Non-marine Ostracoda (Crustacea) collected from the Camargue, southern France, with four species new to France

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Meisch, C., B. Scharf, M. Czajkowska, M.-B. Forel, M. Hoehle, B. Lefebvre, I. Mazzini, V. Perrier, M. Thibault, C. Vittori & A. Thiéry, 2025. Non-marine Ostracoda (Crustacea) collected from the Camargue, southern France, with four species new to France. *Bulletin de la Société des naturalistes luxembourgeois* 127: 107-138. https://doi.org/10.59513/snl.2025.127.107

Published online 7 October 2025 (ISSN 2716-750X), printed volume 5 December 2025 (ISSN 0404-9620).

Abstract. We report on the collection of 21 non-marine Ostracoda (Crustacea) species, mainly in July 2022, in the Rhône delta (Grande Camargue). The material comprises nine species new to the Camargue region (Grand delta du Rhône), of which four are new to France. These four are considered exotic in origin, and we suggest that they have been passively introduced in the Camargue during the second half of the 20th century: *Bradleytriebella spinulosa* (Akatova, 1958) nov. comb., *Candonocypris novaezelandiae* (Baird, 1843), *Cypris granulata* Daday, 1898, and *Ilyodromus viridulus* (Brady, 1886). Notes on these four species, and two previously recorded exotic species, i.e. *Bradleycypris vittata* (Sars, 1903) and *Strandesia reticulata* (Daday, 1898) from the Camargue are presented. Scanning electron micrographs of the carapaces and/or valves of all the species recorded are given. A checklist of the 44 non-marine ostracod species recorded from the Grand delta du Rhône is presented. A new taxonomic combination is provided: *Bradleytriebella spinulosa* (Akatova, 1958) nov. comb.

Keywords. Ostracoda, France, Camargue, Grand delta du Rhône, rice fields, alien species, taxonomy.

1. Introduction

The Rhône delta, also known as the Camargue, is located in southern France and comprises a 145,000 ha wetland area south of Arles. It is situated between the Mediterranean Sea and the two arms of the Rhône River: the Grand Rhône in the east and the Petit Rhône in the west. The first wetland in France by surface area, the Camargue, is the second-largest delta in the Mediterranean, after the Nile (Blondel 2019).

The riverine wetlands and marshes extend well beyond the arms of the Rhône River to form the so-called Grand delta du Rhône, herein designated as Camargue s.l., which includes three geographical areas: (a) the Grande Camargue, limited by the two arms of the Rhône; (b) the Petite Camargue, or Camargue gardoise located west of the Petit Rhône; and (c) the Plan-du-Bourg located east of the Grand Rhône, which extends to the border of the Crau region (Blondel 2019, Fabre 2019) (Fig. 1).

As with deltas in general, the landscape is characterised by the absence of any significant relief. The highest point in the delta is 4 metres above sea level, and the lowest is 1.5 metres below (Parc Camargue 2025).

Due to its exceptional biological richness, best exemplified by the 272 species of birds, the iconic greater flamingo (*Phoenicopterus roseus* Pallas, 1811) included (Chazel & Chazel 2013, UNESCO 2025), the Camargue was designated Parc naturel régional de Camargue in 1970, a UNESCO Biosphere Reserve in 1977 (renewed in 2006 to include the Camargue gardoise and Plan-du-Bourg), and a Ramsar site in 1986. As early as 1907, the étang de Vaccarès, a saltwater lagoon and the adjacent wetlands in the south, were designated as Réserve naturelle nationale de Camargue for strict nature conservation (Coulet 2019, Mathevet et al. 2019, Olivry 2019, Parc Camargue 2025).

The Parc Naturel de Camargue entered into partnership agreements with two other large wetland areas in Europe: the Doňana

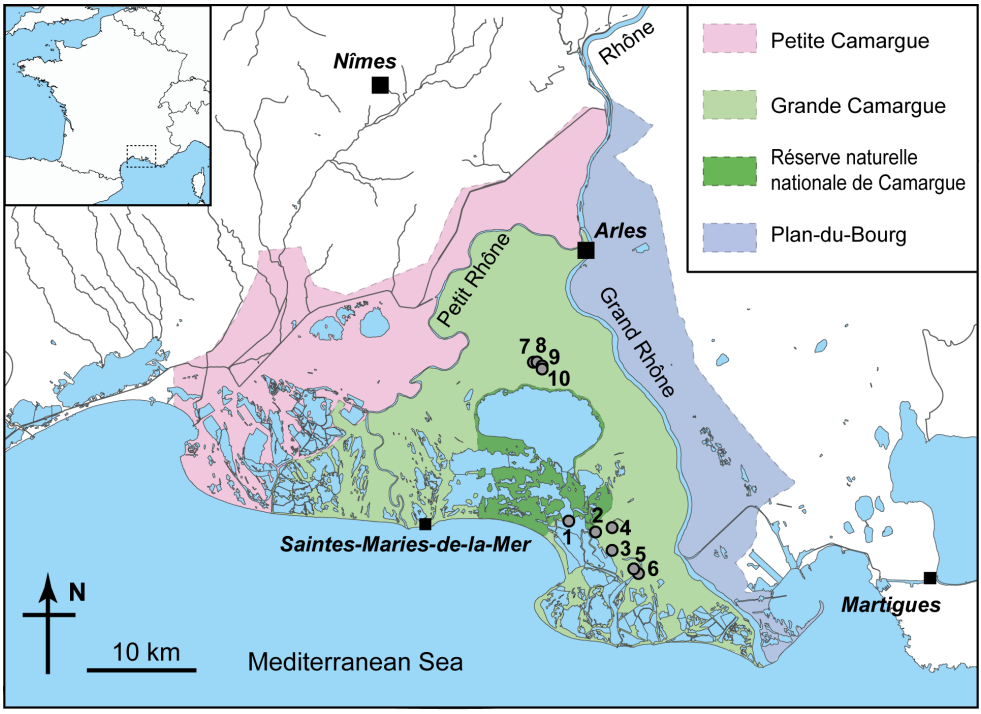


Fig. 1. Map of the Grand Delta du Rhône, showing the locations of the sampling sites visited in 2022.

National Park and Biosphere Reserve in the Guadalquivir Delta in Spain in 2000, and the Danube Delta Biosphere in Romania in 2016 (Parc Camargue 2025).

Although it is a conservation area, the Camargue is home to significant human activity. Rice cultivation, cattle farming, and hunting are prevalent practices. Additionally, the area undergoes intensive management and monitoring for scientific research and conservation efforts (Mouret 2018).

Since the mid-1950s, rice has been the most widely cultivated crop in the delta, primarily in rotation with durum wheat (*Triticum turgidum* ssp. *durum*), alfalfa (*Medicago sativa*), soybeans (*Glycine max*), and common sunflowers (*Helianthus annuus*), or in monoculture (Mouret & Leclerc 2018; Mouret 2019). Alternative crops are limited by soil salinity (Mouret 2018).

The Camargue features a wide variety of natural habitats linked to the exchanges between the Rhône's freshwater and seawater. The landscapes are structured, among others, by lagoons, agricultural fields, including rice fields, ditches, temporary and permanent ponds, marshes, the arms of the Rhône, and roubines (canals supplying agricultural fields with water from the Rhône) (Chazel & Chazel 2013, Parc Camargue 2025).

Rice fields in the Camargue are usually sown and flooded in April, harvested in October, and kept dry thereafter (Pont 1977, Mouret & Leclerc 2018).

By their sheer numbers, microcrustaceans, and ostracods in particular, are an important component of rice-field ecosystems; they can influence rice growth and may act as invasive species that utilise rice fields as stepping stones for further spread (review in Zhai et al. 2024). Dormant developmental stages and/or the production of banks of eggs favour the persistence of ostracods in rice fields and temporary water bodies in general (Stenert et al. 2010, Bandeira et al. 2022, Zhai et al. 2024).

Ostracods are small crustaceans, mostly 0.5–3 mm long, whose bodies are enclosed within a bivalved carapace. They are found worldwide, except in Antarctica, in almost every type of aquatic habitat, ranging from marine to brackish and freshwater, with a small number of species also occurring in (semi-)terrestrial environments (Horne et al. 2002). Meisch et al. (2024) list the 2420 species recorded from non-marine habitats worldwide.

The first record of non-marine ostracods from the Camargue was published by Hertzog (1935), who reported the finding of three species: *Cypris bispinosa* Lucas, 1849, *Cypria ophtalmica* (Jurine, 1820) and *Cyclocypris* sp. In the subsequent decades and up to the present, a series of sporadic investigations of the ostracod fauna have been carried out, except for research undertaken within the framework of the doctoral theses by Schachter (1950) and Stéger (1972). A review of the results of the investigations up to 1990 was presented by Meisch et al. (1990). Since then, we have only been aware of four publications (see caption of Table 5) that mention findings of non-marine ostracods in the Camargue s.l. A total of 34 non-marine ostracod species were known from the Grand delta du Rhône, which now amounts to 44 species (Table 5).

Here we report on a collection of 21 species of non-marine ostracods, of which four are new to France, retrieved from 10 sites in the Grande Camargue – rice fields and adjacent ditches, lagoons, oxbow lakes of the Rhône, and dried-up ponds – by participants on the post-symposium field trip of the 19th International Symposium on Ostracoda (ISO19 in Lyon) in July 2022 (Tables 1-3).

We additionally include the results from five samples of non-marine ostracods collected previously to 2022 by one of us (A.T.) from (a) the Grande Camargue and (b) elsewhere in southern France, with *Candonocypris novaezelandiae*, a species new to France (Table 4).

Notes on the four species new to France and two exotic species previously recorded from the Camargue are presented. Scanning electron micrographs of the 21 species collected are given (Figs 3-9). A checklist of the non-marine ostracods presently known from the Grand delta du Rhône is provided (Table 5).

2. Materials and methods

2.1 Study area

All the studied Camargue samples come from the Grande Camargue as defined in the Introduction. Administratively, these sites are in the department of Bouches-du-Rhône. Two other samples, those including *Candonocypris novaezelandiae,* collected by A.T. outside the Camargue s.l., are from the departments of Bouches-du-Rhône and Gard, respectively.

