agency 2012) and also as a potential alien species in Poland (Rozporządzenie 2011). Although possession and breeding of this species in Poland is limited, requiring a special permit, we found one ad (probably illegal) concerning this species.

4. CONCLUSIONS

Keeping exotic pets entails many benefits for both people and animals; however, special attention should be paid to the resulting risks. To reduce the risk of the release of pathogens into the wild in Poland and/or infection of other captive amphibians, we suggest that animals should be regularly tested for the presence of *Bd* (and other pathogens if possible) and that guidelines should be created for handling amphibians in captivity (Fisher & Garner 2007; Kriger & Hero 2009; Havlíková et al. 2015). The commercial availability of wild-caught specimens is justified; however, it is also important to keep only captive-bred animals deriving from legal sources (Pasmans et al. 2017). At the same time, local studies involving checklists of the pet trade in amphibians should be conducted to obtain a clearer picture of the global trade problem and in order to establish better conservation measures (Ruland & Jeschke 2016). Finally, we stress the need to disseminate the latest knowledge in this area at the local and regional levels, with stronger restrictions or even bans on trade in species that have been obtained illegally. More education and greater awareness on the part of businessmen, breeders and animal owners is the main way to reduce unwanted trafficking in amphibians (Pasmans et al. 2017) or, from a wider perspective, wildlife in general.

Acknowledgements: We are thankful to Tim Sparks, Sergé Bogaerts, Anna Najbar and Jan M. Kaczmarek for their valuable comments on our manuscript. We are also grateful to two anonymous reviewers for their helpful comments.

References

Andreone, F., Lorie, S., Pala, R., Luiselli, L.M. & Carpenter, A. (2012) Trade and exploitation of amphibians and reptiles: a conservation overview. Attidell'Accademia delle Scienze di Torino. Classe di Scienze Fisiche, Matematiche e Naturali, 146, 85–93.

Auliya, M., Altherr, S., Ariano-Sanchez, D., Baard, E.H., Brown, C., Brown, R.M., et al. (2016a) Trade in live reptiles, its impact on wild populations, and the role of the European market. Biological Conservation, 204, 103–119.DOI10.1016/j.biocon.2016.05.017.

Auliya, M., García-Moreno, J., Schmidt, B.R., Schmeller, D.S., Hoogmoed, M.S., Fisher, M.C., et al. (2016b) The global amphibian trade flows through Europe: the need for enforcing and improving legislation. Biodiversity and Conservation, 25(13), 2581–2595. DOI10.1007/s10531-016-1193-8.

Baláž, V., Vojar, J., Civiš, P., Šandera, M. & Rozínek, R. (2014) Chytridiomycosis risk among Central European amphibians based on surveillance data. Diseases of Aquatic Organisms, 112(1), 1−8. DOI 10.3354/dao02799.

Baláž, V., Solský, M., Lastra González, D., Havlíková, B., Gallego Zamorano, J., González et al. (2018) First survey of pathogenic fungus *Batrachochytrium salamandrivorans* in wild and captive amphibians in the Czech Republic. Salamandra, 54, 87–91.

Bergin, D., Atoussi, S. & Waters, S.(2018)Online trade of Barbary macaques *Macaca sylvanus* in Algeria and Morocco. Biodiversity and Conservation, 27(2), 531–534. DOI 10.1007/s10531-017-1434-5.

Broad, S., Mulliken, T. & Roe, D. (2003) The nature and extent of legal and illegal trade in wildlife. In: S. Oldfield, (Ed.), The Trade in Wildlife (pp 3−22). London: Earthscan Publications Ltd.

Bush, E.R., Baker, S.E. & Macdonald, D.V. (2014) Global trade in exotic pets 2006–2012. Conservation Biology, 28, 663−676. DOI 10.1111/cobi.12240.

Carpenter, A.I., Andreone, F., Moore, R.D. & Griffiths, R.A. (2014) A review of the international trade in amphibians: the types, levels and dynamics of trade in CITES-listed species. Oryx, 48, 565−574. DOI 10.1017/S0030605312001627.

