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UPDATED CHECKLIST OF THE FISH FAUNA AND CRUSTACEA  
DECAPODA OF SICILIAN SOUTH-EASTERN SWAMP LAKES  
PANTANO BRUNO, PANTANO LONGARINI AND PANTANO CUBA  
(SICILY, ITALY)

SUMMARY

The Sicilian south-eastern swamp lakes complex represents an important coastal wetland for the conservation of Mediterranean biodiversity and a breeding area for different species of fish and crustaceans. A first fish fauna checklist of the swamp lake named “Pantano Bruno” (Ispica, Ragusa) and an updated fish fauna checklist of “Pantano Longarini” and “Pantano Cuba” (Pachino, Syracuse) are here reported, as well as the first checklist of the Crustacea Decapoda recorded in all of the three swamp lakes. Four species of teleost fish were found in Pantano Bruno: *Anguilla anguilla* (Anguillidae), *Chelon ramada* (Mugilidae), *Gambusia holbrooki* (Poeciliidae) and *Aphanius fasciatus* (Cyprinodontidae); two new teleost fish species, in addition to the last published checklist, were found instead in Pantano Longarini and Pantano Cuba: *Sardinella aurita* (Dorosomatidae) and *Solea solea* (Soleidae). In addition, five species of Crustacea Decapoda were observed: *Palaemon antennarius* (Palaemonidae), *Palaemon elegans* (Palaemonidae), *Carcinus aestuarii* (Portunidae), these last two species also found in Pantano Bruno, and the invasive species *Penaeus aztecus* (Penaeidae) and *Callinectes sapidus* (Portunidae). For all species, estuarine use functional group (EUFG), feeding mode functional group (FMFG) and Global IUCN RED LIST are also indicated. The new data reported, in addition to updating and enriching faunistic information about inland water environments, confirm the importance of monitoring Sicilian coastal wetlands both as hotspots for biodiversity and for the conservation of aquatic fauna, highlight their usefulness for the detection, control and management of invasive alien species.

*Key words:* checklist, Decapoda, ichthyofauna, Sicilian southeast swamp lakes, Stiftung Pro Artenvielfalt.

RIASSUNTO

*Checklist aggiornata delle specie ittiche e dei Crostacei Decapodi (Crustacea Decapoda) dei Pantani della Sicilia sud orientale Pantano Bruno, Pantano Longarini e Pantano Cuba (Sicilia, Ita-*

lia). Il complesso dei Pantani della Sicilia sud orientale rappresenta un'importante zona umida costiera per la conservazione della biodiversità del Mediterraneo nonché un'area di riproduzione per diverse specie di pesci e crostacei. Vengono qui presentate una prima checklist della ittiofauna del pantano denominato "Pantano Bruno" (Ispica, Ragusa), un aggiornamento della checklist della ittiofauna del "Pantano Longarini" e del "Pantano Cuba" (Pachino, Siracusa), ed una prima checklist dei Crostacei Decapodi osservati in tutti e tre i pantani. Quattro specie di pesci teleostei sono state ritrovate nel Pantano Bruno: *Anguilla anguilla* (Anguillidae), *Cheilon ramada* (Mugilidae), *Gambusia holbrooki* (Poeciliidae) e *Aphanius fasciatus* (Cyprinodontidae); due nuove specie di pesci teleostei, in aggiunta all'ultima checklist pubblicata, sono state ritrovate invece nei pantani di Longarini e Cuba: *Sardinella aurita* (Dorosomatidae) e *Solea solea* (Soleidae). Inoltre, sono state osservate cinque specie di Crostacei Decapodi: *Palaemon antennarius* (Palaemonidae), *Palaemon elegans* (Palaemonidae), *Carcinus aestuarii* (Portunidae), queste due ultime specie ritrovate anche al Pantano Bruno, e le specie aliene invasive *Penaeus aztecus* (Penaeidae) e *Callinectes sapidus* (Portunidae). Per tutte le specie vengono anche indicati il gruppo ecologico (EUFG), il gruppo trofico (FMFG) e la Lista Rossa Mondiale IUCN di appartenenza. Queste nuove osservazioni, oltre ad aggiornare e arricchire le informazioni faunistiche sugli ambienti delle acque interne costiere, confermano l'importanza del monitoraggio delle aree umide siciliane sia come hotspots per la biodiversità che per la conservazione della fauna acquatica, evidenziandone l'utilità per il rilevamento, il controllo e la gestione delle specie aliene invasive.