2.2. Material examined

Our material comprises:

(a) Samples collected from 10 sites on 24 and 25 July 2022 during the ISO19 post-symposium field trip to the Camargue, organised by M.B.F. and V.P. Samples were taken from oxbow lakes of the Rhône, lagoons, dried-up ponds, ditches, rice fields, and a pond near rice fields. For each site, the following environmental parameters were recorded (Table 1): elevation, surrounding environment, substrate, water temperature, pH, electrical conductivity, turbidity, and submersed macrophytes.

The samples from sites 1 and 6 (the latter when entirely flooded, as shown in Table 1) are lagoons with marine saline waters located near the Mediterranean Sea. All the remaining samples were taken from fresh or slightly brackish waters, with EC values ranging from 274 to 3700 µS/cm (inferred salinity: 0.1–2.3 ‰).

The rice fields investigated in 2022 are grown organically, without the use of pesticides. The rice field in site 10 uses mallard (or mould) ducks, a domestic hybrid duck breed – ♀ *Anas platyrhynchos* Linnaeus, 1758 × ♂ *Cairina moschata* (Linnaeus, 1758) – for weed control, as described on-site by rice farmer Bernard Poujol (see also Mouret & Falconnier 2018, including an interview with B. Poujol; Noël 2021; Girard 2023) (Fig. 2).

Sites 2 and 3 were dry at the time of sampling. B.S. brought dry mud samples from these sites to Bremen to place them in a beaker with about 1 L of distilled water. The beaker was placed on a windowsill at room temperature. Three weeks later, six species of living ostracods appeared (Table 2).

(b) Three samples were collected in 1990, 1997, and 2003, respectively, from rice fields in the Grande Camargue (leg. A.T., Table 4).

(c) Two samples were collected in 2009 (leg. A.T.) from outside the Camargue s.l., containing the exotic species *Candonocypris novaezelandiae* (Table 4).

(d) The specimen of *Cypris granulata* in Fig. 4E (marked as 'China' in the caption) is in the Ostracoda collection of B.S. It comes from an unknown locality in that country. All the remaining SEMs are from animals collected from the Camargue in 2022.

2.3. Methods

The water samples under 2.2(a) above were taken approximately 5 cm below the surface. Water temperature and conductivity were measured using a TESTR 35 (Co. EUTECH Instruments OAKTON); pH values were determined using a liquid pH indicator (RF1.09175, pH 4-10, with 0.5 pH steps, Merck). The geographic coordinates were obtained using a Garmin GPSMAP 64s (WGS 84).

The samples were collected using a hand net with a 200 µm mesh size and then sieved in the field through a 3 mm mesh to eliminate coarse sediment and retain the fine fraction for further examination. The latter fraction was sieved again with the same hand net to eliminate most of the water. The obtained wet sediment was then stored in a plastic bag with the addition of 96% ethanol. The animals are thus narcotised and killed. Each evening, the animals were separated from the sediment using the so-called 'blowing method,' as described by Scharf et al. (2014a), and preserved in 96% ethanol.

The ostracods were identified using Meisch (2000), Smith et al. (2011, 2018), and Mesquita-Joanes et al. (2024). The taxonomy and distinction of non-marine from marine species follow Meisch et al. (2024). For data on the landscapes and organisms of the Camargue, we used the books by Chazel & Chazel (2013) and Blondel et al. (2019), the Parc de

Table 1. Environmental characteristics of the sampling sites in the Camargue. ---, no measures taken. A local guide provided the EC value of site 6.

Sites	Date July 2022	Time of day	Name of water body	Coordinates	Elevation [m a.s.l.]	Type of water body	Surrounding environment	Substrate	Temp. [° C]	pH	Conductivity [µS/cm]	Turbidity	Submersed macrophytes
1	24	10.00	Étang de Galabert	43°26'21.4"N 04°36'47.9"E	2	lagoon	dune	sand	25.2	8	hypersaline	none	algal mats on stones, *Ruppia spiralis*
2	24	11.00	Mare du Pèbre	43°26'31.9"N 04°38'04.8"E	0.25	dry pond	*Salicornia europaea*	clay	---		---	---	
3	24	11.30	Mare de Briscon	43°25'33.4"N 04°39'06.9"E	0.20	dry pond	*Tamarix* sp.	*Salicornia herbacea*, *Scirpus maritimus*	---		---	---	
4	24	12.10	Vieux marais de Pèbre	43°26'26.5"N 04°38'40.0"E	0	oxbow of the Rhône		mud	30.5	7.5	3700	none	
5	24	13.00	Lône de la Poutrague	43°24'25.8"N 04°40'39.5"E	0	oxbow	*Salicornia europaea*	clay	31.1	8.5	2670	---	
6	24	14.30	Marais de la Poutrague (South)	43°24'22.5"N 04°40'40.5"E	-0.3	oxbow, partly dry	*Tamarix* sp., *Salicornia europaea*	clay	---		when flooded: 24,000 -46,000	none	*Ruppia spiralis*, *Stuckenia pectinata*
7	25	9.45	Ditch	43°36'21.4"N 04°32'50.2"E	0	outflow	rice field	clay	25.6	7	694	turbid	emerged plants
8	25	10.15	Inflow to site 9	a few meters from site 9	0	inflow	rice field	clay	---		---	none	submerged plants
9	25	10.30	Rice field	Close to site 10	0	rice field	rice fields	clay	---		---	---	emerged rice plants
10	25	11.00	Rice field	43°36'19.8"N 04°32'53.8"E	0	pond	*Phragmites* sp., a tree	clay, detritus	27.1	7	274	turbid	

Table 2. Ostracod species collected from the Grande Camargue in July 2022. The numbers of the sampling sites are as in Table 1. Cp, empty carapace; juv., juvenile; V, valve. Abundance: x = 1-10 living ind./sample; xx = > 10 living ind./sample; (x) = 1-10 Cp/V; (xx) = > 10 Cp/V. Species in bold are considered exotic (alien) and new to the Camargue s.l. and France in general.

Sampling sites	Species	Numbers				Remarks
		♂♂	♀♀	Both sexes	juv.	
1	*Cyprideis torosa*	(xx)	(xx)		(xx)	Valves unnoded
	Loxoconcha elliptica	(x)			(x)	
2	*Eucypris virens*		x			Dry pond, all raised from dry mud
	Heterocypris incongruens	x				
	Ilyocypris gibba f. *biplicata*		(xx)		(xx)	
	Sarscypridopsis aculeata				(x)	
3	*Cypridopsis vidua*		(x)		(x)	Dry pond, raised from dry mud
	Eucypris virens				(xx)	
	Heterocypris incongruens		(x)		(xx)	
	Ilyocypris gibba f. *biplicata*		(x)		xx	
	Limnocythere inopinata		(xx)		(x)	
	Sarscypridopsis aculeata		(xx)		(xx)	
4	***Candonocypris novaezelandiae***		(x)			
	Cyprideis torosa	x, (xx)	x, (xx)		x, (xx)	Valves unnoded
	Cypridopsis vidua		(x)			
	Heterocypris salina		xx, (xx)		x, (xx)	
	Physocypria kraepelini		x			
5	*Candona* sp.				(x)	
	Cyprideis torosa	(xx)	(xx)		(xx)	Valves unnoded
	Heterocypris salina				(x)	
	Ilyocypris gibba f. *gibba*				(x)	
	Ilyocypris gibba f. *biplicata*		(x)		(x)	
	Physocypria kraepelini		x, (x)			
	Pseudocandona marchica	(x)				RV with Zenker organ preserved
	Sarscypridopsis aculeata		(x)		(xx)	

Table 2 (continued).

Sampling sites	Species	Numbers				Remarks
		♂♂	♀♀	Both sexes	juv.	
6	*Cyprideis torosa*	(xx)	(xx)		(xx)	1 juv. valve with nodes
	Cypridopsis vidua		(x)			
	Heterocypris salina		(xx)		(xx)	
	Sarscypridopsis aculeata		(xx)		(xx)	
7	*Cypridopsis vidua*		x		x	normally (zebra-like) coloured and rare uniformly green specimens
	Dolerocypris sinensis				xx	
	Fabaeformiscandona fabaeformis		(x)		(x)	
	Heterocypris incongruens		(x)			
	Ilyocypris cf. *gibba*			(x)	(x)	
	Physocypria kraepelini			x	x	
8	***Bradleytriebella spinulosa***		x			
	Cypretta seurati		xx		x	
	Cypridopsis vidua		x		x	
	Cypris granulata		(x)			
	Dolerocypris sinensis		xx		xx	
	Fabaeformiscandona fabaeformis	(x)	x, (x)		x	
	Heterocypris incongruens		(x)		(x)	
	Ilyodromus viridulus		(x)			
	Physocypria kraepelini			xx		
9	***Bradleytriebella spinulosa***		xx			
	Cypretta seurati		xx			
	Dolerocypris sinensis		xx		xx	
	Limnocythere stationis		x			
	Stenocypris major		x		x	
10	***Bradleytriebella spinulosa***		x, (x)			
	Dolerocypris sinensis		(x)			
	Ilyocypris cf. *gibba*			(x)	(x)	



Fig. 2. Photos of part of the sampling sites visited in 2022. A-G: sites 1-7. H: site 10. The site numbers are as in Table 1.

Camargue website, and the book by Mouret & Leclerc (2018) for information on rice farming in the Camargue.

The SEM-images of *Physocypria kraepelini* Müller, 1903, *Ilyocypris gibba* f. *gibba* (Ramdohr, 1808), *Ilyocypris gibba* f. *biplicata* (Koch, 1838), and *Loxoconcha elliptica* Brady, 1868 (Figs 7-9) were taken by M.Cz. with a Zeiss Sigma at the Faculty of Geology, University of Warsaw. B.S. prepared the remaining samples for examination with a LEO 1525 FE 4 at the Zoological Institute of the University of Hamburg. For the latter material, soft membranes attached to the inner valve surface were removed either through bacterial digestion (Scharf &

Meisch, in preparation) or, for most of them, by leaving them overnight in 7% KOH, following the method described by Matzke-Karasz (1995). B.S. examined dissected soft parts under a light microscope Axioscop.

The map (Fig. 1) of the Grand delta du Rhône was prepared by M.Cz. and V.P. The photos of the sampling sites in Fig. 2 are by C.M.

Abbreviations used in text and figures: f., forma; id., specific identification; juv, juvenile; ovig., ovigerous female; LV, left valve; RV, right valve; EC, electrical conductivity; SEM, scanning electron micrograph; the initials of the authors' names, e.g. C.M., B.S., etc.