Challender, D.W., Harrop, S.R., & MacMillan, D.C. (2015) Understanding markets to conserve trade-threatened species in CITES. Biological Conservation, 187, 249−259. DOI 10.1016/j.biocon.2015.04.015.

European Environment Agency (2012) The impacts of invasive alien species in Europe. EEA Technical Report No 16/2012, Copenhagen.

Freund, C. & Weinhold, D.(2004)The effect of the Internet on international trade. Journal of international economics, 62(1), 171–189. DOI 10.1016/S0022-1996(03)00059-X.

Frost, D.R. (2014) Amphibian Species of the World: an Online Reference. Version 6.0. Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. New York: American Museum of Natural History.

Fisher, M.C. & Garner, T.W.J. (2007) The relationship between the emergence of *Batrachochytrium dendrobatidis*, the international trade in amphibians and introduced amphibian species. Fungal Biology Reviews, 21(1), 2–9. DOI 10.1016/j.fbr.2007.02.002.

Gerson, H. (2012) International trade in amphibians: a customs perspective. Alytes, 29, 103−115.

Gorzula, S. (1996) The trade in Dendrobatid frogs from 1987 to 1993. Herpetological Review, 27, 116−123.

Havlíková, B., Baláž, V. & Vojar, J. (2015) First systematic monitoring of *Batrachochytrium dendrobatidis* in collections of captive amphibians in the Czech Republic. Amphibia-Reptilia, 36(1), 27–35. DOI 10.1163/15685381-00002972.

Harris, R.B., Cooney, R. & Leader-Williams, N. (2013) Application of anthropogenic Allee effect model on trophy hunting as a conservation tool. Conservation Biology, 27(5), 945−951. DOI 10.1111/cobi.12115.

Harrison, J.R., Roberts, D.L. & Hernandez-Castro, J. (2016) Assessing the extent and nature of wildlife trade on the dark web. Conservation Biology, 30(4), 900–904. DOI10.1111/cobi.12707.

Herrel, A., & van der Meijden, A. (2014) An analysis of the live reptile and amphibian trade in the USA compared to the global trade in endangered species. The Herpetological Journal, 24(2), 103−110.

Kepel, A., Grebieniow, A., & Kala, B. (2004) Ginące gatunki w sieci. Nielegalny handel zwierzętami w polskim Internecie. Raport 2004. Poznań: PTOP Salamandra, (in Polish).

Kepel, A., Kala, B., & Graclik, A. (2009) Ginące gatunki w sieci. Handel okazami zwierząt zagrożonych wyginięciem w polskojęzycznych stronach internetowych. Raport 2009. Poznań: PTOP Salamandra, (in Polish).

Kolenda, K., Najbar, A., Ogielska, M., & Baláž, V. (2017) *Batrachochytrium dendrobatidis* is present in Poland and associated with reduced fitness in wild populations of *Pelophylax lessonae*. Diseases of Aquatic Organisms, 124(3), 241–245. DOI 10.3354/dao03121.

Kopecký, O., Patoka, J. & Kalous, L. (2016) Establishment risk and potential invasiveness of the selected exotic amphibians from pet trade in the European Union. Journal for Nature Conservation, 31, 22–28. DOI 10.1016/j.jnc.2016.02.007.

Lavorgna, A. (2015) The social organization of pet trafficking in cyberspace. European Journal on Criminal Policy and Research, 21(3), 353–370. DOI 10.1007/s10610-015-9273-y.

Magalhães, A.L.B. & São-Pedro, V.S. (2012) Illegal trade on non-native amphibians and reptiles in southeast Brazil: The status of e-commerce. Phyllomedusa: Journal of Herpetology, 11(2), 155−160. DOI 10.11606/issn.2316-9079.v11i2p155-160.

Martel, A., Blooi M., Adriaensen, C., Van Rooij, P., Beukema, W., Fisher, et al. (2014) Recent introduction of a chytrid fungus endangers Western Palearctic salamanders. Science, 346(6209), 630−631. DOI 10.1126/science.1258268.

