BOLL. MUS. REG. SCI. NAT. TORINO Vol. 42 – N 1-2 ARTICLE doi: 10.4081/bmrsn.2026.89
Submission: 21-8-2026 – Accepted: 23-10-2026

Batrachochytrium salamandrivorans: a threat to the genus *Salamandra*

Sebastiano SALVIDIO,* Elena ERBANI, Lorenzo DONDERO, Elena GRASSELLI

Department of Earth, Environmental and Life Sciences, University of Genoa, Corso Europa 26, 16132 Genoa, Italy;
*E-mail: sebastiano.salvidio@unige.it

ABSTRACT

The recent spread of the amphibian pathogenic fungi *Batrachochytrium dendrobatidis* (Bd) and *Batrachochytrium salamandrivorans* (Bsal) is responsible for widespread population declines in many parts of the world. In Europe, Bsal was recently introduced in the Netherlands from Asia through international trade. Since 2013, Bsal has also spread in Germany, Belgium, and Catalonia, NE Spain, causing local declines in several species of salamanders and newts. Among the species sensitive to Bsal, the salamanders belonging to the genus *Salamandra* are highly susceptible. This research analyzed the peer-reviewed studies dealing with these species and Bsal in field populations, laboratory experiments, and captive collections by using modeling approaches. Overall, we retrieved 53 papers from different online databases. The following species were analyzed in at least one study: *Salamandra atra*, *S. algira*, *S. corsica*, *S. infraimmaculata*, *S. lanzai*, and *S. salamandra*. Overall, studies on wild populations were the most widespread, while those conducted in the lab or on captive individuals were less frequent. Studies using ecological modelling are becoming more frequent over time, suggesting an increasing interest in the possible future impacts of Bsal in geographical regions where the fungus is currently absent.

Keywords: Bsal, chytridiomycosis, emerging infectious disease, fire salamander, population declines, *salamandrivorans*, Urodela.

Introduction

The latest International Union for Conservation of Nature global assessment showed that amphibians are the most threatened vertebrate class, with approximately 41% of species at risk of extinction (Luedtke *et al*., 2023). The main global threats affecting amphibian populations are associated with habitat loss, degradation, or disturbance, climate change, invasive alien species, and the recent diffusion of emerging infectious diseases (Luedtke *et al*., 2023). Among these threats, the recent spread of the amphibian pathogenic fungi *Batrachochytrium dendrobatidis* (Bd) and *Batracho-chytrium salamandrivorans* (Bsal) is responsible for widespread population declines in regions such as Central and South America, Australia, and Central Europe (Martel *et al*., 2014; Byrne *et al*., 2019; Scheele *et al*., 2019). Anura, Urodela, and Gymnophiona are all susceptible to Bd, but only Urodela (*i.e*., salamanders and newts) are lethally affected by Bsal (Martel *et al*., 2014). This fungus is endemic to Asia and was recently introduced into Central Europe, probably through the international trade of Asian amphibians for aquariology and herpetoculture (Martel *et al*., 2014; Scheele *et al*., 2019).

In Europe, the first negative impact of Bsal, although not yet recognized as a new fungus species, was observed in the Netherlands, where local populations of the fire salamander *Salamandra salamandra* were experiencing a steep decline (Spitzen-Van Der Sluijs *et al*., 2013). In that study, the focal salamander population living near the town of Bunderbos remained relatively constant from 1997 to 2007, but starting from 2008, dead individuals were found in the field (Spitzen-Van Der Sluijs *et al*., 2013). Subsequently, a steep decline was observed; a novel chytrid fungus was isolated from these fire salamander populations and described as a new species: Bsal (Martel *et al*., 2013). This fungus causes lethal skin infections in many European salamanders and newts, as reported by Martel *et al*. (2014) and Gilbert *et al*. (2020). Subsequent studies showed that Bsal was already present in fire salamander populations found in the wild in Germany at least since 2004 (Lötters *et al*., 2020a, 2020b).