*Parole chiave:* checklist, Decapoda, ittiofauna, Pantani della Sicilia sud orientale, Stiftung Pro Artenvielfalt.

## INTRODUZIONE

The Sicilian south-eastern swamp lakes area, located in the south-east coast of Sicily, represents the southernmost Italian wetland-complex and one of the most important coastal wetlands of southern Europe. The wetland area consists of more than ten different swamp lakes (locally called "Pantani") located along the coast and involving the two provinces of Ragusa and Syracuse (Fig. 1). The whole wetland-complex extends for about 1600 hectares and is totally included in Natura 2000 as Special Areas of Conservation (SACs ITA090003) and Special Protection Areas (SPAs ITA090029), designated respectively under the Habitats Directive (Directive 92/43/EEC of 21 May 1992) and the Birds Directive (Directive 79/409/EEC of 2 April 1979 and 2009/147/EC of 30 November 2009). All the swamp lakes are dynamic habitats characterized by shallow, brackish and standing waters, surrounded by elophytic and halophilous vegetation characteristic of these environments (GALASSO *et al.*, 2020, 2021).

This survey was focused on three of these swamp lakes:

– PANTANO BRUNO: part of the municipality of Ispica, Ragusa

(36°41'56.72"N; 14°58'55.58"E), its water body has a surface of about 15 hectares, characterised by brackish water; a small canal terminates in a no longer permanent and functional mouth, which is occasionally opened artificially during the winter season allowing marine fauna to enter the swamp lake. Although the water level drops considerably during dry summer periods, the swamp lake hardly ever runs dry. It is located only 1.5 km away from Pantano Longarini and 3 km away from Pantano Cuba.

- PANTANO LONGARINI: the swamp lake is partly included in the municipality of Ispica, Ragusa (36°42'36.78"N; 14°59'59.23"E) and partly in the municipalities of Noto and Pachino, Syracuse (36°42'41.27"N; 15°0'42.34"E), for a total water surface of about 150 hectares. The two parts of the water body, called Pantano Longarini 1 (Ragusa) and Pantano Longarini 2 (Syracuse), are separated by a NE-SW oriented canal at the border between the two provinces and between the municipalities of Ispica and Pachino (ARPA, 2019). The swamp lake is characterised by a muddy-silty bottom devoid of hard substrates (with occasional anoxia phenomena of bottom water) and never reaches a depth higher than one meter (ARPA, 2019) with the exception of a system of artificial canals, up to 2 metres deep, made in the past decades as part of a fish farm active until the 70s.

The average salinity of the water is <30 PSU (20-27 PSU) and the lake is therefore classified as LCNTAME (Arpa, 2019), falling in the range of euryhaline waters (between 20 and 30 PSU). Pantano Longarini has two main tributary canals supplying fresh water from the NW and N-N/E with a variable contribution, depending on rainfalls. It is regularly connected to the sea during the winter season or periods of greatest water abundance through two mouths (FARANDA, 1977), a main one and a secondary one at the end of an artificial canal, allowing the entry of different marine species (DUCHI, 2021). Despite the mouths provide an additional water supply to the tributary canals, the main water contribution comes from rainfall (MAZZOLA *et al.*, 2010; SCIANDRELLO *et al.*, 2014; ARPA, 2019). Its brackish waters can reach high salinity levels during the summer and almost every year the whole lake is subjected to a sharp decrease in water availability that can cause it to dry up almost completely (MAZZOLA *et al.*, 2010; SCIANDRELLO *et al.*, 2014) with the only exception of the artificial canal system that then acts as water reservoirs allowing the survival of fish fauna and aquatic species in general.