Measey, G.J., Rödder, D., Green, S.L., Kobayashi, R., Lillo, F., Lobos, G., et al. (2012) Ongoing invasions of the African Clawed Frog: *Xenopus laevis*: A global review. Biological Invasions, 14(11), 2255–2270. DOI 10.1007/s10530-012-0227-8.

Measey, J. (2017) Where do African clawed frogs come from? An analysis of trade in live *Xenopus laevis* imported into the USA. Salamandra, 53(3), 398–404.

Mobaraki, A., Mohsen Amiri, M., Alvandi, R.,Tehrani M.E., Kia, H.Z., Khoshnamvand, et al. (2013) A conservation reassessment of the Critically Endangered, Lorestan newt *Neurergus kaiseri* (Schmidt 1952) in Iran. Amphibian and Reptile Conservation, 9(1), 16–25.

Mori, E., Grandi, G., Menchetti, M., Tella, J.L., Jackson, H.A., Reino, L., van Kleunen, A. et al. (2017) Worldwide distribution of non–native Amazon parrots and temporal trends of their global trade. Animal Biodiversity and Conservation, 40(1), 49–62.

Mutschmann, F., Berger, L., Zwart, P. & Gaedicke, C. (2000) Chytridiomycosis on amphibians - first report from Europe. Berliner und Münchener tierärztliche Wochenschrift, 113(10), 380−383.

Nguyen, T.T., Van Nguyen, T., Ziegler, T., Pasmans, F. & Martel, A. (2017) Trade in wild anurans vectors the urodelan pathogen *Batrachochytrium salamandrivorans* into Europe. Amphibia-Reptilia, 38(4), 554–556. DOI 10.1163/15685381-00003125.

Nijman, V. & Shepherd, C.R. (2010) The Role of Asia in the global trade in CITES II-listed poison arrow frogs: Hopping from Kazakhstan to

Lebanon to Thailand and beyond. Biodiversity and Conservation, 19(7), 1963–1970. DOI 10.1007/s10531-010-9814-0.

Nijman, V., & Shepherd, C.R. (2011) The role of Thailand in the international trade in CITES-listed live reptiles and amphibians. PLoS ONE, 6(3), e17825. DOI 10.1371/journal.pone.0017825.

Ohst, T., Gräser, Y., & Plötner, J. (2013) *Batrachochytrium dendrobatidis* in Germany: distribution, prevalences, and prediction of high risk areas. Diseases of Aquatic Organisms, 107(1), 49–59. DOI 10.3354/dao02662.

Olson, D.H., Aanensen, D.M., Ronnenberg, K.L., Powell, C.I., Walker, S.F., Bielby, J., et al. (2013) Mapping the global emergence of *Batrachochytrium dendrobatidis*, the amphibian chytrid fungus. PLoS ONE, 8(2), e56802. DOI 10.1371/journal.pone.0056802.

Picco, A.M. & Collins, J.P. (2008) Amphibian commerce as a likely source of pathogen pollution. Conservation Biology, 22(6), 1582–1589. DOI 10.1111/j.1523-1739.2008.01025.x.

Pistoni, J.& Toledo, L.F. (2010) Amphibian illegal trade in Brazil: what do we know? South American Journal of Herpetology 5(1), 51–56. DOI 10.2994/057.005.0106.

Prestridge, H.L., Fitzegerald, L.A. & Hibbits, T.J. (2011) Trade in nonnative amphibian and reptiles in Texas: Lessons for better monitoring and implications for species introduction. Herpetological Conservation and Biology, 6(3), 324−339.

Robinson, J.E., Griffiths, R.A., St. John, F.A.V. & Roberts, D.L. (2015) Dynamics of the global trade in live reptiles: Shifting trends in production and consequences for sustainability. Biological Conservation, 184, 42−50. DOI 10.1016/j.biocon.2014.12.019.

Rowley, J.L.J., Shepherd, C.R., Stuart, B.L., Nguyen, T.Q., Hoang, H.D., Cutajar, T.P., et al. (2016) Estimating the global trade in Southeast Asian newts. Biological Conservation, 199, 96−100. DOI 10.1016/j.biocon.2016.05.001.