Currently, Bsal infection has been found in the wild on different species of salamanders and newts from the Netherlands, Germany, Belgium and Southern Spain (Martel *et al*., 2020). It was also found in several private herpetological collections maintained by private owners in different European countries (*e.g*., Sabino-Pinto *et al*., 2015; Lastra Gonzalez *et al*., 2020). In Central Europe, it has been estimated that Bsal infection is spreading naturally with an annual rate of 10–12 km (Akcakaya *et al*., 2023). Conversely, the completely isolated 2018 Bsal outbreak in Catalonia, Northeast Spain, was probably caused by the release in the wild of exotic newts kept in captivity by a local private owner (Martel *et al*., 2020). Therefore, considering the natural and anthropogenic vectors facilitating the spread of Bsal, the projections of the future impact of this pathogen indicate a high risk of extinction for several European salamanders (Gilbert *et al*., 2020; Akcakaya *et al*., 2023).

A recent paper compiled the host species and the invasion-range data of Bsal up to 2021 (Castro Monzon *et al*., 2022). In this paper, we specifically focus on the genus *Salamandra* Garsault, 1764, reviewing the scientific literature concerning the chytrid pathogen Bsal to compile information on the geographic distribution, temporal trends, and development of the different research approaches (observational, experimental, or modelling). Our main goal was to focus specifically on analyzing the taxonomic and geographic range of these studies. In addition, we were interested in better understanding the main scientific approaches to studying the relationship between Bsal and the species of the genus *Salamandra* and their development over time.

Materials and Methods

In this paper, we are reporting on the six currently recognized species belonging to the genus *Salamandra* (Bosch *et al*., 2021; Burgon *et al*., 2021). In addition to these six full species, we also considered one subspecies, the golden Alpine salamander *S. atra aurorae*, because it is listed as a priority taxon in Annexes II and IV of the European Union "Habitat" Directive 92/43/EEC.

Different online databases were used to compile this preliminary review. The bibliographic search was completed in April 2026, but only papers published through 2025 were considered in our study. Scopus database was searched by the means of this prompt: (TITLE-ABS-KEY (salamandra) AND TITLE-ABS-KEY (chytridiomycosis) OR TITLE-ABS-KEY (chytrid) OR TITLE-ABS-KEY salamandrivorans)). Scholar Lab was searched with: Find papers dealing with the genus "Salamandra" and the chytrid "salamandrivorans". In addition, the reference list of the retrieved papers was consulted to obtain further scientific articles. We considered only papers in which Bsal was directly connected to species belonging to the genus *Salamandra*, thus excluding reviews referencing the results of other studies. For each paper, we recorded the study species, the country from which samples or individuals were obtained, and whether the analyses were on wild, captive, or experimentally infected individuals in the laboratory. Moreover, papers modelling the ecological niche or projecting Bsal spreading rates if the starting parameters were estimated from the fire salamander biological traits were considered. We were interested in the temporal evolution of different research approaches and, therefore, if the same paper reported results from field, captive, and experimentally infected individuals, each approach was counted once, potentially totalling three.

Temporal trends in the observed time series were analysed with the Mann-Kendall non-parametric test (Gilbert, 1987).

Results

Overall, we retrieved and analysed 53 papers dealing with at least one of the species belonging to the genus *Salamandra* and the chytrid fungus Bsal (*Supplementary Table I*). In our analysis, we also included the first article reporting the enigmatic decline of the fire salamander in the Netherlands (Spitzen-Van Der Sluijs *et al*., 2013). At that time, Bsal was not yet isolated and described, but the authors correctly suggested that "…the most likely cause seems to be either an infectious agent or intoxication, possibly in combination with other causes" (Spitzen-Van Der Sluijs *et al*., 2013).

