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PERSPECTIVE NOTE OPEN ACCESS

Reported declines of the grooved carpet-shell clam (*Ruditapes decussatus*) across southwestern Europe and the Mediterranean: insights from expert knowledge

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Abstract – The grooved carpet-shell clam (*Ruditapes decussatus*) is a native clam species that inhabits estuaries, lagoons, and coastal flats along the Mediterranean Sea and the northeast Atlantic. This highly prized bivalve is an ecosystem engineer that provides major ecological functions, including water filtration and sediment bioturbation. A decline in production has recently been observed in several areas of southwestern European and the Mediterranean region; however, data documenting this phenomenon remain scarce and are largely unpublished. To address this knowledge gap, we conducted a study based on official statistics, the expertise of 24 marine ecosystem experts from eight countries covering 17 coastal sites, and a preliminary literature map. This approach enabled the development of an expert-informed regional perspective on the reported declines of *R. decussatus*, as well as a synthesis of the regulatory measures and restoration actions implemented across the study area. The findings indicate a sharp decline in both production (−32 to −100%) and stocks (≈ −80%) over the past two decades. The onset of the decline varied among sites, occurring between 2003 and 2024. According to the participating experts, the main suspected

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drivers of the decline were disease, overfishing, competition with alien species, and climate change. The most common regulatory measures were minimum conservation reference sizes, closed fishing seasons, and licenses. Only a few restoration projects were identified, focusing on restocking through seeding, the collection of natural broodstock, harvesting natural spat or substrate modification. This study provides a preliminary overview of the seemingly widespread decline of *R. decussatus* across the southwestern European and Mediterranean region and highlights the need for coordinated research to elucidate the causes of this reported decline, as well as for restoration actions to support the recovery of this native species.

Keywords: Collapse / *Ruditapes decussatus* / grooved carpet-shell clam / expert knowledge / ecological restoration / southwestern Europe and the Mediterranean

1 Introduction

Clams of the genus *Ruditapes*, particularly the Manila clam *R. philippinarum* (A. Adams and Reeve, 1850) and the grooved carpet shell clam *R. decussatus* (Linnaeus, 1758), are major ecological and socioeconomic resources in temperate coastal ecosystems of the Pacific, Atlantic, and Mediterranean regions. They are ecosystem engineers that provide major ecological functions, including water filtration and sediment bioturbation. In the 1970s, *R. philippinarum* was introduced beyond its native range into several European regions for aquaculture purposes because of its high adaptability to a wide range of environmental conditions (Latrouite and Claude, 1976; Drummond et al., 2006; de Montaudouin et al., 2016). Following these introductions, the species spread under favourable conditions to numerous sites, where it established self-sustaining populations (Pastres et al., 2001; Jensen et al., 2004; de Montaudouin et al., 2016; Reise et al., 2024). During the same period, native *R. decussatus* populations experienced reduced abundance and declining catches (Bidegain and Juanes, 2013; Román et al., 2023).

R. decussatus inhabits estuaries, lagoons, and coastal flats along the Mediterranean Sea and the northeastern Atlantic coasts. Most of the global production of this highly prized bivalve comes from southern Europe, where it is harvested by artisanal fishers and cultivated in aquaculture. Declines in production have been reported in several areas of southwestern Europe and the Mediterranean region. These declines were particularly marked in Portugal during the 1990s and were followed by a further decrease between 2009 and 2015, with particularly sharp declines observed in Tunisia (Fig. 1). Similar trends have been observed elsewhere; for example, in Galicia (NW Spain) only 69.8 t of *R. decussatus* were sold in 2025 compared with 830 t in 2020 (http://www.pescadegalicia.gal). However, data documenting these declines remain scarce and are largely unpublished. The aim of this study is therefore to assess the current status of *R. decussatus* clam populations across the southwestern European and Mediterranean region. To achieve this objective, we combined official production statistics, expert knowledge, and a preliminary literature map to develop an expert-informed regional perspective on the reported declines of *R. decussatus*, while also synthesizing current regulatory measures and restoration actions.