Rozporządzenie (2011) Rozporządzenie Ministra Środowiska z dnia 9 września 2011 r. w sprawie listy roślin i zwierząt gatunków obcych, które w przypadku uwolnienia do środowiska przyrodniczego mogą zagrozić gatunkom rodzimym lub siedliskom przyrodniczym, (Dz. U. 2011 nr 2010 poz. 1260, (in Polish)

Ruland, F. & Jeschke, J.M. (2016) Threat-dependent traits of endangered frogs. Biological Conservation, 206, 310−313. DOI 10.1016/j.biocon.2016.11.027.

Sabino-Pinto, J., Bletz, M., Hendrix, R., Perl, R.B., Martel, A., Pasmans, F., et al. (2015) First detection of the emerging fungal pathogen *Batrachochytrium salamandrivorans* in Germany. Amphibia-Reptilia, 36(4), 411−416. DOI 10.1163/15685381-00003008.

Schlaepfer, M.A., Hoover, C. & Dodd K. (2005) Challenges in evaluating the impact of trade in amphibians and reptiles on wild populations. BioScience, 55(3), 256−264. DOI 10.1641/0006-3568(2005)055[0256:CIETIO]2.0.CO;2.

Sy, E.Y. (2014) Checklist of exotic species in the Philippine pet trade I. Amphibians. Journal of Nature Studies, 13, 48−57.

Schloegel, L.M, Picco, A., Kilpatrick, A.M., Hyatt, A. & Daszak, P. (2009) Magnitude of the US trade in amphibians and presence of *Batrachochytrium dendrobatidis* and ranavirus infection in imported North American bullfrogs (*Rana catesbeiana*). Biological Conservation, 142(7), 1420–1426. DOI 10.1016/j.biocon.2009.02.007.

Spitzen-van der Sluijs, A., Martel, Asselberghs, J., Bales, E.K., Beukema, W., Bletz, M.C., et al. (2016) Expanding distribution of lethal amphibian fungus *Batrachochytrium salamandrivorans* in Europe. Emerging Infectious Diseases, 22, 1286–1288. DOI 10.3201/eid2207.160109.

Stöhr, A.C., Fleck, J., Mutschmann, F. & Marschang, R.E. (2013) Ranavirus infection in a group of wild-caught Lake Urmia newts *Neurergus crocatus* imported from Iraq into Germany. Diseases of Aquatic Organisms, 103(3), 185–189. DOI 10.3354/dao02556.

Stuart, S.N., Chanson, J.S., Cox, N.A., Young, B.E., Rodrigues, A.S.L., Fischman, D.L., et al. (2004) Status and trends of amphibian declines and extinctions worldwide. Science 306, 1783–1786. DOI 10.1126/science.1103538.

Stuart, B.L., Rowley, J.J., Phimmachak, S., Aowphol, A. & Sivongxay, N. (2014) Salamander protection starts with the newt. Science 346(6213), 1067−1068. DOI 10.1126/science. 346.6213.1067-a.

Tapley, B., Griffiths, R.A. & Bride, I.(2011) Dynamics of the trade in reptiles and amphibians within the United Kingdom over a ten-year period. The Herpetological Journal, 21(1), 27−34.

APPENDIX 1.

Full list of amphibians available via Internet trade in Poland; Bd positive column: '+' species confirmed as a host for Bd (see source column); '–' Bd not yet recorded in this species.