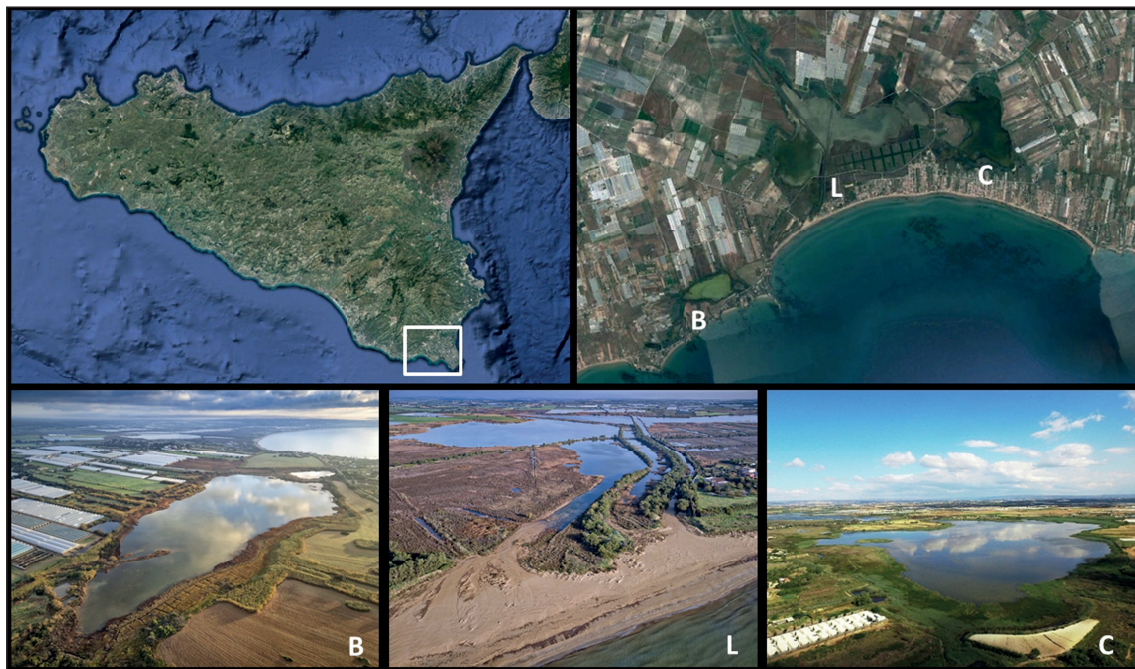
- PANTANO CUBA: part of the municipalities of Noto and Pachino, Syracuse (36°42'27.55"N; 15° 1'38.77"E), has a water surface of about 50 hectares and reaches a maximum depth of three metres during periods of maximum rainfall (ARPA, 2019). It is categorised in mesohaline waters of intermediate salinity (between 5 and 20 PSU), and then classified as LCNTAME and the swamp bottom is of a silty-melty type, with occasional anoxia phenomena of bottom water throughout the year (ARPA, 2019). Pantano Cuba is directly connected to Pantano Longarini through a canal which provides the main water supply and allows the passage of fish and other aquatic fauna between the two swamp lakes. Despite its natural mouth was definitely closed in the past decades, it is still served by a few small tributary freshwater canals, mostly during the winter. Occasionally, it may run totally dry during the summer season.

Due to their great relevance for the Mediterranean biodiversity, and especially for the avifauna, Pantano Cuba and Pantano Longarini, were purchased, starting from 2013, by the German foundation “Stiftung Pro Artenvielfalt ®” - Foundation Pro Biodiversity, for a total, up to date, of more than 420 hectares. The foundation is specialized on biodiversity conservation and habitat management (GALASSO *et al.*, 2021). The same foundation has promoted the publishing of this paper.

However, despite the importance of these habitats, knowledge about the aquatic fauna is still rather limited. The only information about the fish fauna of these swamp lakes, is from the fish map of the Ragusa province (DUCHI, 2008), which only included Pantano Longarini, and the most recent ichthyofauna checklist of the swamp lakes Pantano Cuba and Pantano Longarini, updated with data from the literature and recent integrations by DUCHI (2021), reporting 10 different fish species for these two swamp lakes: *Anguilla anguilla* (Anguillidae), *Atherina boyeri* (Atherinidae), *Sardina pilchardus* (Clupeidae), *Aphanius fasciatus* (Cyprinodontidae), *Pomatoschistus marmoratus* (Gobiidae), *Chelon ramada* (Mugilidae), *Chelon auratus* (Mugilidae), *Mugil cephalus* (Mugilidae), *Gambusia holbrooki* (Poeciliidae) e *Sparus aurata* (Sparidae). On the other hand, there is currently no any checklist, nor any general information, about the ichthyofauna of “Pantano Bruno”. Likely, there is no any specific Crustacea Decapoda checklist available for such area with the exception of *P. elegans* reported by VECCHIONI *et al.*, 2022 in Pantano Bruno; in

fact, the list of Crustacea Decapoda of Sicily (PIPITONE & ARCULEO, 2003) has not been updated recently, and it is not very detailed for inland wetlands.