3. Results

3.1. Species collected

Twenty-one species of ostracods were retrieved from the samples collected during the July 2022 field trip to the Grande Camargue (Table 3). The samples are from a hypersaline lagoon (site 1), two dried-up ponds (sites 2 and 3), three oxbow lakes (sites 4-6), two ditches (sites 7 and 8), and two rice fields (sites 9 and 10). Among those 21 species, four appeared to be new to the Camargue s.l. and France in general. The four species are known as alien (exotic) species in Europe,

Table 3. Ostracods collected during the July 2022 field trip to the Grande Camargue. Genera and species are listed in alphabetical order. Species new to the Grand delta du Rhône are marked with *, those new to France are in bold. See Table 5 for the species, along with the authors' names.

Species	Lagoons	Oxbows	Dry ponds	Rice fields and adjacent waters
* ***Bradleytriebella spinulosa***				x
* ***Candonocypris novaezelandiae***		x		
* *Cypretta seurati*				x
Cyprideis torosa	x	x		
Cypridopsis vidua		x	x	x
* ***Cypris granulata***				x
Dolerocypris sinensis				x
Eucypris virens			x	
* *Fabaeformiscandona fabaeformis*				x
Heterocypris incongruens			x	x
Heterocypris salina		x		
Ilyocypris gibba f. *gibba*		x	x	x
Ilyocypris gibba f. *biplicata*		x	x	
* ***Ilyodromus viridulus***				x
* *Limnocythere inopinata*			x	
* *Limnocythere stationis*				x
Loxoconcha elliptica	x			
Neglecandona cf. *neglecta* (juv.)		x		
* *Physocypria kraepelini*		x		x
Pseudocandona marchica		x		
Sarscypridopsis aculeata		x	x	
Stenocypris major				x
Number of species	2	10	7	12

having been introduced from elsewhere (see Notes on species).

Three species of ostracods were collected from rice fields of the Grande Camargue in 1990, 1997 and 2003, respectively (leg. A.T., id. C.M.) (Table 4). Specimens of *Candonocypris novaezelandiae* (and *Eucypris virens*) collected from two sites outside the Camargue in southern France are included in our study (Table 4).

3.2. Notes on the species new to France

The following four species are considered alien species in Europe, meaning they were introduced, for instance, via birds, rice seeds, and/or rice plants.

Candonocypris novaezelandiae (Baird, 1843) (Fig. 3F)

1843 *Cypris Novae Zelandiae* n. sp. Baird: 268.
1855 *Cypris sydneia* n. sp. King: 65; pl. X M.
1855 *Cypris Candonioides* n. sp. King: 66; pl. X: F.
1894 *Candonocypris assimilis* n. sp. Sars: 36; pl. 5: 2a-c.
1939 *Herpetocypris caledonica* n. sp. Méhes: 556; fig. III; pl. 12: 14-18; pl. 13: 1.
1981 *Candonocypris caledonica* (Méhes, 1939) nov. comb. De Deckker: 48.
1971 *Candonocypris novaezelandiae* (Baird, 1843) nov. comb. Eagar: 55.

A single RV of this species was found in the sample from site 4, an oxbow lake, in the Camargue.

We here additionally report the so far unpublished finding of two samples comprising three adult females of this species from the departments of Bouches-du-Rhône (river Bayeux, also Bayon, 1 ♀) and Gard (pond at Valliguières; 2 ♀♀), both sites located outside the Grand delta du Rhône in southern France (leg. A.T.; Table 4). *C. novaezelandiae* is new to the Camargue s.l. and France in general. Among the European species of the Cyprididae, *C. novaezelandiae* is readily recognised by the combination of the following features: (a) the distal triangle-shaped chitinous support of the uropodal attachment (a diagnostic character of the subfamily Herpetocypridinae) and (b) the presence of two (instead of one) posterior setae on that ramus.

Ecology and distribution. This species inhabits a wide range of habitats, such as lakes, reservoirs, artificial dam lakes, pools, ponds, rice fields, and rivers (see below). The species colonises permanent and temporary water bodies and tolerates a slight increase in salt content (Valls et al. 2013, Scharf et al. 2014b).

Table 4. Samples collected previously to 2022 from the Grande Camargue and two sites elsewhere in southern France (leg. A.T., id. C.M.). Dep, Department; ad., adult; ovig., ovigerous; L, length of carapace; SE, southeast.

Locality and date	Geographical coordinates	Type of habitat	Species	Number of individuals
Camargue, south of Arles, 9/05/1990	43°37'38" N 4°35'56" E	Rice field	*Heterocypris incongruens*	29 ♀♀ (5 ovig., 24 juv.)
Camargue, Petit Badon, 21/05/1997	43°27'00" N 4°41'04" E	Rice field	*Heterocypris incongruens*	2 ♀♀ juv.; 1 ad. empty carapace
Camargue, near Le Sambuc, SE of Arles, 19/05/2003	43°31'30" N 4°42'22" E	Rice field	*Heterocypris incongruens*	54 ♀♀(30 ovig., 24 juv.)
			Dolerocypris sinensis	10 ♀♀ (9. subad., 1 juv.)
			Cypridopsis vidua	1 ♀ ad.
			Cypridopsis vidua f. *obesa*	3 ♀♀ ad., L=0.73-0.78 mm
Dep. of Bouches-du-Rhône, Bayeux, 14/03/2009	43°30'00" N 5°30'55" E	Brook	*Candonocypris novaezelandiae*	1 ♀ ad.
Dep. of Gard, Valliguières, Natura 2000 zone, 25/01/2009	44°0'42.0" N 4°35'40.9" E	Pond	*Candonocypris novaezelandiae*	2 ♀♀ ad.
			Eucypris virens	2 ♀♀ ad.

C. novaezelandiae has been recorded in Australia, including Tasmania, New Zealand, New Caledonia, China, Japan, South Africa, Tunisia, Egypt (reviewed in Valls et al. 2014, Scharf et al. 2014b), and Turkey (as *Candonocypris caledonica*; Yavuzatmaca et al. 2024). In Europe, Scharf et al. (2014b) mention records from Germany (eight sites in North Rhine-Westphalia and one site in Bremen), Belgium (a brackish lake), and the United Kingdom (specifically England, with a channel featuring fresh to slightly brackish water). Further European records are from Spain (rice fields and interdune ponds in the Albufera Natural Park; Valls et al. 2013, Bisquert-Ribes et al. 2023) and Italy, including Sicily (Pieri et al. 2020, Di Bella et al. 2020). Males of this species are exclusively known from Australia (De Deckker 1981, 1983, Chaplin 1992, Chaplin & Ayre 1989, 1993).

We agree with Valls et al. (2013) that the area of origin of this species is Australasia, as males are exclusively found there and the species is present in Pleistocene sediments there (Eagar 1995), but never in European Quaternary sediments (Griffiths 1995).

Morphological variation. Chaplin (1992) and Chaplin & Ayre (1993) reported the finding of two morphs of this species in Australia: a large, green morph and a small, brown morph (no precise sizes were given), with, however, individuals exhibiting intermediate characters. Our specimens have carapaces with lengths of 1.75-1.93 mm; their carapaces were green.

We confirm the presence, first illustrated by Valls et al. (2013) and more recently by Scharf et al. (2014b), of a row of small pustules on the posteroventral inner list of the LV of our specimens (not illustrated here). This might be a diagnostic feature of the species.

Cypris granulata Daday, 1898 **(**Fig. 4C-E)

1840 *Cypris subglobosa* n. sp. Sowerby: pl. 47: 3. (Fossil species).
1859 *Cypris subglobosa* Sowerby, 1840 – Baird: 232; pl. 63: 2. (Extant species).
1886 *Chlamydotheca subglobosa* (Sowerby, 1840) nov. comb. Brady: 300; pl. 38: 24-27a. (Extant species).
1898 *Cypris granulata* n. sp. Daday: 73; fig. 36a-f. (Extant species).
1906 *Eurycypris subglobosa* (Sowerby, 1840) nov. comb. Vávra: 420; pl. 24: 9-13. (Extant species).

One single empty female carapace of this species was found in a sample from an inflow to a rice field (site 8; Table 2). The species is new to the Camargue s.l. and France in general.

Ecology and distribution. C. granulata is distributed worldwide, primarily in tropical and subtropical regions, extending into warm-temperate areas. The species has been reported from both permanent and temporary water bodies, particularly from oxbow lakes, reservoirs, ponds, springs, rivers, canals, irrigation ditches, and rice fields (Broodbakker 1983, Boix et al. 2005, Valls et al. 2014, Savatenalinton & Suttajit 2016). For a review of the occurrence of the species in rice fields, see Smith et al. (2018). The males of *C. granulata* remain unknown.

The European records of this species are from rice fields and nearby waters in North Macedonia (Petkovski 1964), Spain (Baltanás 1992, Baltanás et al. 1996, Valls et al. 2014), Portugal (Baltanás et al. 1996), and now the Camargue s.l. in southern France.