Order/Family	*Species*	Number of offers	*Bd* positive	Source
Anura				
Artholeptidae	*Leptopelis argenteus*	2	–	-
	Leptopelis uluguruensis	2	+	Tamukai et al. 2014
	Leptopelis vermiculatus	4	+	Spitzen-van der Sluijs et al. 2011
	Leptopelis sp.	5		
Bombinatoridae	*Bombina maxima*	1	+	bd-maps.net
	Bombina orientalis	22	+	bd-maps.net
Bufonidae	*Amietophrynus garmani*	1	–	-
	Amietophrynus regularis	5	+	bd-maps.net
	Anaxyrus cognatus	1	–	-
	Atelopus spumarius	1	–	-
	Bufo japonicus	1	–	-
	Bufo sp.	1		
	Duttaphrynus melanostictus	4	+	bd-maps.net
	Incilius alvarius	2	–	-
	Ingerophrynus galeatus	1	–	-
	Melanophryniscus stelzneri	1	–	-
	Pedostibes hosii	1	–	-
	Phrynoidis aspera	1	–	-
	Rhinella marina	10	+	bd-maps.net
Ceratophryidae	*Ceratophrys cranwelli*	20	+	Tamukai et al. 2014
	Ceratophrys ornata	13	+	Tamukai et al. 2014
	Lepidobatrachus laevis	1	+	Tamukai et al. 2014
	Ceratophrys sp. (with hybrids)	9		
Dendrobatidae	*Adelphobates galactonotus*	2	+	Speare and Berger 2004
	Dendrobates auratus	12	+	Miller et al. 2008
	Dendrobates leucomelas	14	+	Spitzen-van der Sluijs et al. 2011
	Dendrobates tinctorius	26	+	Courtois et al. 2015
	Dendrobates truncatus	3	–	-
	Epipedobates anthonyi	5	+	bd-maps.net
	Epipedobates tricolor	10	+	Spitzen-van der Sluijs et al. 2011
	Excidobates mysteriosus	1	–	-
	Oophaga pumillo	5	+	Spitzen-van der Sluijs et al. 2011
	Phyllobates bicolor	6	+	Kik et al. 2012
	Phyllobates terribilis	3	+	Miller et al. 2008
	Phyllobates vittatus	5	+	Kik et al. 2012
	Ranitomeya amazonica	2	+	Courtois et al. 2015
	Ranitomeya benedicta	3	+	Tamukai et al. 2014
	Ranitomeya imitator	7	+	Tamukai et al. 2014
	Ranitomeya intermedia	1	–	-

Order/Family	*Species*	Number of offers	*Bd* positive	Source
	Ranitomeya sirensis	3	–	-
	Ranitomeya variabilis	1	–	-
	Ranitomeya ventrimaculata	4	–	-
Discoglossidae	*Discoglossus pictus*	3	–	-
Hemisotidae	*Hemisus marmoratus*	1	–	-
Hylidae	*Agalychnis annae*	1	–	-
	Agalychnis callidryas	10	+	bd-maps.net
	Dendropsophus leucophyllatus	1	–	-
	Hyla cinerea	14	+	bd-maps.net
	Hyla squirella	1	–	-
	Hyla versicolor	2	+	bd-maps.net
	Litoria caerulea	15	+	bd-maps.net
	Litoria infrafrenata	3	+	bd-maps.net
	Litoria sp.	1		
	Osteopilus septentrionalis	3	+	bd-maps.net
	Phyllomedusa sauvagii	2	–	-
	Tlalocohyla loquax	1	–	-
	Trachycephalus resinifictrix	8	+	Tamukai et al. 2014
	Trachycephalus venulosus	1	–	-
Hyperoliidae	*Afrixalus fornasini*	3	+	bd-maps.net
	Afrixalus sp.	1		
	Hyperolius argus	1	+	Peel et al. 2012
	Hyperolius concolor	2	+	Imasuen et al. 2011
	Hyperolius marmoratus	1	–	-
	Hyperolius puncticulatus	6	+	bd-maps.net
	Hyperolius viridiflavus	1	+	bd-maps.net
	Hyperolius sp.	3		
	Kassina maculata	7	–	-
	Kassina senegalensis	4	+	Weldon 2005
Mantelidae	*Boophis albilabris*	1	–	-
	Boophis luteus	1	–	-
	Boophis viridis	1	+	Bletz et al. 2015
	Mantella aurantiaca	4	–	-
	Mantella betsileo	5	–	-
	Mantella nigricans	2	–	-
Megophryidae	*Megophrys montana*	1	–	-
	Megophrys nasuta	2	+	Bowerman et al. 2010
Microhylidae	*Dyscophus antongilii*	1	+	Peel et al. 2012
	Dyscophus guineti	7	+	Voyles et al. 2010
	Dyscophus sp.	1		
	Kaloula pulchra	9	+	Savage et al. 2011
	Microhyla pulchra	3	–	-
	Phrynomantis bifasciatus	7	+	bd-maps.net