The aim of this study is therefore to update the list of fish species of such an important wetland area and to update and draw up a first checklist of Crustacea Decapoda, sharing the data collected during the environmental sampling and monitoring activities conducted by the German foundation Stiftung Pro Artenvielfalt.



*Fig. 1* — Location and panoramic view of the three swamp lakes, in the south-eastern coast of Sicily: B: Pantano Bruno; L: Pantano Longarini and its mouths; C: Pantano Cuba (Photos: B/L by T. Puma; C by ©SPA.IT).

## MATERIALS AND METHODS

During the monitoring activities conducted by the Stiftung Pro Artenvielfalt staff, fish and crustaceans were sampled and analysed by means of sampling transect along the canals and banks of the swamp lakes: 1 transect in Pantano Bruno, 2 in Pantano Longarini and 1 in Pantano Cuba. Specimens were collected by means of a hand net, a hand-pulled fine-mesh net (2 mm internode) towed by two operators, or using fish pots primed with baits. In addition to these sampling methods, some of the information was obtained during the removal of illegal fish-

ing nets placed inside the protected area. The study of the fish fauna was carried out from July 2017 to December 2022, while the study of the crustaceans from June 2020 to December 2022, using the same methods. Sampling activities were always carried out between 8:00 and 12:30 a.m., in good weather conditions and in the absence of wind. Captured specimens, when possible, were identified to species level directly in the field and temporarily stabled in small tanks (appropriately set up with water and substrate collected directly from the swamp lake of origin) for photographic documentation; subsequently, the specimens were released at the same location of capture, with the exception of invasive species. However, some specimens (or a sample of them) required taxonomic identification in laboratory. Further information are provided by the estuarine use functional group (EUFG) (DI: diadromous; ES: estuarine; F: freshwater; MM: marine migrant; MS: marine straggler; ALIEN: invasive alien species), the feeding mode functional group (FMFG) (Bma: macrobenthivore; Bmi: microbenthivore; DV: detritivore; HP: hyperbenthivore/piscivore; HV: herbivores; HZ: hyperbenthivore/zooplanktivore; OV: omnivore; PL: planktivore) (FRANCO *et al.*, 2008; PENNA *et al.*, 2017) and the most recent global IUCN RED LIST (<https://www.iucnredlist.org/>) to which each species belongs.

## RESULTS AND DISCUSSION

During sampling, four species of teleost fish were found in Pantano Bruno: the European eel *Anguilla anguilla* (Linnaeus, 1758), the Mediterranean banded killifish *Aphanius fasciatus* (Valenciennes, 1821), the Eastern mosquitofish *Gambusia holbrooki* Girard, 1859 and the Thin-lipped mullet *Chelon ramada* (Risso, 1827). Two new species, in addition to the last published checklist by DUCHI (2021), were found instead in Pantano Longarini and Pantano Cuba: the Round sardinella *Sardinella aurita* Valenciennes, 1847 and the Common sole *Solea solea* (Linnaeus, 1758). Furthermore, we report five different species of Crustacea Decapoda found in Pantano Cuba and Longarini: the Pond shrimp *Palaemon antennarius* H. Milne Edwards, 1837, the Rockpool prawn *Palaemon elegans* Rathke, 1836, the Mediterranean shore crab *Carcinus aestuarii* Nardo, 1847 and two invasive species, the Northern brown shrimp *Penaeus aztecus* Ives, 1891 and the Atlantic blue crab *Callinectes sapidus* Rathbun, 1896. In Pantano Bruno, only *Carcinus aestuarii* and *Palaemon elegans*, were found. The ichthyofauna checklist is shown in Table 1, and the Crustacea Decapoda checklist in Table 2.