Starting from 2013, the number of scientific papers increased gradually and peaked at 10 in 2020, but subsequently decreased to five or fewer (Fig. 1). Over the entire period 2013–2025, no significant temporal trend was observed (Mann-Kendall test, $Z=1.064$, $p=0.2874$). The temporal analysis showed that Bsal field analyses were continuous, while testing salamanders in captive collections and experimentally in the laboratory was more sporadic. The ecological modelling approach began in 2017 and has been frequently used since.

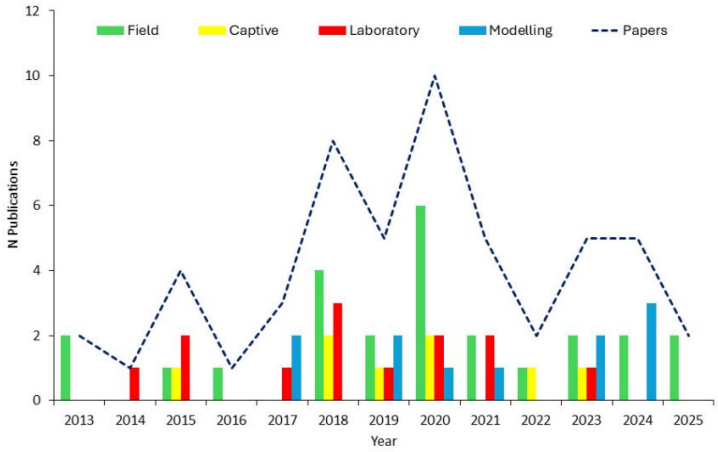


Fig. 1. Distribution over time of different types of studies relating species of the genus *Salamandra* to the emerging infectious disease *Batrachochytrium salamandrivorans*.

Bsal infection was assessed in wild populations of four species and one subspecies, on all six species in captive collections, and was tested experimentally on two species (Tab. I). The sampling and testing for Bsal infection in wild populations were conducted in 23 different studies at times using multiple approaches. These studies concentrated in 14 European countries in addition to Israel (Fig. 2). It is noteworthy that almost 60% (21/36) of these studies were conducted in Germany, the Netherlands, Belgium and Spain, all countries in which Bsal has been confirmed in wild amphibian hosts.

Tab. I. Synthesis of the studies connecting Bsal and the species of the genus *Salamandra* Garsault, 1764.

Species	Author	Field	Laboratory	Captive
Salamandra algira	Bedriaga, 1883	0	1	1
Salamandra atra	Laurenti, 1768	1	0	1
Salamandra atra aurorae	Trevisan, 1982	1	0	0
Salamandra corsica	Savi, 1838	0	0	1
Salamandra infraimmaculata	(Martens, 1885)	1	0	1
Salamandra lanzai	Nascetti, Andreone, Capula & Bullini, 1988	1	0	1
Salamandra salamandra	Linnaeus, 1758	1	1	1

Bsal, *Batrachochytrium salamandrivorans*.

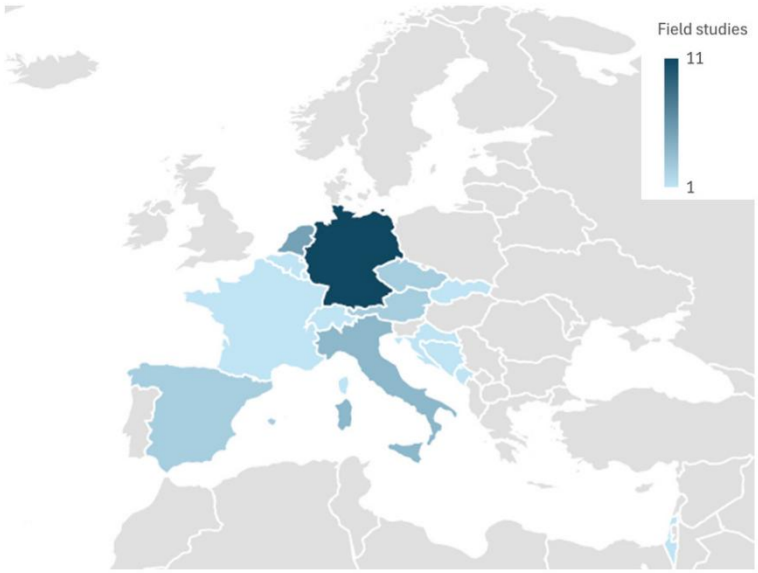


Fig. 2. Geographical distribution of field studies relating species of the genus *Salamandra* to the emerging infectious disease *Batrachochytrium salamandrivorans*.