Taxonomic history. This species was first described by Baird (1859) from specimens collected in freshwater pools at Nagpur in central India; the author believed his animals to belong to *Cypris subglobosa* Sowerby, 1840, a similarly looking fossil species retrieved from Cretaceous sediments in India. Most of the subsequent authors followed this view, and so even up to very recently (e.g., Bronstein 1947, Triebel 1961, Petkovski 1964, Neale 1976, 1977, 1984, Victor & Fernando 1982, Baltanás et al. 1996, Petkovski & Meisch 1996, Poquet et al. 2007, Yu et al. 2009, Karanovic 2012, Valls et al. 2014, Savatenalinton & Suttajit 2016, Savatenalinton 2017, 2018, Castillo-Escrivà et al. 2023). Whatley et al. (2003) recognised that the fossil *subglobosa* from the Cretaceous is not conspecific with the modern form and (a) concluded that the extant species should be renamed later, and (b) reassigned the Cretaceous (and possibly Palaeocene) fossil species to the genus *Paracypretta* Sars, 1924: *Paracypretta subglobosa* (Sow-

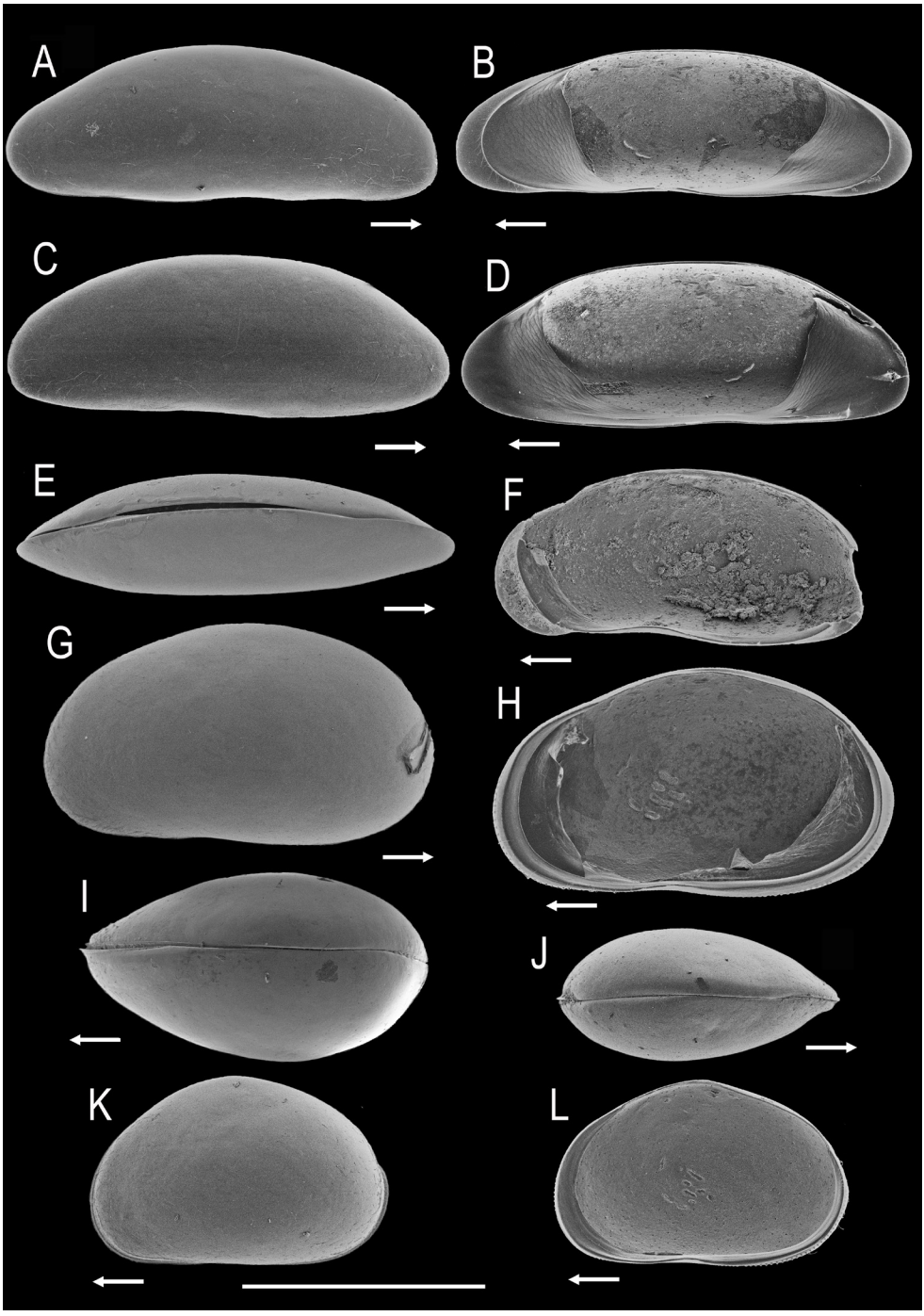


Fig. 3. ***Dolerocypris sinensis*** Sars, 1903, A-D ♀. **A:** RV ext.; **B:** RV int.; **C:** LV ext.; **D:** RV int.; **E:** Carapace in inclined dorsal view. ***Candonocypris novaezelandiae*** (Baird, 1843), ♀. **F:**. RV int. ***Heterocypris incongruens*** (Ramdohr, 1808), G-H ♀. **G:** LV ext.; **H:** RV int.; **I:** Carapace in dorsal view. ***Heterocypris salina*** (Brady, 1868), J-L ♀. **J:** Carapace in dorsal view; **K:** LV ext.; **L:** RV int. Scale bar: 1.0 mm. Arrows point to the anterior in all the SEM images.

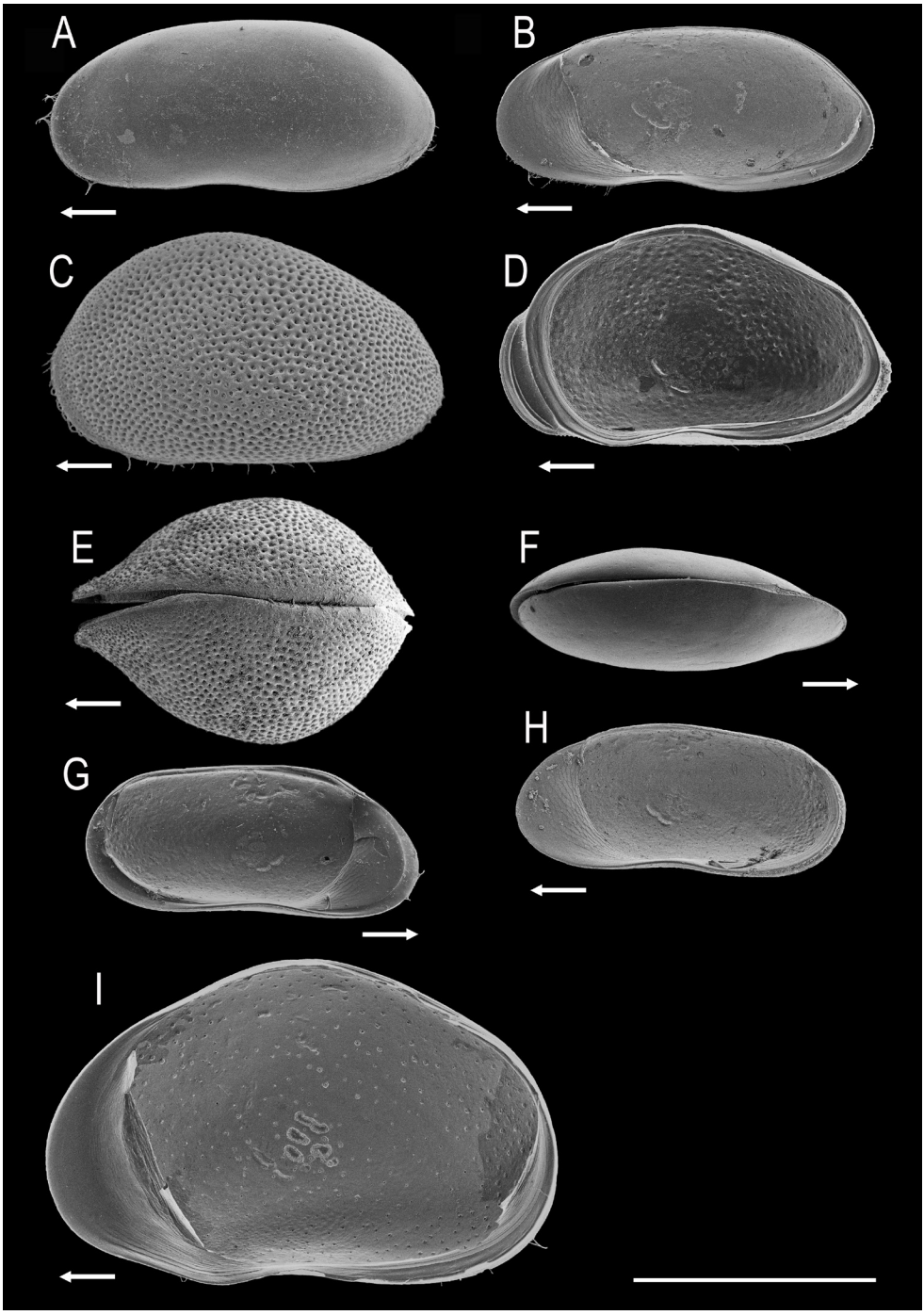


Fig. 4. ***Stenocypris major*** (Baird, 1859), A-B ♀. **A:** LV ext.; **B:** RV int. ***Cypris granulata*** Daday, 1898, C-E ♀. **C:** LV ext.; **D:** RV int. **E:** Carapace in dorsal view (animal from China). ***Ilyodromus viridulus*** (Brady, 1886), F-H ♀. **F:** Carapace in dorsal view; **G:** LV int.; **H:** RV int. ***Eucypris virens*** (Jurine, 1820), ♀. **I:** RV int. Scale bar: 1.0 mm.

erby, 1840) Whatley et al., 2003. However, all the mentioned authors were unaware that the modern species had been described as *Cypris granulata* Daday, 1898 from Ceylon (Sri Lanka). Relying on the examination of Daday's (1898) type material of *C. granulata*, Klie (1932) was the first to recognise that the extant specimens assigned to *C. subglobosa* are conspecific with Daday's *C. granulata*. The synonymy was confirmed by Martens & Toguebaye (1985, with a list of all published records of the modern species), Smith et al. (2011), and Meisch et al. (2019, 2024).

For descriptions and illustrations of *C. granulata*, see Triebel (1961), Okubo (1972, 2004), Neale (1976), Martens (1990), and Fig. 4C-E herein.

Ilyodromus viridulus (Brady, 1886) (Fig. 4F-H)

1886 C*ypris viridula* n. sp. Brady: 88; pl. 8: 1-2.
1889 *Herpetocypris viridula* (Brady, 1886) nov. comb. G.O. Sars: 41; pl. 2: 3-4; pl. 5: 8-11.
1896 *Ilyodromus viridulus* (Brady, 1886) nov. comb. G.O. Sars: 56.

Our sample of this species was collected from an inflow to a rice field (site 8, Tables 1 and 2). It comprises several empty female carapaces and valves. *I. viridulus* is new to the Camargue s.l. and France in general.

Ecology and distribution. This species was first reported from ponds in Australia (Brady 1886) and has been repeatedly reported from there more recently (e.g., De Deckker 1981, 1982, review in Shearn et al. 2014). *Ilyodromus viridulus* was not found outside that continent until it was discovered in Italian rice fields (Moroni 1961; Fox 1965; McKenzie & Moroni 1986; reviews in Rossi et al. 2003 and Pieri et al. 2015). Elsewhere in Europe, it is known from North Macedonia (Petkovski & Meisch 1995), Portugal (Baltanás et al. 1996, review in Fernandes Martins et al. 2010), and now southern France. The species has not yet been recorded from rice fields in Spain, but it is likely to occur there. Elsewhere, the species has only been recorded from South Africa – where it has repeatedly been found co-occurring with *Candonocypris novaezelandiae* (Martens et al. 1996, Namiotko et al. 2023) – and, most recently, from New Caledonia (Higuti & Martens 2024). The males of this species remain unknown.