2 Local knowledge regarding the status of *Ruditapes decussatus* populations

We drew on information provided by 24 marine ecosystem experts from eight countries, covering 17 coastal sites, to assess whether *R. decussatus* populations are declining in their ecosystems, identify the main suspected drivers of these declines, and compile information on current regulatory measures and restoration initiatives. Experts were initially contacted by email between December 2025 and February 2026 through the authors' professional network, drawing in particular on the contacts established during the SYMPA conference (Riquet et al., 2026). They were asked the following question: *"Could you please help us identify information, analyses, or summarised data on the status of European grooved carpet clam populations in your region (e.g. has a recent decline or collapse been observed?) and on the restoration measures that have been implemented or are planned?"* The respondents included 23 scientists and one representative of the fishing community. In a second phase, one member of the research team summarised the responses in a spreadsheet and circulated it to all respondents for validation and completion. Additional information was requested for four categories: (i) stock or production decline, (ii) suspected causes of the decline, (iii) management measures, and (iv) restoration measures. In parallel, we conducted a systematic review of studies indexed in the Web of Science between 2000 and 2025 (Tab. S1, search performed on 16 March 2026; TOPIC = "*Ruditapes decussatus*" AND ["climate change" OR "disease" OR "alien" OR "chemical" OR "habitat" OR "fishing" OR "eutrophication" OR "anoxia" OR "starvation" OR "oligotrophication" OR "recruitment"]). Synonyms of the species name were also included in the search. Review papers and studies focusing primarily on *R. philippinarum* were excluded. The review aimed to assess whether the suspected drivers identified by the experts have been empirically investigated in *R. decussatus* and to identify remaining knowledge gaps. It should be noted that all studies examining the effects of the suspected drivers were included, even if the studies did not explicitly investigate their causal role in the observed declines or focus on the 17 study sites. Consequently, Figure 3 and Table S1 should be interpreted as reflecting research efforts rather than providing evidence for the causes of the reported declines.

Based on the experts' reports, declines in *R. decussatus* were identified at 13 of the 17 study sites (Fig. 2). Over the past two decades, harvests declined by 32–100%, while stock abundance decreased by approximately 80% (Tab. 1). The onset of the decline varied among sites, occurring between 2003 and 2024, consistent with trends reported in FAO statistics (FAO, 2025; Fig. 1). At the remaining four sites, no assessment was possible because of a lack of records or the absence of reported fishing activity.

Among the regulatory measures cited, minimum conservation reference size (MCRS) was the most common (n=10),

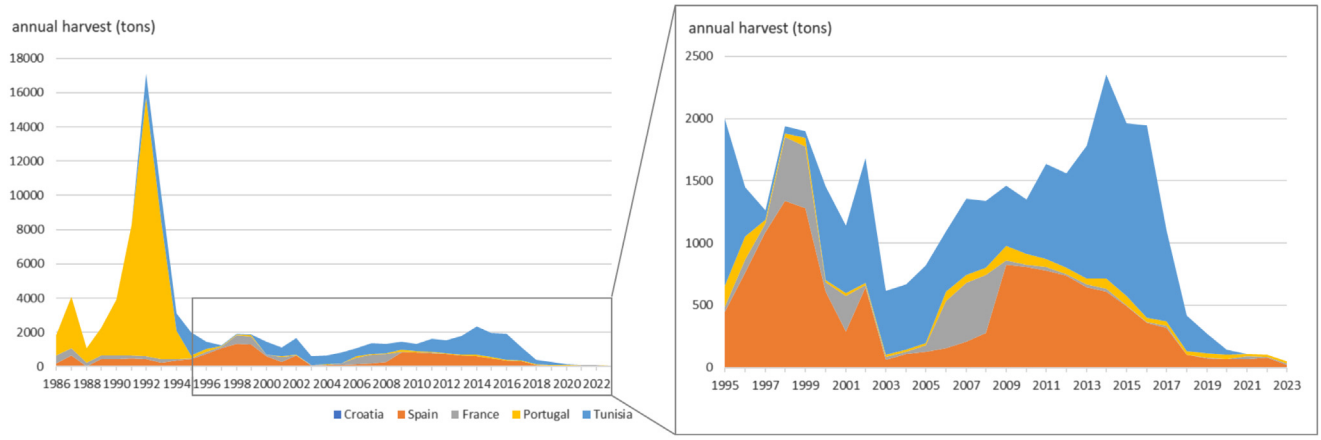

Fig. 1. Annual harvest (tons) of *R. decussatus* in the southwestern Europe and the Mediterranean from 1986 to 2023 (left panel) and focus on the period 1995–2023 (right panel). The data for Croatia are barely discernible, as tonnages were zero until 2008, after which they varied between 0.019 t and 6 t. Data from FAO (2025).