Order/Family	*Species*	Number of offers	*Bd* positive	Source
	Phrynomantis microps	2	–	-
Pipidae	*Hymenochirus boettgeri*	10	+	bd-maps.net
	Pipa pipa	2	–	-
	Xenopus laevis	8	+	Tamukai et al. 2014
Pyxicephalidae	*Pyxicephalus adspersus*	4	+	Miller et al. 2008
	Pyxicephalus edulis	2	–	-
	Pyxicephalus sp.	1		
	Strongylopus fasciatus	1	–	-
Ranidae	*Lithobates catesbeianus*	1	+	bd-maps.net
	Odorrana livida	3	+	bd-maps.net
Rhacophoridae	*Kurixalus odontotarsus*	1	–	-
	Polypedates leucomystax	6	+	Gilbert et al. 2012
	Polypedates otilophus	2	–	-
	Rhacophorus annamensis	1	–	-
	Rhacophorus dennysi	3	+	Miller et al. 2008
	Rhacophorus reinwardtii	3	–	-
	Theloderma asperum	1	+	Tamukai et al. 2014
	Theloderma corticale	2	+	Peel et al. 2012
	Theloderma gordoni	1	–	-
	Theloderma stellatum	6	+	bd-maps.net
Caudata				
Ambystomidae	*Ambystoma maculatum*	1	+	Ouellet et al. 2005
	Ambystoma mavortium	1	+	Spitzen-van der Sluijs et al. 2011
	Ambystoma mexicanum	18	+	Berger et al. 1999
	Ambystoma opacum	1	+	Tamukai et al. 2014
	Ambystoma tigrinum	8	+	Tamukai et al. 2014
Salamandridae	*Cynops pyrrhogaster*	1	–	-
	Hypselotriton cyanurus	1	–	-
	Hypselotriton orientalis	7	–	-
	Neurergus crocatus	3	–	-
	Notophthalmus viridescens	1	+	Rothermel et al. 2008
	Ommatotriton vittatus	2	–	-
	Pachytriton labiatus	2	–	-
	Paramesotriton chinensis	2	–	-
	Pleurodeles waltl	7	+	Tamukai et al. 2014
	Triturus marmoratus	3	+	bd-maps.net
	Tylototriton shanjing	2	–	-
	Tylototriton verrucosus	2	–	-
Gymnophiona				
Caeciliidae	*Typhlonectes natans*	1	+	Churgin et al. 2013

References in appendix

Berger, L., Speare, R. & Hyatt A. (1999) Chytrid fungi and amphibian declines: overview, implications and future directions. In: A. Campbell (Ed.), Declines and disappearances of Australian frogs (pp. 23–33). Environment Australia, Canberra.

Bletz, M.C., Rosa, G.M., Andreone, F., Courtis, E.A., Schmeller, D.S., Rabibisoa, N.H.C. et al. (2015) Widespread presence of the pathogenic fungus *Batrachochytrium dendrobatidis* in wild amphibian communities in Madagascar. Scientific Reports, 5, 8633. DOI 10.1038/srep08633.

Bowerman, J., Rombough, C., Weinstock, S.R. & Padgett-Flohr G.E. (2010) Terbinafine hydrochloride in ethanol effectively clears *Batrachochytrium dendrobatidis* in amphibians. Journal of Herpetological Medicine and Surgery, 20, 24–28. DOI 10.5818/1529-9651-20.1.24.

Churgin, S.M., Raphael, B.L., Trupkiewicz, J.G. & West G. (2013) *Batrachochytrium dendrobatidis* in aquatic caecilians (*Typhlonectes natans*): a series of cases from two institutions. Journal of Zoo and Wildlife Medicine, 44, 1002–1009. DOI 10.1638/2012-0288R1.1.