Taxonomic remark. The specific identification of our specimens relies on the descriptions and illustrations presented by Petkovski & Meisch (1995) and, above all, Shearn et al. (2014). The valves of our individuals appear smooth (Fig. 4F), while those illustrated from North Macedonia show a very delicate striation (Petkovski & Meisch 1995: Fig. 5D). It is, indeed, known that on the valves of part of the individuals of *I. viridulus* striations are visible anteriorly and posteriorly, and that, more rarely, the valves are finely striated on their entire surface (De Deckker 1981). For distinction of the 18 known species of the genus *Ilyodromus,* see Shearn et al. (2014).

Bradleytriebella spinulosa (Akatova, 1958) **nov. comb.** (Fig. 6A-G)

1941 *Strandesia spinulosa* n. sp. Muhamediev (nom. nudum).
1958 *Strandesia spinulosa* Bronstein (in litt.) n. sp. Akatova: 37; fig. 1.
1964 *Strandesia tuberculata* n. sp. Hartmann: 118; figs 50a-b, 51a-e.
1985 *Strandesia antetuberculata* Hartmann & Petersen nom. nov. pro *S. tuberculata* Hartmann, 1964 nec Sharpe, 1908: 267.
2009a *Bradleytriebella tuberculata* (Hartmann, 1964) nov. comb. Savatenalinton & Martens: 32; figs 27-29.

Our material comprises 124 female living individuals of this species collected from two rice fields and one adjacent water body (sites 8, 9 and 10, Tables 1 and 2). *B. spinulosa* is easily recognised through two more or less conspicuous tubercles – best seen in dorsal view (Fig. 6A-C) – sitting slightly below mid-height close to each valve's anterior and posterior margins. *B. spinulosa* is new to the Camargue and France in general. The males of this species remain unknown.

Ecology and distribution. In Europe, the species is so far exclusively known from rice fields in Italy (Fox 1965, McKenzie & Moroni 1986, Rossi et al. 2003, Gherardi et al. 2008; review in Pieri et al. 2015), North Macedonia (Petkovski & Meisch 1996), and now the Camargue in France. We expect the

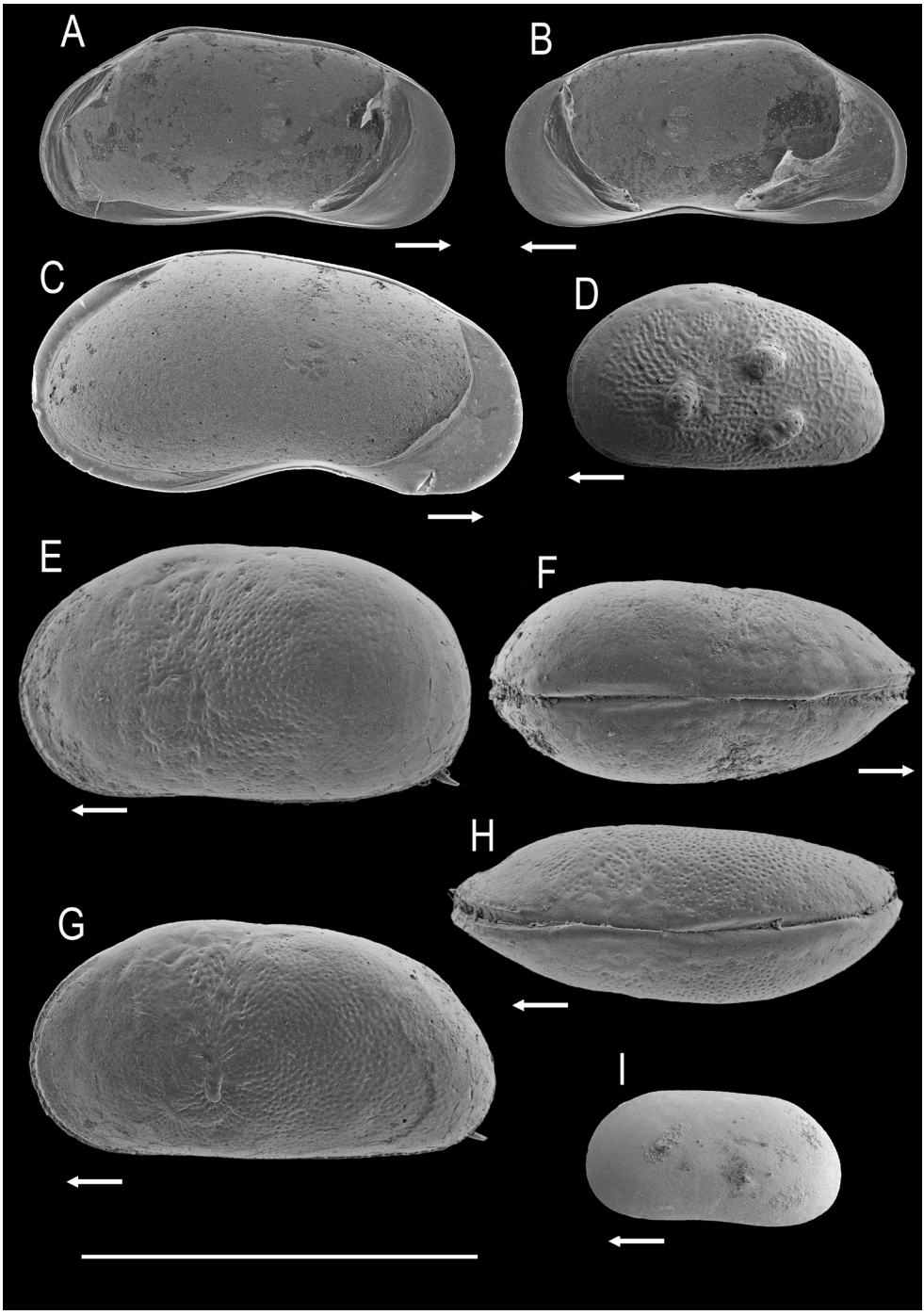


Fig. 5. ***Fabaeformiscandona fabaeformis*** (Fischer, 1851), A-C. **A:** ♀, LV int.; **B:** ♀, RV int.; **C:** ♂, LV int. ***Cyprideis torosa*** (Jones, 1850), D-H. **D:** juv. LV ext.; **E:** ad. ♀, LV ext.; **F:** ad. ♀, carapace in dorsal view; **G:** ad. ♂, LV ext.; **H:** ad. ♂, carapace in dorsal view. ***Neglecandona*** cf. ***neglecta*** (Sars, 1887), **I:** Juv., LV ext. Scale bar: 0.5 mm.

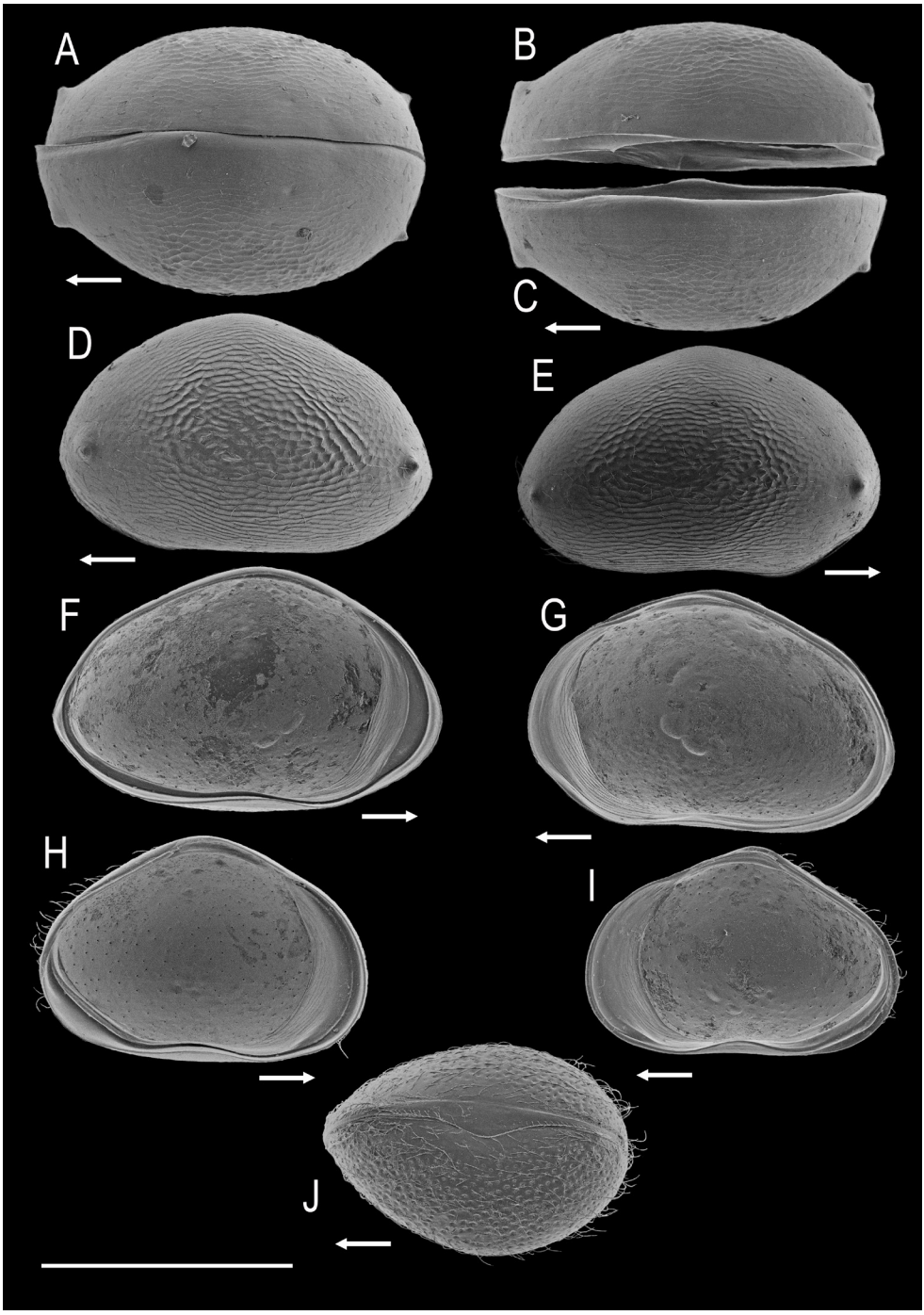


Fig. 6. ***Bradleytriebella spinulosa*** (Akatova, 1958) **nov. comb.,** A-G ♀. **A:** Carapace in dorsal view; **B** and **C:** LV and RV in ventral view; **D:** LV ext.; **E:** RV ext.; **F:** LV int.; **G:** RV int. ***Cypridopsis vidua*** (O.F. Müller, 1776)**,** H-J ♀. **H:** LV int.; **I:** RV int.; **J:** Carapace in ventral view. Scale bar: 0.5 mm.

species to be found elsewhere in European rice fields in the future.