These new observations made it possible to update the current ichthyofauna checklist of Pantano Longarini and Pantano Cuba published by DUCHI (2021), and to draw up a first ichthyofauna checklist of Pantano Bruno and a checklist of Crustacea Decapoda found in all of the three swamp lakes. Some of the species found during this survey are shown in Fig. 2.

**Table 1.** Osteichthyes recorded from 2017 to 2022 in the study area (B: Pantano Bruno; C: Pantano Cuba; L: Pantano Longarini).

\*species reported for the first time in the related swamp lake.

EUFG: Estuarine use functional group (DI: diadromous; ES: estuarine;

MM: marine migrant; MS: marine straggler); FMFG: Feeding mode functional group

(Bma: macrobenthivore; Bmi: microbenthivore; DV: detritivore; HP: hyperbenthivore/piscivore;

HZ: hyperbenthivore/zooplanktivore; OV: omnivore; PL: planktivore).

FAMILY	SCIENTIFIC NAME	FINDING AREA	EUFG	FMFG	IUCN RED LIST
ANGUILLIDAE	<i>Anguilla anguilla</i>	B*, C, L	DI	Bmi, Bma, HP	CR
ATHERINIDAE	<i>Atherina boyeri</i>	C, L	ES	HZ	LC
CLUPEIDAE	<i>Sardina pilchardus</i>	L	MM	PL	LC
CYPRINODONTIDAE	<i>Aphanius fasciatus</i>	B*, C, L	ES	Bmi, OV	LC
DOROSOMATIDAE	<i>Sardinella aurita</i> *	L*	MS	PL, OV	LC
GOBIIDAE	<i>Pomatoschistus marmoratus</i>	C, L	ES	Bmi, HZ	LC
MUGILIDAE	<i>Chelon ramada</i>	B*, L	DI	DV, HZ	LC
MUGILIDAE	<i>Chelon saliens</i>	L	MM	DV, HZ	LC
MUGILIDAE	<i>Mugil cephalus</i>	L	DI	DV, HZ	LC
POECILIIDAE	<i>Gambusia holbrooki</i>	B*, L	ES	Bmi, HZ	LC
SOLEIDAE	<i>Solea solea</i> *	L*	MM	Bmi, Bma	DD
SPARIDAE	<i>Sparus aurata</i>	L	MM	Bmi, Bma, HZ	LC

**Table 2.** Crustacea Decapoda recorded from 2020 to 2022 in the study area (B: Pantano Bruno; C: Pantano Cuba; L: Pantano Longarini).

\*species reported for the first time for the related swamp

lake. EUFG: Estuarine use functional group (ES: estuarine; ALIEN: invasive alien species);

FMFG: Feeding mode functional group (Bma: macrobenthivore;

HP: hyperbenthivore/piscivore; OV: omnivore).

FAMILY	SCIENTIFIC NAME	FINDING AREA	EUFG	FMFG	IUCN RED LIST
PALAEEMONIDAE	<i>Palaemon antennarius</i>	C*, L*	ES	OV	LC
PALAEEMONIDAE	<i>Palaemon elegans</i>	B, C*, L*	ES	OV	NE
PENAEIDAE	<i>Penaeus aztecus</i>	L*	ALIEN	OV	NE
PORTUNIDAE	<i>Callinectes sapidus</i>	C*, L*	ALIEN	Bma, HP, OV	NE
PORTUNIDAE	<i>Carcinus aestuarii</i>	B*, C*, L*	ES	OV	NE