Discussion and Conclusions

Our overview highlights the rapid development of scientific research concerning the interaction between Bsal and species of the genus *Salamandra* since the first documented population collapse of *Salamandra salamandra* in the Netherlands (Spitzen-Van Der Sluijs *et al*., 2013). The publication temporal trend increased starting from the discovery and description of Bsal in 2013, peaking in 2020 (Fig. 1).

The concentration of field studies in Germany, the Netherlands, Belgium and Spain, all countries in which the occurrence of Bsal was confirmed, stresses the need to better understand its local epidemiology and the possible impacts on the local urodeles communities. However, several European and Caucasian areas hosting endemic salamander taxa remain under-investigated despite being potentially highly suitable habitats for Bsal (Beukema *et al*., 2018; Beukema *et al*., 2021). Experimental studies in the lab represented only a minor proportion of the literature analyzed. This is because the experimental use of live animals is strictly regulated by national and international laws maximizing animal protection and welfare (EU Regulation 2019/1010), often necessitating specific study permits and highly specialized research facilities. Recently, the use of experiments with the use of Bsal on living salamanders appears decreasing, with only one study in the 4-year period 2022–2025. This may suggest that increasing ethical concerns about animal welfare could possibly contribute to the evaluation of the experimental approach to Bsal testing on live salamanders (Boren *et al*., 2026)

Finally, since 2017, ecological modeling has become a regular component of Bsal research, reflecting growing interest in forecasting disease spread and identifying vulnerable areas at risk before pathogen arrival. Predictive models are particularly valuable because Bsal is currently absent from large portions of Europe where many susceptible salamander hosts occur (Beukema *et al*., 2018). To reduce the fungus introduction, biosecurity measures and control of animal trade should be prioritized by researchers and policymakers (Thomas *et al*., 2020; Böning *et al*., 2026). However, model reliability remains dependent on the quality of occurrence data of both Bsal and its amphibian hosts and on evidence and assumptions regarding specific host susceptibility, environmental suitability and transmission dynamics, all issues that remain highly debated in the herpetological community (e.g., Akcakaya *et al*., 2023; Canessa *et al*., 2024).

RIASSUNTO

Batrachochytrium salamandrivorans: una minaccia per il genere *Salamandra*

La recente diffusione dei funghi patogeni *Batrachochytrium dendrobatidis* (Bd) e *Batrachochytrium salamandrivorans* (Bsal) è responsabile di un diffuso declino delle popolazioni di anfibi in molte zone del mondo. In Europa, Bsal è stato introdotto di recente nei Paesi Bassi dall'Asia attraverso il commercio internazionale di animali da terrario. Dal 2013, Bsal si è diffuso anche in Germania, Belgio e nel sud della Spagna, causando il declino locale di diverse specie di salamandre e tritoni. Tra le specie sensibili a Bsal, quelle appartenenti al genere *Salamandra* sono estremamente suscettibili. La presente ricerca ha analizzato gli studi sottoposti a revisione riguardanti queste specie e Bsal, su popolazioni in natura, esperimenti di laboratorio, esemplari in cattività e uso di modelli ecologici. Complessivamente, sono stati reperiti 53 articoli da diverse banche dati online. Le specie analizzate in almeno uno studio sono state: *Salamandra atra*, *S. corsica*, *S. infraimmaculata*, *S. lanzai* e *S. salamandra*. Nel complesso, gli studi su popolazioni selvatiche sono risultati i più numerosi, mentre quelli condotti in laboratorio o su esemplari in cattività sono poco frequenti. Gli studi che utilizzano modelli ecologici stanno diventando sempre più comuni, suggerendo un crescente interesse per i possibili impatti futuri di Bsal nelle regioni geografiche in cui il fungo è attualmente assente.