Outside Europe, too, the species is almost exclusively known from rice fields in Asia, specifically in Uzbekistan, Tajikistan, Japan, and Thailand (as *Strandesia spinulosa* and *Bradleytriebella tuberculata*, respectively; reviewed in Smith et al. 2018; Smith & Chang 2022). The only other known habitat is a ditch in the province of Sikkim in northern India (Hartmann 1964, as *Strandesia tuberculata*). *B. spinulosa* is unknown in Africa, Australia, and the Americas (Meisch et al. 2024).

Taxonomic history. This species was first recorded by Muhamediev (1941) – the specific identification was by Z.S. Bronstein, but without any accompanying description, hence as a *nomen nudum* – from rice fields in Uzbekistan. Akatova (1958) described the species as '*Strandesia spinulosa* Bronstein (in litt.) sp. n.' from both her material collected from rice fields in Tadjikistan and the unpublished notes and drawings of the species by the then late Z.S. Bronstein, thus introducing *spinulosa* as a taxonomically valid name. Muhamediev (1959) presented indications on the ecology and life history of the species in Uzbekistan.

Upon comparing Hartmann's (1964) description of *Strandesia tuberculata* collected from a ditch in the Indian province of Sikkim with the descriptions of *S. spinulosa*, we agree with Karanovic (2005), who proposed the two forms to be conspecific. In addition to the similarity of the structure of both the carapace and appendages, the specific identity is supported by the fact that Hartmann (1964) obviously was unaware of the previous description of *S. spinulosa*: Hartmann (op. cit.), indeed, compared his new species *tuberculata* with three other species of *Strandesia,* but not with *S. spinulosa*.

More recently, Savatenalinton & Martens (2009a) designated *Strandesia tuberculata* Hartmann, 1964 as the type species of their newly erected genus *Bradleytriebella*. The synonymy of *S. tuberculata* with *Strandesia spinulosa* entails the transfer, which is here proposed, of *spinulosa* to the genus *Bradleytriebella*: *Bradleytriebella spinulosa* nov. comb. The new combination renders the name *Strandesia antetuberculata,* introduced as a nom. nov. by Hartmann & Petersen (1985), obsolete (see list of synonyms above).

3.3. Notes on two alien species previously known from the Camargue (see Table 5)

Bradleycypris vittata (Sars, 1903)

1903 *Cypris* (*Strandesia*) *vittata* n. sp. Sars: 5; pl. 2: 3a-c.
1912 *Strandesia vittata* (Sars) nov. comb. G.W. Müller: 190.
2009a *Bradleycypris vittata* (Sars) nov. comb. Savatenalinton & Martens: 3.

This species was recorded from temporary waters of the Grande Camargue by Stéger (1972, 1979, as *Strandesia vittata*), where she mentioned it to be rare. Meisch et al. (1990: 11) considered the identification erroneous and assigned the record to the somewhat morphologically similar *Bradleystrandesia fuscata* (Jurine, 1820). Although this view is not adopted here, we believe that the occurrence of this species in the Camargue requires confirmation. It should be noticed that up to the 2000s *B. vittata* was poorly known and difficult to identify, with detailed redescriptions of the species being provided only more recently (Savatenalinton & Martens 2010, Zhai & Zhao 2014, Ma & Yu 2018, Smith et al. 2024). *B. vittata* is widely distributed in Asia, where it is found in rivers, ponds, lakes, swamps, and rice fields (reviews in Savatenalinton & Suttajit 2016 and Smith et al. 2024). There is one recent European record of the species from Serbia (Pokrajac et al. 2024).

Strandesia reticulata (Daday, 1898)

1898 *Cypricercus reticulatus* n. sp. Daday: 75; figs 37-38.
1912 *Strandesia reticulata* nov. comb. G.W. Müller: 191.

This species was first discovered in Sri Lanka (Ceylon; Daday 1898) and later recorded from Java (Tressler 1937). However, it has since then not been recorded in Southeast Asia or Asia in general (Savatenalinton 2015). The species was then repeatedly reported in North America (review

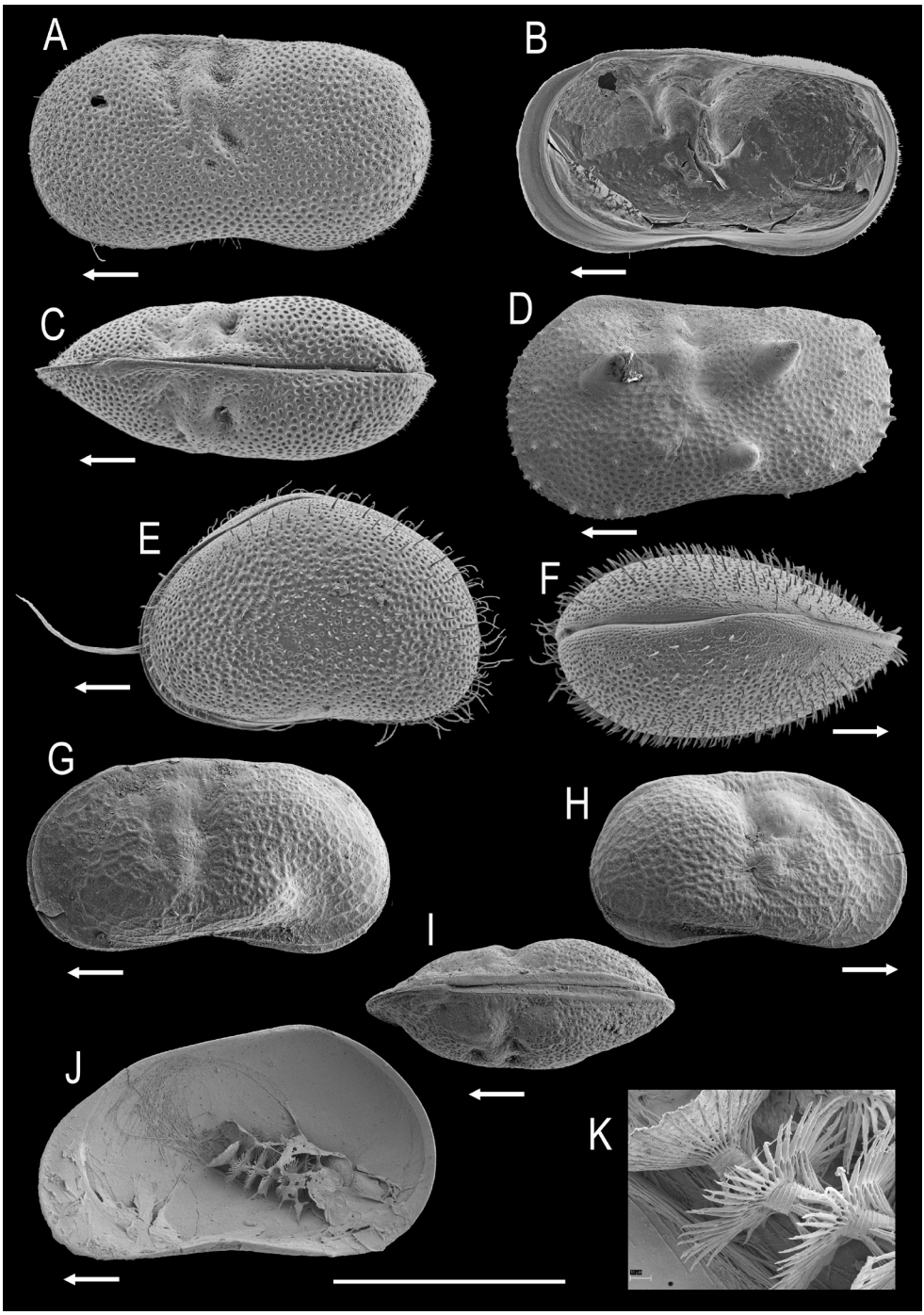


Fig. 7. ***Ilyocypris gibba*** f. ***biplicata*** (Koch, 1838), A-C ♀. **A:** LV ext.; **B:** RV int.; **C:** Carapace in dorsal view. ***Ilyocypris gibba*** f. ***gibba*** (Ramdohr, 1808), ♀, **D:** LV ext. ***Sarscypridopsis aculeata*** (Costa, 1847), E-F ♀. **E:** Carapace in lateral view; **F:** Carapace in dorsal view. ***Limnocythere inopinata*** (Baird, 1843), G-I ♀. **G:** LV ext.; **H:** RV ext.; I: Carapace in dorsal view. ***Pseudocandona marchica*** Hartwig, 1899, J-K ♂. **J:** RV int.; **K:** detail of Zenker organ. Scale bar: 0.5 mm.