Courtois, E.A., Gaucher, P., Chave, J. & Schmeller, D.S. (2015) Widespread occurrence of *Bd* in French Guiana, South America. PLoS ONE, 10:e0125128. DOI 10.1371/journal.pone.0125128.

Gilbert, M., Bickford, D., Clark, L., Johnson, A. Joyner, P.H. Keatts, L.O. et al. (2012) Amphibian pathogens in southeast Asian frog trade. EcoHealth, 9, 386–398. DOI 10.1007/s10393-013-0817-7.

Imasuen, A.A., Aisien, M.S.O., Weldon, C., Dalton, D.L., Kotze, A. & du-Preez, L.H. (2011) Occurrence of *Batrachochytrium dendrobatidis* in amphibian populations of Okomu National Park, Nigeria. Herpetological Review, 42, 379–382.

Kik, M., Stege, M., Boonyarittichaikij, R. & van Asten. A. (2012) Concurrent ranavirus and *Batrachochytrium dendrobatidis* infection in captive frogs (*Phyllobates* and *Dendrobates* species), The Netherlands, 2012: A first report. Veterinary Journal, 194, 246–249. DOI 10.1016/j.tvjl.2012.09.016.

Miller, D.L., Rajeev, S., Brookins, M., Cook, J., Whittington, L. & Baldwin, Ch.A. (2008) Concurrent infection with Ranavirus, *Batrachochytrium dendrobatidis*, and *Aeromonas* in a captive anuran colony. Journal of Zoo and Wildlife Medicine, 39, 445–449. DOI 10.1638/2008-0012.1.

Ouellet, M., Mikaelian, I., Pauli, B.D., Rodrigue, J. & Green, D.M. (2005) Historical evidence for widespread chytrid infection in North American amphibian populations. Conservation Biology, 19, 1431–1440. DOI 10.1111/j.1523-1739.2005.00108.x.

Peel, A.J., Hartley, M. & Cunningham, A.A. (2012) Qualitative risk analysis of introducing *Batrachochytrium dendrobatidis* to the UK through the importation of live amphibians. Diseases of Aquatic Organisms, 98, 95–112. DOI 10.3354/dao02424.

Rothermel, B.B., Walls, S.C., Mitchell, J.C., Dodd Jr., C.K. Irwin, L.K., Green, D.E. et al. (2008) Widespread occurrence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* in the southeastern USA. Diseases of Aquatic Organisms, 82, 3–18. DOI 10.3354/dao01974.

Savage, A.E., Grismer, L.L., Anuar, S., Onn, C.K., Grismer, J.L., Quah, E. et al. (2011) First record of *Batrachochytrium dendrobatidis* infecting four frog families from Peninsular Malaysia. EcoHealth, 8, 121–128. DOI 10.1007/s10393-011-0685-y.

Speare, R. & Berger, L. (2004) Global distribution of chytridiomycosis in amphibians. Amphibian Diseases Research Group, Townsville, Australia.

Spitzen-van der Sluijs, A., Martel, A., Wombwell, E., Van Rooij, P., Zollinger, R., Woeltjes, T. et al. (2011) Clinically healthy amphibians in captive collections and at pet fairs: A reservoir of *Batrachochytrium dendrobatidis*. Amphibia-Reptilia, 32, 419–423. DOI 10.1163/017353711x579830.

Tamukai, K., Une, Y., Tominaga, A., Suzuki, K. & Goka, K. (2014) *Batrachochytrium dendrobatidis* prevalence and haplotypes in domestic and imported pet amphibians in Japan. Diseases of Aquatic Organisms, 109, 165–175. DOI 10.3354/dao02732.

Voyles, J., Richards-Hrdlicka, K., Cashins, S.D., Rosenblum, E.B., Hyatt, A.D. Berger, L. et al. (2010) *Batrachochytrium dendrobatidis*: requirement for further isolate collection and archiving. Diseases of Aquatic Organisms, 92, 109–112. DOI 10.3354/dao02216.

Weldon, C. (2005) Chytridiomycosis, an emerging infectious disease of amphibians in South Africa. PhD Dissertation, North-West University, Potchefstroom, South Africa.