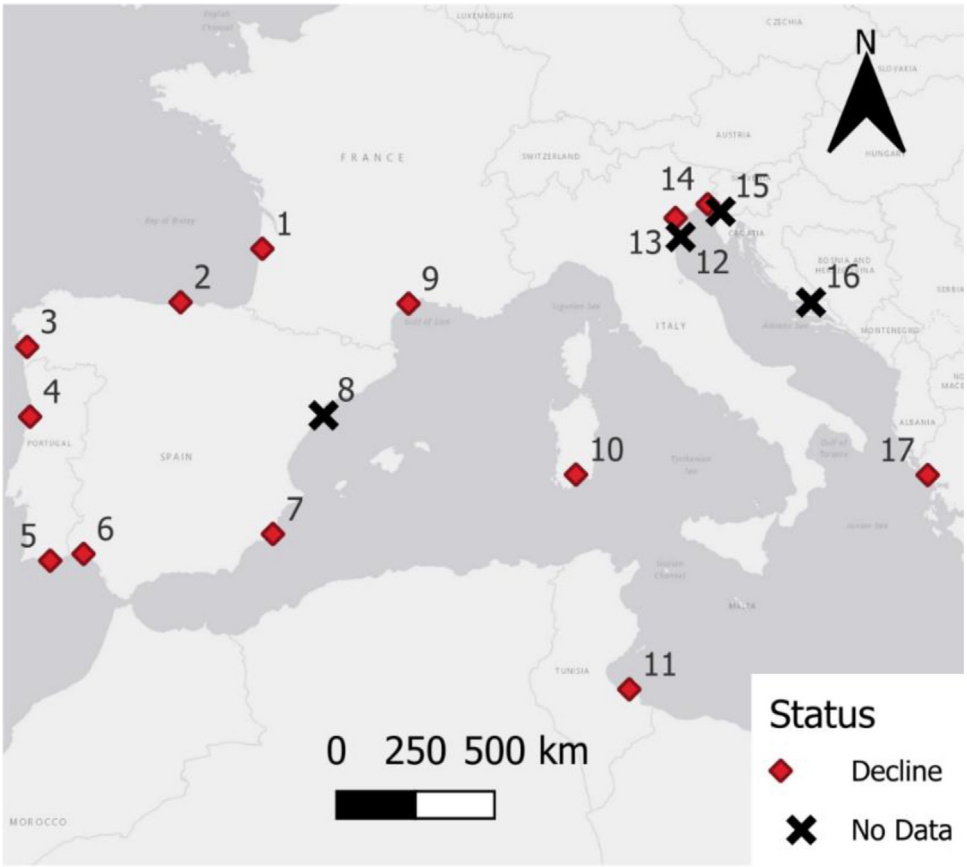

Fig. 2. Location of the sites and status of the *R. decussatus* reported by the experts. "No data" means either a lack of data or the absence of fishing activity.

followed by closed fishing seasons and licensing requirements (n=3). The severity of the declines has resulted in fishing bans in Cantabria (Spain) and the Gulf of Gabès (Tunisia) (OESA - Fundación Biodiversidad, 2021; Gharbi et al., 2023). Restoration actions were identified at only six sites and focused on restocking through clam seeding, the collecting of natural broodstock, the harvesting of natural spat, and substrate modification (Tab. 1) (OESA - Fundación Biodiversidad, 2021; S. Román et al., 2024b; Medhioub et al., 2024). The restoration actions identified in this study began as early as the 1980s in France and were implemented more recently at other sites (from 2015 onwards). However, their