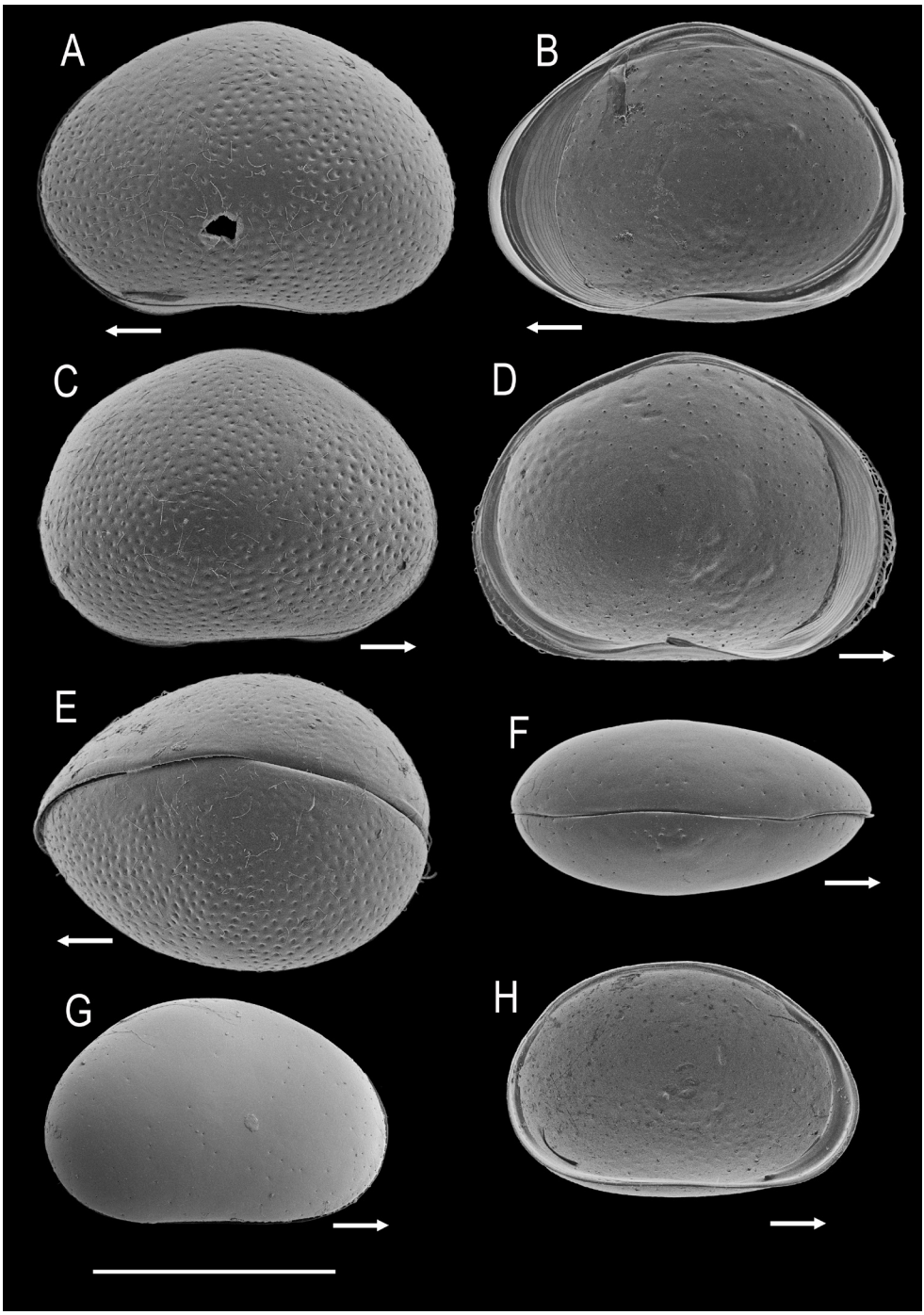


Fig. 8. ***Cypretta seurati*** Gauthier, 1929, A-E ♀. **A:** LV ext.; **B:** RV int.; **C:** RV ext.; **D:** LV int.; **E:** Carapace in inclined dorsal view. ***Physocypria kraepelini*** G.W. Müller, 1903, sex not identified, F-H. **F:** Carapace in dorsal view; **G:** RV ext.; **H:** LV int. Scale bar: 0.5 mm.

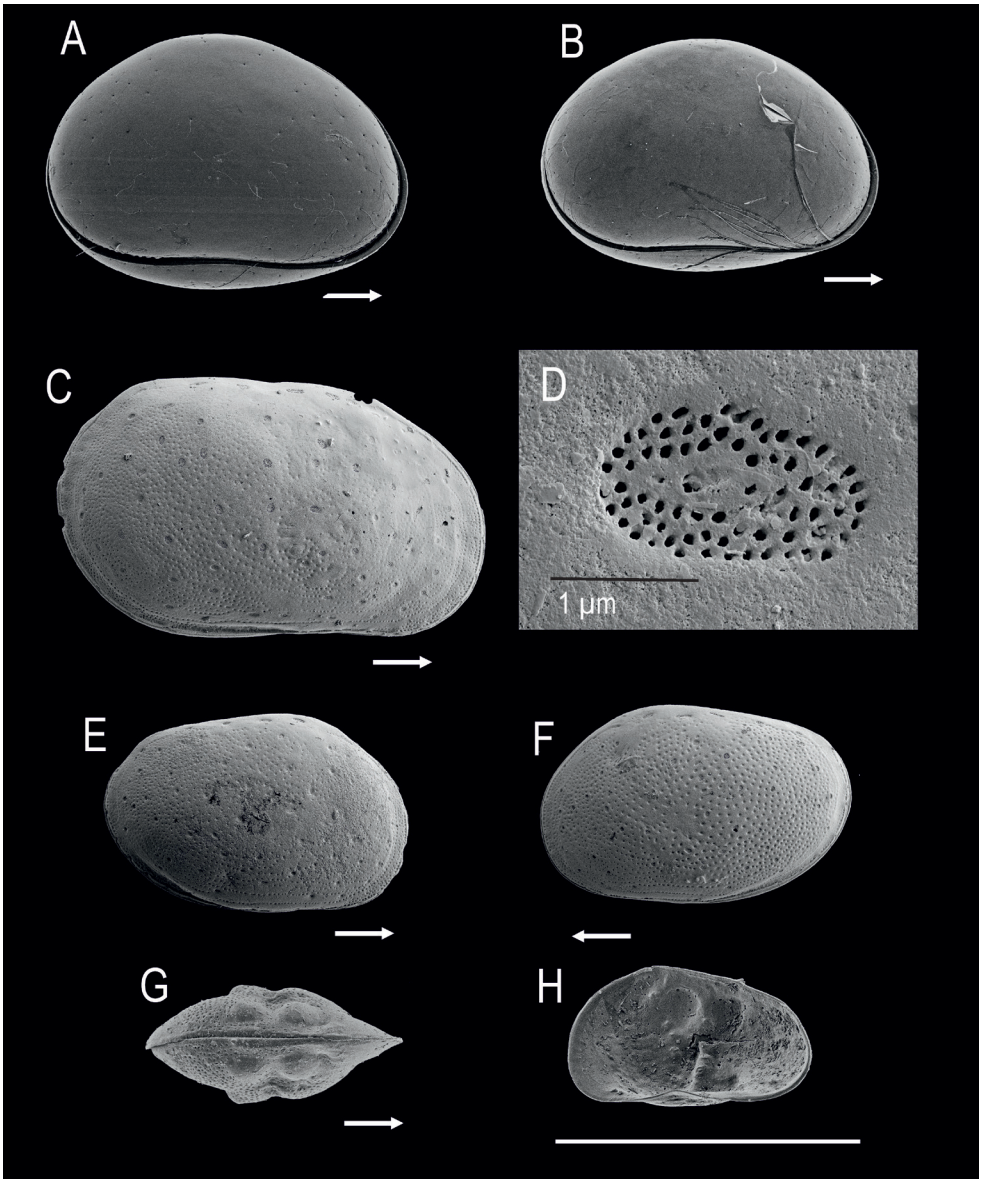


Fig. 9. ***Physocypria kraepelini*** G.W. Müller, 1903, sex not identified. **A-B:** two carapaces in lateral inclined view. ***Loxoconcha elliptica*** Brady, 1868, sex not identified, C-F. **C:** ad. RV ext.; **D:** detail of sieve pores; **E:** juv. RV, ext.; **F:** juv. LV, ext. ***Limnocythere stationis*** Vávra, 1891, G-H ♀. **G:** Carapace in dorsal view; **H:** RV int. Scale bar: 0.5 mm.

in Tressler 1947, Delorme 1967), without detailed taxonomic indications. The examination of the literature by C.M. showed that all the American records listed by Tressler (1947) and Delorme (1967) are based on mistakes due to the confusion of *Eucypris reticulata* (Zaddach, 1844) – now *Bradleystrandesia reticulata* (Zaddach, 1844) – with *Cypricercus reticulatus* (Daday, 1898), now *Strandesia reticulata* (Daday, 1898). The American records of Daday's species have therefore to be cancelled.

This species has been repeatedly reported from temporary waters, including rice fields, in Italy (Ghetti & McKenzie 1981; review in

Pieri et al. 2015). These records, however, were later considered misidentifications, as McKenzie & Moroni (1986) and Rossi et al. (2003) omitted *S. reticulata* (Daday) from their revised lists of ostracods from Italian rice fields. Pont (1977) reported the finding of *Strandesia reticulata* (Daday, 1898) from the Camargue, without any taxonomic indications and illustrations. Meisch et al. (1990) considered the latter record doubtful, a view also adopted here.

Finally, it should be noticed that Savatenalinton & Martens (2009b), upon redescribing *Strandesia mercatorum* (Vávra, 1895), the type species of the genus, list *Strandesia reticulata* (Daday, 1898) as a species with an uncertain position in the genus. *S. reticulata* needs to be redescribed, as best based on Daday's (1898) abundant type material of the species deposited in the Hungarian Natural History Museum (Forró et al. 1987).

4. Discussion

1. The following questions arise about the four exotic (or alien) ostracod species recorded herein as new to the Camargue s.l. and France in general:

(a) Did these species arrive recently?
None of them had been recorded in the Camargue before our two-day sampling trip in July 2022. They were indeed absent from all previously published collections, including those compiled during the extensive research conducted as part of the doctoral theses by Schachter (1950, 1960) and Stéger (1972, 1979), who respectively listed 6 and 20 species of non-marine ostracods.

For the species that appear to be strictly linked to rice fields and adjacent waters in Europe, it seems reasonable to admit that they were introduced with rice seeds and/or plants in these countries. This is the case for *Cypris granulata, Bradleytriebella spinulosa*, and *Ilyodromus viridulus*, which are so far exclusively known from that type of habitat in North Macedonia, Italy, Spain, and now the Camargue (see above).

This suggests that these species were introduced in Europe along with rice seeds or plants in the second half of the 20th century. The three species are unknown north of the circum-Mediterranean regions, where they probably reach their northernmost European distribution.