Parole chiave: Bsal, chitridiomicosi, malattia infettiva emergente, salamandra pezzata, declino delle popolazioni, *salamandrivorans*, Urodela.

REFERENCES

AKCAKAYA H.R., NEAM K., HOBIN L., LÖTTERS S., MARTEL A., PASMANS F., 2023. Assessing the extinction risks of amphibians impacted by infectious diseases. – Biological Conservation, 284: 110205.

BEUKEMA W., MARTEL A., NGUYEN T.T., GOKA K., SCHMELLER D.S., YUAN Z., LAKING A., NGUYEN T.Q., LIN C-F., SHELTON J., LOYAU A., PASMANS F., 2018. Environmental context and differences between native and invasive observed niches of *Batrachochytrium salamandrivorans* affect invasion risk assessments in the Western Palaearctic. – Diversity and Distribution, 24: 1788–1801.

BEUKEMA W., ERENS J., SCHULZ V., STEGEN G., SPITZEN-VAN DER SLUIJS A., STARK T., LAUDELOUT A., KINET T., KIRSCHEY T., POULAIN M., MIAUD C., STEINFARTZ S., MARTEL A., PASMANS F., 2021. Landscape epidemiology of *Batrachochytrium salamandrivorans*: reconciling data limitations and conservation urgency. – Ecological Applications, 31: e02342.

BÖNING P., LÖTTERS S., BALÁŽ V., BEUKEMA W., BOSCH J., CARRANZA S., CUNNINGHAM A.A., ERENS J., FISHER M.C., GARNER T.W.J., GILBERT M.J., GLASER F., GORTAZAR C., GRASSELLI E., GRAY M.J., FERNÁNDEZ-GUIBERTEAU D., KINET T., KOSTANJŠEK R., GONZÁLEZ D.L., LAUDELOUT A., MARTEL A., MARTÍNEZ-SILVESTRE A., MIAUD C., PABIJAN M., PLEWNIA A., PREININGER D., RANNAP R., SALVIDIO S., SCHWEINSBERG M., SPITZEN-VAN DER SLUIJS A., STASSEN R., STRACHINIS I., THUMSOVÁ B., VIRGO J., VOJAR J., VEITH M., PASMANS F., 2026. Inconsistent strategies to mitigate the effects of *Batrachochytrium salamandrivorans*, Europe. – Emerging Infectious Diseases, 32: 1–5.

BOREN A., LESBARRÈRES D., BYRNE A.Q., 2026. Replace, reduce, refine: A review of animal use in *Batrachochytrium salamandrivorans* research. – Conservation Science and Practice, 2026: e70322.

BOSCH J., MARTEL A., SOPNIEWSKI J., THUMSOVÁ B., AYRES C., SCHEELE B.C., VELO-ANTÓN G., PASMANS F., 2021. *Batrachochytrium salamandrivorans* threat to the Iberian Urodele hotspot. – Journal of Fungi, 2021: 644.

BURGON J.D., VENCES M., STEINFARTZ S., BOGAERTS S., BONATO L., DONAIRE-BARROSO D., MARTÍNEZ-SOLANO I., VELO-ANTON G., VIEITES D.R., MABLE B.K., ELMER K.R., 2021. Phylogenomic inference of species and subspecies diversity in the Palearctic salamander genus *Salamandra*. – Molecular Phylogenetics and Evolution, 157: 107063.