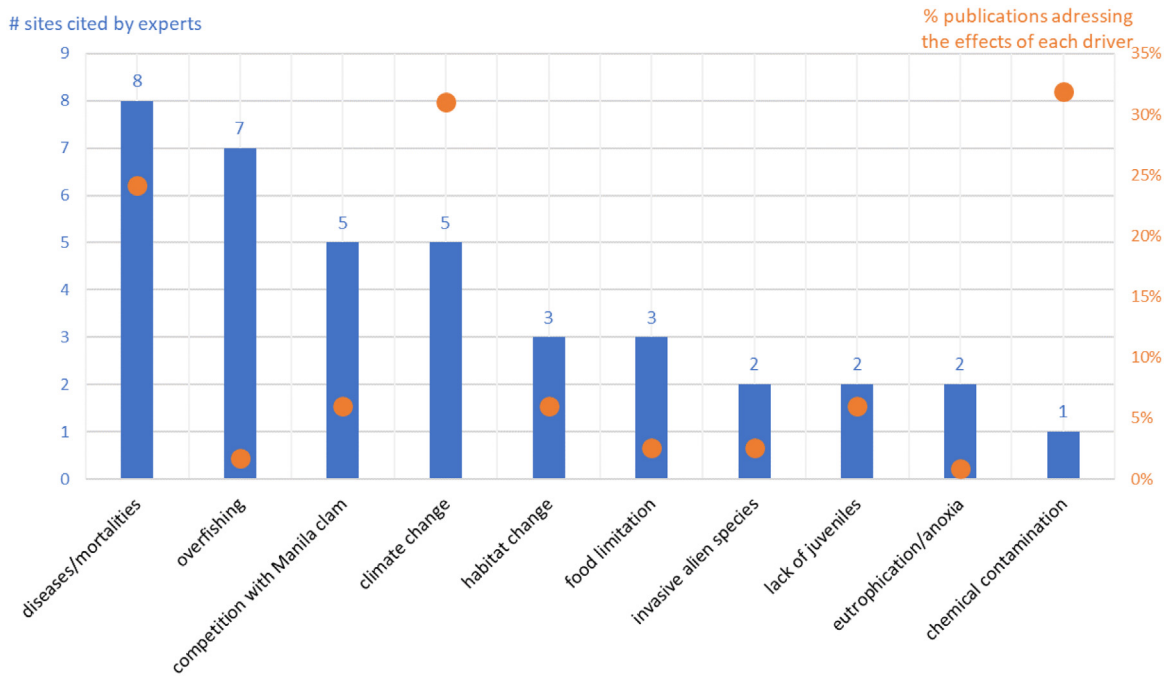

Fig. 3. Suspected drivers cited by the experts for the decline in *R. decussatus* (number of sites cited for each case of decline, blue barplot with the *y*-axis on the left) compared to the percentage of publications addressing the effects of these drivers (orange dots with the *y*-axis on the right) from 2000 to 2025 (n = 116).

effectiveness has not yet been evaluated by either the experts or the scientific literature.

The predominant suspected drivers of the observed decline, as identified by the experts across the 13 affected study sites, are shown in Figure 3 and Table S1. The four most frequently reported were disease and mass mortality events, overfishing, competition with *R. philippinarum*, and climate change, whereas chemical contamination was the least frequently cited. Although overfishing was identified as one of the main suspected drivers, only two publications investigated its effects on *R. decussatus*. In contrast, chemical contamination was reported as a suspected driver at only one site, despite accounting for 32% of the publications included in the literature map. Some suspected drivers, such as eutrophication/anoxia, food limitation, and lack of juveniles, received very limited research attention, together representing only 6% of the publications.

3 Discussion

Our study confirms the recent regional-scale decline in *R. decussatus* highlighted by the FAO for the periods 1999–2003 and 2009–2015 (Fig. 1), and complements these observations with information provided by local experts from 13 sites across the southwestern European and Mediterranean region. The experts identified several suspected drivers whose effects on *R. decussatus* have been investigated in recent studies. These drivers are consistent with observations for *R. philippinarum* in Japan, where the decline has been attributed not to a single factor but to the combined effects of environmental, biological, and anthropogenic pressures acting at different stages of the clam's life cycle (Toba, 2017; Toba et al., 2025; Shindo and Hibino, 2025). Similarly, in Arcachon Bay (France), the observed variability and reduced performance of *R. philippinarum* appear to result from the combined effects of infectious diseases, environmental conditions, fishing pressure, and site-specific ecological constraints (de Montaudouin et al., 2016). Although *R. decussatus* and *R. philippinarum* differ in their ecological characteristics, environmental sensitivities, and fisheries contexts, the much broader body of knowledge available for *R. philippinarum* provides a useful framework for interpreting the decline in *R. decussatus*. Accordingly, the following discussion largely draws on research conducted on *R. philippinarum* to highlight potential priorities and directions for future research on *R. decussatus*.