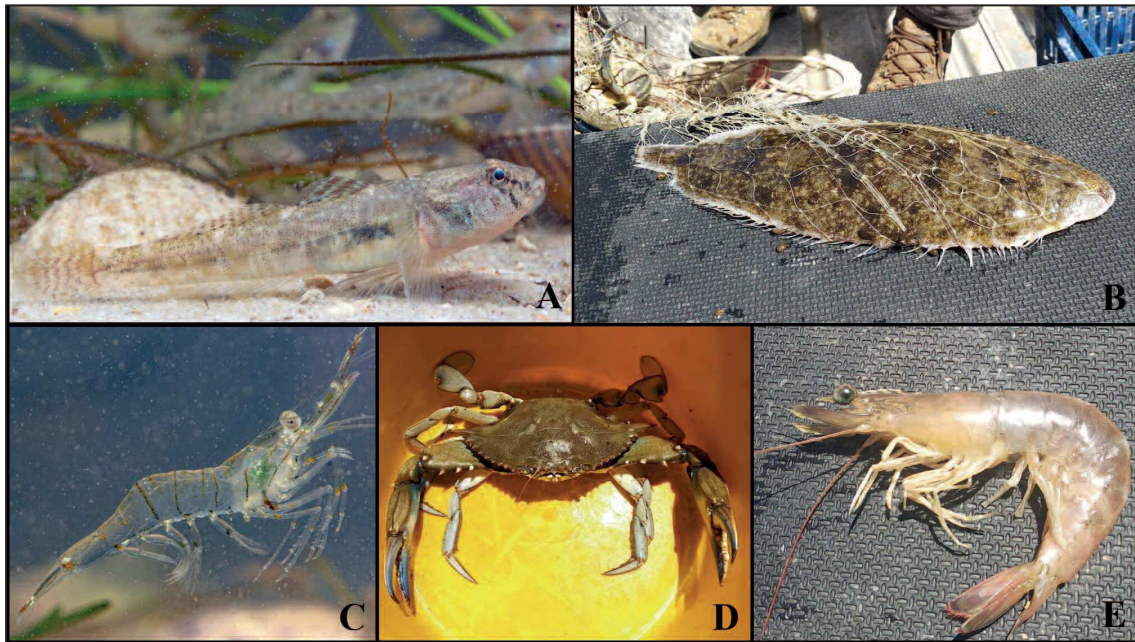


Fig. 2 — Some of the teleost fish and decapod crustaceans found and sampled in the three swamp lakes: A: *Pomatoschistus marmoratus*; B: *Solea solea*; C: *Palaemon elegans*; D: *Callinectes sapidus*; E: *Penaeus aztecus* (Photos: A/C by T. Puma; B/D/E by ©SPA.IT).

The presence of numerous juvenile and subadult forms of *Palaemon elegans* and *Palaemon antennarius*, as well as of the records of a very high density of *Pomatoschistus marmoratus*, highlights the importance of these habitats as breeding and nursery sites for these species which exploit the rich plant populations of *Ruppia maritima*. Furthermore, the European eel *Anguilla anguilla*, frequently observed in all of the swamp lakes, is classified as “Critically Endangered” (CR) species in the last Italian Red List (RONDININI *et al.*, 2022): for this species in need of conservation strategies and sustainable management, a specific regulation has been issued at the European Union level (Reg. EC 1100/2007) (DE PIETRO & DUCHI, 2022). Indeed, Mediterranean coastal wetlands are among the most suitable environments for the development of the continental phase of the life cycle of *Anguilla anguilla* and most important for its reproduction (DE PIETRO & DUCHI, 2022), despite these areas are also the most subject to anthropic remediation. In the last century, for example, the Gelsari and Lentini marshes (central-eastern coast of Sicily) have undergone invasive water reclamation interventions through the construction of drainage canals and hydrovore systems, to lower the water level and create agricultural areas with a sharp negative impact on the fish fauna (DE PIETRO, 2011). The same situation should be avoided in the Sicilian south-eastern swamp lakes: if on the one hand Pantano Longarini and Pantano Cuba, owned and properly managed by the German foundation Stiftung



Pro Artenvielfalt, represent now a safe and important breeding and conservation area for different species of Mediterranean fish and crustaceans, on the other hand, all the other swamp lakes do not enjoy the same form of water protection and management. Furthermore, in Pantano Bruno, an uncontrolled and often illegal fishing activity was observed throughout the years, posing not only a threat to ichthyofauna but also to avifauna and other aquatic species. The presence of such a rich ichthyofauna in the swamp lakes of Pantano Longarini and Pantano Cuba, also partly present in Pantano Bruno, as well as the presence of different species of decapod crustaceans, represents an important and abundant source of food for many other animal species, including water birds, making this wetland an important foraging area during their migration, wintering and breeding seasons. This survey highlighted the importance of environmental monitoring both for the collection of information, fauna and ecological data for inland water environments, which are often inadequate, and, at the same time, for the detection, control and management of invasive alien species.

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