BYRNE A.Q., VREDENBURG V.T., MARTEL A., PASMANS F., BELL R.C., BLACKBURN D.C., BLETZ M.C., BOSCH J., BRIGGS C.J., BROWN R.M., CATENAZZI A., FAMILIAR LÓPEZ M., FIGUEROA-VALENZUELA R., GHOSE S.L., JAEGER J.R., JANI A.J., JIRKU M., KNAPP R.A., MUÑOZ A., PORTIK D.M., RICHARDS-ZAWACKI C.L., ROCKNEY H., ROVITO S.M., STARK T., SULAEMAN H., TAO N.T., VOYLES J., WADDLE A.W., YUAN Z., ROSENBLUM E.B., 2019. Cryptic diversity of a widespread global pathogen reveals expanded threats to amphibian conservation. – Proceedings of the National Academy of Sciences USA, 116: 20382–20387.

CANESSA S., BIANCOLINI D., IANNELLA M., BERNABO I., SALVI D., VIGNOLI L., LUNGHI E., COSTA E., RAZZETTI E., FICETOLA G.F., ROMANO A., 2024. Uncertain future and uncertain projections: assessing extinction risks in European salamanders from projected chytrid fungus invasion using IUCN Criterion E. – Acta Herpetologica, 19: 155–159.

CASTRO MONZON F., KANNING N., YASELGA E.G., ZHU W., LÖTTERS S., 2022. Batrachochytrium salamandrivorans' impact on host communities. – EcoHealth, 19: 492–507.

GILBERT M.J., SPITZEN-VAN DER SLUIJS A.M., CANESSA S., BOSCH J., CUNNINGHAM A.A., GRASSELLI E., LAUDELOUT A., LÖTTERS S., MIAUD C., SALVIDIO S., VEITH M., MARTEL A., PASMANS F., 2020. Mitigating *Batrachochytrium salamandrivorans* in Europe. *Batrachochytrium salamandrivorans* Action Plan for European urodeles. – Nijmegen, the Netherlands.

GILBERT R.O., 1987. Statistical methods for environmental pollution monitoring. – Van Nostrand Reinhold, New York.

LASTRA GONZÁLEZ D., BALÁŽ V., CHAJMA P., VOJAR J., 2020. Surveying for *Batrachochytrium salamandrivorans* presence in Spanish captive collections of amphibians. – Diseases of Aquatic Organisms, 142: 99–103.

LÖTTERS S., WAGNER N., ALBALDEJO G., BÖNING P., DALBECK L., DUSSEL H., FELDMEIER S., GUSCHAL M., KIRST K., OHLHOFF D., PREISSLER K., REINHARDT T., SCHLUPMANN M., SCHULTE U., SCHULZ V., STEINFARTZ S., TWIETMEYER S., VEITH M., VENCES M., WEGGE J., 2020a. The amphibian pathogen *Batrachochytrium salamandrivorans* in the hotspot of its European invasive range: past – present – future. – Salamandra, 56: 173–188.

LÖTTERS S., VEITH M., WAGNER N., MARTEL A., PASMANS F., 2020b. Bsal-driven salamander mortality predates the European index outbreak. – Salamandra, 56: 239–242.

LUEDTKE J.A., CHANSON J., NEAM K., HOBIN L., MACIEL A.O., CATENAZZI A., BORZÉE A., HAMIDY A., AOWPHOL A., JEAN A., SOSA-BARTUANO Á., FONG G.A., DE SILVA A., FOUQUET A., ANGULO A., KIDOV A.A., MUÑOZ SARAVIA A., DIESMOS A.C., TOMINAGA A., SHRESTHA B., GRATWICKE B., TJATURADI B., MARTÍNEZ RIVERA C.C., VÁSQUEZ ALMAZÁN C.R., SEÑARIS C., CHANDRAMOULI S.R., STRÜSSMANN C., CORTEZ FERNÁNDEZ C.F., AZAT C., HOSKIN C.J., HILTON-TAYLOR C., WHYTE D.L., GOWER D.J., OLSON D.H., CISNEROS-HEREDIA D.F., SANTANA D.J., NAGOMBI E., NAJAFI-MAJD E., QUAH E.S.H., BOLAÑOS F., XIE F., BRUSQUETTI F., ÁLVAREZ F.S., ANDREONE F., GLAW F., CASTAÑEDA F.E., KRAUS F., PARRA-OLEA G., CHAVES G., MEDINA-RANGEL G.F., GONZÁLEZ-DURÁN G., ORTEGA-ANDRADE H.M., MACHADO I.F., DAS I., DIAS I.R., URBINA-CARDONA J.N., CRNOBRNJA-ISAILOVIĆ J., YANG J.H., JIANPING J., WANGYAL J.T., ROWLEY J.J.L., MEASEY J., VASUDEVAN K.,