In contrast, *Candonocypris novaezelandiae* has a widespread distribution throughout western Europe, from the circum-Mediterranean areas to southern Britain (see the species note above). The earliest European record of living individuals of this species dates back to 1993 in Germany (Scharf et al. 2014b; for more recent European records, see above). The known European records suggest that this species was passively introduced to Europe in the second half of the 20th century, possibly by birds migrating via North Africa, where it is known to occur in Egypt and Tunisia (Yousef 2010, Scharf et al. 2014b). *C. novaezelandiae*'s relatively wide ecological tolerance probably explains its relatively rapid dispersion throughout Europe.

(b) Are they (potential) invasive species?
The small number of individuals of each of the four exotic species captured during our 2022 field trip (Table 2) does not suggest that they are invasive in the Camargue. However, further research in this area is needed to confirm this.

2. Individuals of six species of ostracods emerged from the dry mud collected from sites 2 and 3 (Tables 2 and 4) three weeks after hydration in Bremen: *Eucypris virens, Cypridopsis vidua, Heterocypris incongruens, Ilyocypris gibba* forma *biplicata*, *Sarscypridopsis aculeata,* and *Limnocythere inopinata*. The three-week interval suggests that the animals, represented by females only, hatched from egg banks, rather than from living dormant specimens (e.g., Rossi et al. 2004 for *H. incongruens*; Vandekerkhove et al. 2013 for *E. virens*).

3. The checklist of the non-marine ostracods of the Grand delta du Rhône presently comprises 44 non-marine species (Table 5). Besides the four exotic species mentioned above, our samples include five species new to the Camargue s.l. (Table 5): *Fabaeformiscandona fabaeformis, Physocypria kraepelini,*

Limnocythere inopinata, Limnocythere stationis, and *Cypretta seurati*. The discovery of the first four species is not a surprise, as they are widespread in European waters (Meisch 2000), while *Cypretta seurati* is known, among other locations, from around the Mediterranean Sea (e.g., Pieri et al. 2015, Castillo-Escrivà et al. 2023). These new records obtained from a 2-day sampling activity indicate that the non-marine ostracod fauna of the Camargue s.l. is still incompletely known.

Table 5. Checklist of the non-marine Ostracoda recorded from the Grand delta du Rhône. The list is based on the review in Meisch et al. (1990; here completed with Bodergat 1983), as well as subsequent publications (Bodergat et al. 1991; Marmonier & Creuzé des Châteliers 1992; Brochet et al. 2010; Ruiz et al. 2013), and the species recorded during the present study. *Paralimnocythere psammophila* from Petite Camargue by Brochet et al. (2010) was listed as *P.* cf. *psammophila* by the authors. Species new to the Camargue s.l. are marked with *, and those new to France are in bold.

TAXA	Grande Camargue	Petite Camargue	Plan du Bourg
Darwinulidae Brady & Robertson, 1885			
Darwinula stevensoni (Brady & Robertson, 1870)		X	
Candonidae Kaufmann, 1900			
Candona candida (O.F. Müller, 1776)	X		
Neglecandona neglecta (Sars, 1887)	X		X
* *Fabaeformiscandona fabaeformis* (Fischer, 1851)	X		
Pseudocandona albicans (Brady, 1864)	X	X	
Pseudocandona marchica (Hartwig, 1899)	X		
Pseudocandona lobipes (Hartwig, 1900)	X		
Cyclocyprididae Kaufmann, 1900			
Cypria ophtalmica (Jurine, 1820)	X		
* *Physocypria kraepelini* G.W. Müller, 1903	X		
Cyclocypris ovum (Jurine, 1820)		X	
Ilyocyprididae Kaufmann, 1900			
Ilyocypris bradyi Sars, 1890	X		
Ilyocypris gibba (Ramdohr, 1808) Syn.: *Ilyocypris biplicata* (Koch, 1838)	X		
Notodromadidae Kaufman, 1900			
Notodromas persica Gurney, 1921	X		
Cyprididae: Cyprettinae Hartmann, 1963			
* *Cypretta seurati* Gauthier, 1929	X		
Cyprididae: Cypricercinae McKenzie, 1971			
Bradleycypris vittata (Sars, 1903)	X		
* ***Bradleytriebella spinulosa* (Akatova, 1958)**	X		
Strandesia bicuspis (Claus, 1892)	X		
Strandesia reticulata (Daday, 1898) Dubious record	X		
Cyprididae: Cypridinae Baird, 1845			
Cypris bispinosa Lucas, 1849	X		X

Table 5 (continued).

TAXA	Grande Camargue	Petite Camargue	Plan du Bourg
* ***Cypris granulata* Daday, 1898**	X		
Cyprididae: Cypridopsinae Kaufmann, 1900			
Cypridopsis hartwigi G.W. Müller, 1900	X		
Cypridopsis vidua (O.F. Müller, 1776) Syn.: *Cypridopsis parva* G.W. Müller, 1900	X		
Potamocypris mastigophora Methuen, 1910 Syn.: *Potamocypris producta* (Sars, 1924) Syn.: *Potamocypris reniformis* (Brady, 1907)	X		
Potamocypris variegata (Brady & Norman, 1889)	X	X	
Sarscypridopsis aculeata (Costa, 1847)	X		
Cyprididae: Cyprinotinae Bronstein, 1947			
Heterocypris barbara (Gauthier & Brehm, 1928)	X		
Heterocypris incongruens (Ramdohr, 1808)	X		
Heterocypris salina (Brady, 1868)	X		
Cyprididae: Dolerocypridinae Triebel, 1961			
Dolerocypris sinensis Sars, 1903	X		
Cyprididae: Eucypridinae Bronstein, 1947			
Eucypris virens (Jurine, 1820)	X		X
Cyprididae: Herpetocypridinae Kaufmann, 1900			
* ***Candonocypris novaezelandiae* (Baird, 1843)**	X		
Herpetocypris chevreuxi (Sars, 1896)	X		
* ***Ilyodromus viridulus* (Brady, 1886)**	X		
Stenocypris major (Baird, 1859) Syn.: *Stenocypris malcolmsoni* (Brady, 1886)	X		
Cytheroidea: Cytherideidae Sars, 1925			
Cyprideis torosa (Jones 1850) Syn.: *Cyprideis littoralis* (Brady, 1870)	X	X	
Cytheroidea: Limnocytheridae Sars, 1925			
* *Limnocythere inopinata* (Baird, 1843)	X		
Limnocythere sanctipatricii (Brady & Robertson, 1869)	X	X	
* *Limnocythere stationis* Vávra, 1891	X		
Metacypris cordata Brady & Robertson, 1870	X		
Paralimnocythere psammophila (Flössner, 1965)	X	X (cf.)	
Cytheroidea: Loxoconchidae Sars, 1925			
Cytheromorpha fuscata (Brady, 1869)	X		
Loxoconcha elliptica Brady, 1868	X	X	
Loxoconcha rhomboidea (Fischer, 1855)	X		
Cytheroidea: Xestoleberididae Sars, 1928			
Xestoleberis aurantia (Baird, 1838)	X		

4. Specimens of all eight species reported herein from the Camargue rice fields (sites 9 and 10) consist of females only and are inferred to reproduce parthenogenetically. This number amounts to nine species out of twelve when both rice fields and adjacent waters are considered (sites 7-10) (see Tables 2, 3, and 4). The observation that parthenogenetic species dominate in rice fields agrees well with that of Smith et al. (2018).

5. *Eucypris virens* and *Heterocypris incongruens* are well known for their geographical parthenogenesis in Europe and North Africa, with (rare) bisexual populations in the south and exclusively all-female populations north of the Mediterranean areas (Meisch 2000, Symonova et al. 2018). Noticeably, no males of these two species were found in our material.

6. Though this goes beyond the scope of the present work, we would like to draw attention to the fact that research on ostracods in rice fields is valuable to ecology. Due to their abundance, these ostracods, and microcrustaceans in general, are an important component of rice-field ecosystems; they can influence rice growth and may act as invasive species that use rice fields as stepping stones for further spread (review in Zhai et al. 2024).

7. Rossi et al. (2003) noted that the number of ostracod species has decreased significantly over the past 30 years in Italian rice fields, which the authors attribute mainly to the increased use of pesticides. Rice in the Camargue is either grown without (25%) or with (75%) pesticides, mainly herbicides for weed control (Beaudouin 2024). As ostracods and the microcrustacean fauna in general are good proxies for the environmental impact of pesticides in rice fields (reviews in Simpson & Roger 1995, Roger 1996, Smith et al. 2018), and the connected aquatic habitats, we recommend further and more intensive studies comparing these two farming methods to document the influence of the pesticides on these animals. This would be especially important as Camargue rice farmers recently obtained permission to use the previously forbidden herbicide benzobicyclon to combat weeds (Beaudouin 2024).

5. Conclusions

1. Our 2022 sampling field trip in the Grande Camargue resulted in the collection of 21 species of non-marine ostracod species, of which four are considered exotic and new to the Grand delta du Rhône and France in general: *Bradleytriebella spinulosa* (Akatova, 1958) nov. comb., *Cypris granulata* (Daday, 1898), *Ilyodromus viridulus* (Brady, 1886), and *Candonocypris novaezelandiae* (Baird, 1843). The absence of records of these species in previous studies is best explained by their recent arrival with rice seeds or plants, and, for *Candonocypris novaezelandiae,* through passive transport on the plumage or feet of birds migrating from the south, most probably from North Africa, to the Camargue. Forty-four species of non-marine ostracods are presently known from the Grand delta du Rhône.

2. Six species of ostracods hatched from egg banks preserved in dry mud collected from two sites. No males of *Heterocypris incongruens* and *Eucypris virens*, two species with geographical parthenogenetic reproduction in Europe, were collected.

3. A new combination is introduced: *Bradleytriebella spinulosa* nov. comb.

4. Forty-four species of non-marine ostracods are presently known from the Grand delta du Rhône.

5. We recommend further, more intensive studies of the ostracods in rice fields and other aquatic habitats of the Camargue s.l. to document the environmental effects of pesticides used in rice farming on the aquatic fauna.

Acknowledgements

We are grateful to Monsieur Bernard Poujol, who accompanied us to his rice fields in the Camargue and explained his system of organic rice farming, which is remarkable thanks to the use of mallard ducks for weed control. We thank Dietmar Keyser and Elke Woelken (Museum der Natur—Zoologisches Museum Hamburg, Germany) for preparing part of the SEM figures. Koen Mar-

tens (Brussels) confirmed the identification of *Ilyodromus viridulus*. We thank Renate Matzke-Karasz and Dietmar Keyser for reviewing the manuscript and providing helpful comments that improved the manuscript.

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