Among the suspected drivers of the decline of *R. decussatus*, diseases and mass mortality events were the most frequently reported by experts, whereas climate change was the most extensively studied topic in the literature published since 2000. As in *R. philippinarum*, increasing physiological stress associated with climate change appears to be an important factor affecting *R. decussatus* populations. Rising temperatures, more frequent extreme heat events, and decreases in salinity caused by heavy rainfall can profoundly alter bivalve energy metabolism. This may lead to a reallocation of energetic resources, potentially affecting growth, reproduction, and resilience to additional stressors (Domínguez et al., 2020, 2021a, 2021b, 2023; Castro-Olivares et al., 2022; S. Román et al., 2022, 2024a, 2025; Vázquez et al., 2021, Papadopoulos et al., 2025b). In this context, emerging or opportunistic diseases represent a major health concern. In *R. philippinarum*, for example, the detection of viral particles associated with brown muscle disease suggests that infectious agents may contribute to increased physiological stress and mortality when individuals are already weakened by unfavourable environmental conditions (Dang et al., 2009).

Table 1. Trends in *R. decussatus* stock or harvest, current regulatory measures and restoration actions reported by the experts. (*) including expert cited in the Acknowledgement section.

		Trend in stock or harvest & period				Current regulatory measures							Restoration actions (period)		
Country	Site (n° in Fig. 2) Nb of experts (N)	Decline in stock	Decline in harvest	Reported decline	Lack of data or no fishing	Closed fishing season	Minimum conservation reference size (MCRS)	Daily catch limits	Quotas	Ban of fishing	Licenses	Fishing closure areas	Restocking by clam seeding	Substrate modification	Collection of natural breeders
Portugal	Ria de Aveiro [4] (N=2)	abundance -88% from 2006 to 2019				x	x	x							
	Ria Formosa [5] (N=3)			since 2018			x								
Spain	Galicia [3] (N=2)		-90% from 2005 to 2024			x	x	x			x	x	2015-2019	2018-2020	
	Cantabria [2] (N=1*)			since 2015		x			max. weight of catch	from 2015 to 2018			2015-2019		
	Andalusia [6] (N=1*)			x											2018-2019
	Ebro Delta [8] (N=1)				x										
	Mar Menor [7] (N=1)			since 2020	no fishing										
Italy	Sardinia [10] (N=1)		-32% from 2018 to 2022				x	x			x	x	2025		2025
	Grado & Marano lagoon [14] (N=2)			x			x								
	Venice lagoon [13] (N=1)			since the 1970s-1980s			x								
	Po River Delta [12] (N=2*)				x		x								
Slovenia	Škocjanski Zatok Nature Reserve [15] (N=2)				x										
Greece	Papas lagoon [17] (N=1)			from 1998 to 2015	sporadic data		x								
Croatia	Kaštela Bay, Zelena lagoon, estuaries of Cetina, Mirna, Neretva, Karinsko More [16] (N=1)				low catch (<0.5t/y), scarce data										
France	Arcachon Bay [1] (N=2)	-79% from 2003 to 2024					x				x	x			
	Thau lagoon [9] (N=2)		-100% from 2005 to 2016				x		max. 750 fishers		x	x	1980, 1989, 2003, 2005, 2015, 2017		
Tunisia	Gulf of Gabès [11] (N=1)		-80% from 2016 to 2020							since Nov. 2020			2021-2026		
	nb of sites	2	4	7	6	3	10	3	2	2	4	4	5	1	2