CHAN K.O., GURURAJA K.V., OVASKA K., WARR L.C., CANSECO-MÁRQUEZ L., TOLEDO L.F., DÍAZ L.M., KHAN M.M.H., MEEGASKUMBURA M., ACEVEDO M.E., NAPOLI M.F., PONCE M.A., VAIRA M., LAMPO M., YÁNEZ-MUÑOZ M.H., SCHERZ M.D., RÖDEL M.O., MATSUI M., FILDOR M., KUSRINI M.D., AHMED M.F., RAIS M., KOUAMÉ N.G., GARCÍA N., GONWOUO N.L., BURROWES P.A., IMBUN P.Y., WAGNER P., KOK P.J.R., JOGLAR R.L., AUGUSTE R.J., BRANDÃO R.A., IBÁÑEZ R., VON MAY R., HEDGES S.B., BIJU S.D., GANESH S.R., WREN S., DAS S., FLECHAS S.V., ASHPOLE S.L., ROBLETO-HERNÁNDEZ S.J., LOADER S.P., INCHÁUSTEGUI S.J., GARG S., PHIMMACHAK S., RICHARDS S.J., SLIMANI T., OSBORNE-NAIKATINI T., ABREU-JARDIM T.P.F., CONDEZ T.H., DE CARVALHO T.R., CUTAJAR T.P., PIERSON T.W., NGUYEN T.Q., KAYA U., YUAN Z., LONG B., LANGHAMMER P., STUART S.N., 2023. Ongoing declines for the world's amphibians in the face of emerging threats. – Nature, 622: 308–314.

MARTEL A., SPITZEN-VAN DER SLUIJS A., PASMANS F., 2013. *Batrachochytrium salamandrivorans* sp. nov. causes lethal chytridiomycosis in amphibians. – Proceedings of the National Academy of Sciences USA, 110: 15325–15329.

MARTEL A., BLOOI M., ADRIAENSEN C., VAN ROOIJ P., BEUKEMA W., FISHER M.C., FARRER R.A., SCHMIDT B.R., TOBLER U., GOKA K., LIPS K.R., MULETZ C., ZAMUDIO K.R., BOSCH J., LÖTTERS S., WOMBWELL E., GARNER T.W., CUNNINGHAM A.A., SPITZEN-VAN DER SLUIJS A., SALVIDIO S., DUCATELLE R., NISHIKAWA K., NGUYEN T.T., KOLBY J.E., VAN BOCXLAER I., BOSSUYT F., PASMANS F., 2014. Recent introduction of a chytrid fungus endangers Western Palearctic salamanders. – Science, 346: 630–631.

MARTEL A., VILA-ESCALE M., FERNANDEZ-GUIBERTEAU D., MARTINEZ-SILVESTRE A., CANESSA S., VAN PRAET S., PANNON P., CHIERS K., FERRAN A., KELLY M., PICART M., PIULATS D., LI Z., PAGONE V., PEREZ-SORRIBES L., MOLINA C., TARRAGO-GUARRO A., VELARDE-NIETO R., CARBONELL F., OBON E., MARTINEZ-MARTINEZ D., GUINART D., CASANOVAS R., CARRANZA S., PASMANS F., 2020. Integral chain management of wildlife diseases. – Conservation Letters, 13: e12707.

SABINO-PINTO J., BLETZ M., HENDRIX R., PERL R.B., MARTEL A., PASMANS F., LÖTTERS S., MUTSCHMANN F., SCHMELLER D.S., SCHMIDT B.R., VEITH M., WAGNER N., VENCES M., STEINFARTZ S., 2015. First detection of the emerging fungal pathogen *Batrachochytrium salamandrivorans* in Germany. – Amphibia-Reptilia, 36: 411–416.

SCHEELE B.C., PASMANS F., SKERRATT L.F., BERGER L., MARTEL A., BEUKEMA W., ACEVEDO A.A., BURROWES P.A., CARVALHO T., CATENAZZI A., DE LA RIVA I., FISHER M.C., FLECHAS S.V., FOSTER C.N., FRÍAS-ÁLVAREZ P., GARNER T.W., GRATWICKE B., GUAYASAMIN J.M., HIRSCHFELD M., KOLBY J.E., KOSCH T.A., LA MARCA E., LINDENMAYER D.B., LIPS K.R., LONGO A.V., MANEYRO R., MCDONALD C.A., MENDELSON III J., PALACIOS-RODRIGUEZ P., PARRA-OLEA G., RICHARDS-ZAWACKI C.L., RÖDEL M.O., ROVITO S.M., SOTO-AZAT C., TOLEDO L.F., VOYLES J., WELDON C., WHITFIELD S.M., WILKINSON M., ZAMUDIO K.R., CANESSA S., 2019. Amphibian fungal panzootic causes catastrophic and ongoing loss of biodiversity. – Science, 363: 1459–1463.

SPITZEN-VAN DER SLUIJS A., SPIKMANS F., BOSMAN W., DE ZEEUW M., VAN DER MEIJ T., GOVERSE E., KIK M., PASMANS F., MARTEL A., 2013. Rapid enigmatic decline drives the fire salamander (*Salamandra salamandra*) to the edge of extinction in the Netherlands. – Amphibia-Reptilia, 34: 233–239.

THOMAS V., WANG Y., VAN ROOIJ P., VERBRUGGHE E., BALAZ V., BOSCH J., CUNNINGHAM A.A., FISHER M.C., GARNER T.W.J., GILBERT M., KINET T., LAUDELOUT A., LÖTTERS S., LOYAU A., MIAUD C., SALVIDIO S., SCHEMELLER D.S., SCHMIDT B., SPITZEN-VAN DER SLUIJS A., STEINFARTZ S., VEITH M., VENCES M., WAGNER N., CANESSA S., MARTEL A., PASMANS F., 2019. Mitigating *Batrachochytrium salamandrivorans* in Europe. – Amphibia-Reptilia, 40: 265–290.

Contributions: Elena Grasselli and Sebastiano Salvidio devised this research. Sebastiano Salvidio and Elena Erbani wrote a first draft of the manuscript. Elena Erbani and Lorenzo Dondero made bibliographic research; all authors read and approved the manuscript.

Conflict of interest: the authors declare no conflicts of interest.

Ethics approval: This paper is based on published references, all cited in the Reference list. Therefore, no ethical approval is needed.

Availability of data and materials: all data used in this manuscript are provided in Supplementary Material (APPENDIX I).

Acknowledgments: the authors are grateful to Franco Andreone, Fabio Maria Guarino and Raoul Manenti for organizing the Salamandra Workshop in Ostana. Two anonymous Reviewers improved the final version of the manuscript.

Declaration of generative artificial intelligence and artificial intelligence-assisted technologies in the writing process: the entire writing process was human-generated.

Conference presentation: this paper was presented on the occasion of the 1st "Workshop Salamandra", which was held in Ostana (Cuneo) on 11-12 July 2026.