NA
No
x Yes

Several local experts participating in our study have also expressed concerns about the long-term genetic and ecological impacts of *R. philippinarum* on native *R. decussatus* populations, particularly through competition, although there is currently no clear evidence of direct competitive exclusion (Bidegain and Juanes, 2013). FAO statistics for fisheries and aquaculture production of *R. philippinarum* in the study region also show marked temporal fluctuations; however, no clear relationship with variations in *R. decussatus* catches is apparent (Fig. S1). Declines in *R. philippinarum* fisheries were observed between 2014 and 2019, while aquaculture production decreased during 1999–2003, again between 2008–2012 (mainly in Italy), and from 2019 onwards. Hybridisation with the native species *R. decussatus* documented in the western Mediterranean (Carugati et al., 2024) and in the northwestern Iberian Peninsula (Hurtado et al., 2011), raises concerns about the erosion of genetic diversity, the loss of local adaptations, and the long-term resilience of natural populations. Furthermore, a recent study suggested that the prevalence and infection level of perkinsosis in *R. decussatus* may be linked to the historical translocation of *R. philippinarum* into areas occupied by the native species (Sambade et al., 2025). By contrast, the experts identified overfishing as the second most frequently suspected driver of the decline of *R. decussatus*, yet only two studies have investigated its effects, possibly because of the limited availability of reliable clam production data (Caill-Milly et al., 2025). The complex population dynamics of *R. decussatus*, together with this lack of knowledge, make it difficult to interpret observed trends and pose major challenges for the sustainable management of natural stocks.

Hypotheses related to recruitment failure and low juvenile abundance have received little attention from both local experts and publications on *R. decussatus*. However, studies conducted primarily on *R. philippinarum* in Japan indicate that the larval and juvenile stages are particularly vulnerable. Larval recruitment depends strongly on hydrobiological conditions and sediment grain-size characteristics, and even modest alterations to benthic habitats may permanently impair population renewal (Tezuka et al., 2013). In addition, juvenile and subadult *R. philippinarum* are especially susceptible to environmental disturbances, particularly wind-induced hydrodynamic events, which can cause substantial mortality and pronounced interannual fluctuations in population density (Kurihara et al., 2025). Trophic alterations may also have important consequences for *R. philippinarum* (Inoue et al., 2025; Houki et al., 2025), although their effects have not yet been investigated in *R. decussatus*.

As with *R. philippinarum*, the reported decline and marked variability of *R. decussatus* populations are likely to result from the combined effects of physical disturbances, climatic stress, physiological constraints, disease, and genetic changes, all of which may be exacerbated by human activities and coastal habitat degradation (Toba, 2017).

4 Conclusion and perspectives

This study provides a first regional overview of the seemingly widespread decline of *R. decussatus* across southwestern Europe and the Mediterranean. The available evidence suggests that this decline is likely to have multiple interacting causes. Our study also highlights important

knowledge gaps regarding several suspected drivers, including overfishing, trophic alterations, recruitment failure, and low juvenile abundance. In this context, an integrative approach that considers the entire life cycle, population dynamics, and interactions among these drivers is essential to improve our understanding of *Ruditapes spp*. Populations and to better inform their conservation and management. A chronological analysis comparing the timing of the reported declines with major environmental and anthropogenic events - such as the spread of alien species, disease outbreaks, marine heatwaves, or changes in fisheries regulations - would be a valuable next step. Such an analysis would require integrating the literature compiled in this study with expert knowledge and additional regional data. It would help assess of whether certain are the temporal plausibility of the different suspected drivers and provide a stronger basis for prioritizing future research.

Given the extensive body of research on *R. philippinarum*, particularly in Asia, strengthening links between the European and Asian scientific communities would be highly valuable. Our study highlights the opportunity to establish a Euro-Asian research network dedicated to *Ruditapes* spp., as also called for by Riquet et al. (2026), with the aim of: developing coordinated research programmes to elucidate the causes of the reported decline of *R. decussatus*, fostering collaborations among scientists, clam fishers, aquaculture producers, and others stakeholders, promoting and coordinating restoration actions for this native species, and jointly evaluating their effectiveness using integrated ecological, social, and economic indicators.

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Supplementary material

Table S1. Suspected drivers cited by the experts for the decline in R. decussatus (number of sites cited for each case of decline) and publications focusing on these topics from 2000 to 2025 (n=116).

Figure S1. Annual production of R. philippinarum (tons) in southwestern Europe and the Mediterranean from 1986 to 2023: (a) from fisheries (data for France have been excluded due to their lack of reliability (see Caill-Milly et al. 2025)); (b) from aquaculture. Data from FAO (2025).

The Supplementary Material is available at https://www.alr-journal.org/10.1051/alr/2026022/olm

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